Increase Physical Fitness and Create Health Awareness through Exergames and Gamification

The Role of Individual Factors, Motivation and Acceptance

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Abstract. Demographic change and the aging population push health and welfare system to its limits. Increased physical fitness and increased awareness for health issues will help elderly to live independently for longer and will thereby reduce the costs in the health care system. Exergames seem to be a promising solution for promoting physical fitness. Still, there is little evidence under what conditions Exergames will be accepted and used by elderly. To investigate promoting and hindering factors we conducted a user study with a prototype of an Exergame. We contrasted young vs. elderly players and investigated the role of gamer types, personality factors and technical expertise on the performance within the game and changes in the attitude towards individual health after the game. Surprisingly, performance within the game is not affected by performance motivation but by gamer type. More importantly, a universal positive effect on perceived pain is detected after the Exergame intervention.

Keywords: Exergame, Health Awareness, Design For All, Gamer types, Physical Fitness, User Acceptance, Gamification.

1 Introduction

Todays society is facing a tremendous demographic change that will push the health and welfare system to its limits. One central issue is the rising number of elderly and frail people that depend on the support of others. Currently, 3.2 jobholders support one elderly person. According to current projections this dependency ratio will fall by over 50% to 1.85 jobholders supporting one elderly person within the next 40 years. Furthermore, the share of elderly people being 80 years and older will rise from 5% in 2008 to 14% in 2060[1]. As these very old people demand special medical attention and increased support by others, this leads to additional stress in the health and welfare system in many societies. In

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order to keep the health-care system affordable, new and innovative approaches must be developed. One central goal should be to focus on prevention instead of treatment. Some preliminary results suggest that "Exergaming" – a combination of the words "Exercise" and "Gaming" – is a suitable tool to offer prevention instead of treatment by increasing physical and cognitive fitness of elderly [2,3].

Various Exergames exist in various different domains. However, only few of them are targeted at the growing population of elderly people. To build commercially successful and clinically useful Exergames the factors promoting or hindering the acceptance and usage of these games must be identified. To understand these factors we conducted a formal user study. Although focused on acceptance and performance aspects of Exergaming, we also investigated whether these games raise the awareness of the importance of individual health. In the following section we will very briefly review related work, in section 3 we will describe the Exergame we used in the study. The results of the study are presented in section 4, which is followed by a discussion of the findings in section 5. The paper concludes an outlook for subsequent research.

2 Related Work

Exergames seem to be a useful approach to meet the challenges raised by the threatening cost explosion in the care sector. By including people – especially the older ones – to keep physically fit, the demands for increased care costs and the shortcomings in the care personnel could be met.

The popularity of Exergames however is not only supporting the health status of persons, even though this is a key factor in this context. They also help to establish a health related behavior, an awareness of healthy living habits and a sensitivity of the individual responsibility to care for themselves, especially at older age[4]. This novel shift from former public care – which traditionally was mostly limited to health insurances and medical personnel – to individual care responsibility is an important step into a cognitive reframing of peoples mindset. Understanding health issues and the importance of prevention in combination with a playful approach increases the health motivation to promote bodily interaction to play the game.

The potential power of Exergames are based on old psychological principles, as e.g. performance feedback and rewards[5], self-control and self-efficacy[6], fun [7] and motivation principles, such as the Premack principle[8]. According to Premack the intrinsic motivation of humans can be harnessed by coupling a less desirable activity with more desirable activities. In the context of physical exercises and raising health awareness would be coupled with joyful activities such as playing a (computer-) game within an enjoyable setting.

Beyond these positive effects of games, the design process of Exergames also needs to consider some specifics of seniors. Beyond the well-known decrease in short-time memory, speed, executive functions and visual perception[9], it should be taken into account that older adults have an outdated understanding of technology and a reduced experience in using current technology[10]. Still it has been found that the interest in novel technology in older adults is high[11]. Contrary to young users, technology is not merely interesting because it is just novel, but technology interest in older seniors heavily depends on how useful technology is for them and how much the technology meets seniors high standards for aesthetic design and fun. The fear of being stigmatized by technology also influences seniors interest in technology[12].

There are limited valid psychometric instruments to describe people regarding their gaming preferences. One approach is the Bartle Player Type that origins from the analysis of massive multiplayer online games (MMOGs). The Bartle test was revised by Yee[13] and developed into a scale with the three main dimensions *Social*, *Achievement* and *Immersion* and 10 sub-dimensions that describe different gaming motives. People who score high on the social scale like to play games for building and maintaining relationships either within the game or outside to game. Achievers are driven understanding the game mechanics and optimizing their strategy accordingly, by competing against others or by advancing in a game and collecting money or resources. Players, who dive into a new role, customize their appearance and enjoy discovering new areas within a game score high on the Immersion scale.

Unknown in this regard is what motivational concepts can be leveraged to harness the desire to play an Exergame especially in regard to the very old.

3 Method

In this section we detail the methodology underlying this paper. First we describe the game "FruitSalad" which had been developed for this work. Then the experimental setup, the independent and dependent variables are outlined and the formation of the participant group and their characteristics are outlined.

3.1 Game Development

To investigate human factors affecting the acceptance of Exergames we first developed a prototypic game by using a participatory, user-centered and iterative design process. The game is similar to an already existing prototype "GrabApple" [14] that uses a Kinect sensor for detecting the users movements and also places the user inside a virtual garden to pick up apples from a tree. The difference between "GrabApple" and our custom-tailored "FruitSalad" lies in the target group. "GrabApple" is de-signed as a casual game to promote physical fitness, while "FruitSalad" explicitly targets elderly people and therefore focused on high contrast images, sounds that are perceivable even with hearing impairments and game play that leverages the cognitive abilities of the elderly. Also the "FruitSalad" game is – besides its gaming nature – designed as a tool in which different factors can be modified, varied and examined.

Regarding the development process, we started with a paper prototype and gathered feedback from potential users about the game concept and the visual appearance. As previous studies revealed that elderly users like games with a gardening theme[15], we designed a game in which fruits and vegetables had to be collected from trees and soil. The game starts with a brief introduction screen that explains how the in-game avatar is controlled and how the game can be paused at any given time by performing a specific gesture. For detecting the users body movements and performed gestures we used a Microsoft Kinect sensor. To allow the users to see themselves in the garden and to get direct feedback on their body movements and picking activities, the player is presented as a virtual avatar within a garden.

Currently the game consists of three consecutive levels: The first two are training levels for practicing the movements to grab a fruit from the tree (level 1) and to pick up a carrot from the soil (level 2). In the third level, the users have to pick up fruits and vegetables from both trees and soil (Fig. 1 shows an in-game screenshot (left) and a user playing the game during the study (right)).

Fig. 1. In-game screenshot of the game (left) and a user playing the game (right)

3.2 Experimental Setup

To understand what factors influence the liking of Serious Games for promoting body movements and task performance within Exergames we carried out a controlled experiment. Although the game supports serving multiple fruits and vegetables at the same time, we limited this to exactly one element at a given time and thereby reduced confounding effects in this study. Participants were instructed with a predefined script and were interviewed prior and after the experiment. For deriving hypotheses a research model with crucial factors had been formed (see Fig. 2). The independent and dependent variables are listed in the following.

Independent Variables. On the side of independent variables, we examined gender and age (contrasting a younger and an older group) as typical "carrier variables" which need to be detailed regarding other individual moderator variables. As moderation variables we surveyed the individual extent of performance motivation, gaming motivation and inclination towards games, technical expertise (usage frequency and perceived ease of use of technology) and technical

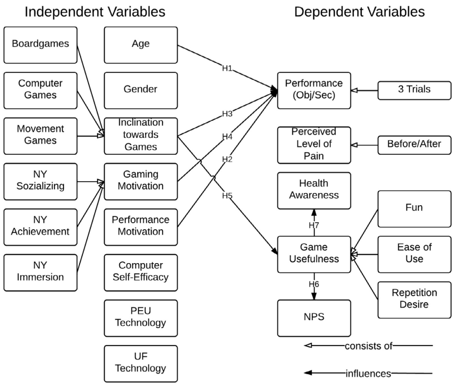

Fig. 2. Research model and Hypotheses. NY = Nick Yee Player Types, PEU = Perceived Ease of Use, UF = Usage Frequency, NPS = Net Promoter Score.

self-efficacy. Based on findings from previous studies we suspected that technical expertise influences task performance as well as liking of the developed game prototype. To validate this assumption we measured the technical expertise of the participants with three scales: First, the usage frequency of a set of technical devices (computers, TVs, . . .). Second, the perceived ease of use of these devices was assessed.. Third, the participants subjective technical expertise (STC)[16]. The latter scale consists of questions such as "I can solve many technical difficulties I encounter on my own". This scale is closely related to self-efficacy can explain difference in learnability, performance differences and differences in product liking [17,18]. Also, as individual attitudes towards gaming could impact the liking and performance, we assessed gamer types by a revised Bartle Player Types scale by Yee[13] and the inclination towards different game types in general. We measured performance motivation by a scale from Schuler[19].

Dependent Variables. As dependent variables we measured the task performance (seconds per object) for each of the three levels, the participants perceived pain level before and after the experiment and the evaluation of the games usefulness in terms of "easy to use", "fun" and "wish to play the game again". As an overall rating of the developed prototype we additionally inquired the Net Promoter Score (NPS)[20]. The single 10-level Likert scale asks how likely the user will recommend the game to its peers. While consisting of a single item, this scale can effectively predict the success of a product.

Hypotheses. We assumed that age had a negative effect on performance, as younger players are expected to have a higher fitness level (H1). We also expected that people with high performance motivation are more inclined to use Serious Games for increasing physical fitness than people with a lower performance motivation (H2). Furthermore both inclinations towards gaming in general (H3) as well as gaming motivation (H4) in particular should influence performance.

General inclination towards gaming should also affect the evaluation of the games usefulness (H5), which in turn should influence NPS (H6) and changes in health awareness (H7). Gender, technical expertise and changes in perceived level of pain are used as controlling variables (see Fig. 2).

3.3 Description of the Sample

In total 71 persons volunteered to take part. The age range was 20 to 86 years ($M = 48.3$; $SD = 21.6$). 50.3% of participants were female (36 females, $M_{female} = 48.2 years$; $SD_{female} = 20$; 35 males: $M_{male} = 48.5$; $SD_{male} = 23.7$). Overall, 30% reported to suffer from a chronic illness (mainly asthma and allergies, but also diabetes and cardiovascular diseases, which was found to increase with age ($r = 0.23$; $p = .057$). To investigate the age-related effects we partitioned the subjects by age in three distinct groups: Young ($< 30 years$, $n = 21$), middle ($30 - 65 years$, $n = 29$) and old ($> 65 years$, $n = 21$). Gender was equally distributed across the age groups ($\chi^2(2, N = 71) = 2.914$, $p = .233 > .05$).

3.4 Performance Motivation, Gamer Types, Inclination to Gaming

Performance motivation was equal across both genders ($F(1, 63) = .271, p = .605, n.s.$) and the three age groups ($F(2, 63) = .008, p = .992, n.s.$). We analyzed the interdependencies of the game preferences and the player types. While these scales correlate to a great extent ($r = .407$, $p < .01$), only limited dependencies between gender and age on these scales were found.

We found no significant gender effects on Bartles Achievement scale ($r = -.227$, $p = .063 < .1$, $n.s.$), Social scale ($r = -.071$, $p = .563, n.s.$) and the Immersion scale ($r = -.187$, $p = .112$, $n.s.$). Gender did also not affect the inclination towards classical board and card games ($r = .053$, $p = .660$, $n.s.$), computer games ($r = -.173$, $p = .149$, $n.s.$) and movement games, such as geocaching or sports ($r = -.194$, $p = .105$, $n.s.$).

Age did not affect the achievement ($r = -.127$, $p = .302$, $n.s.$) and social scale ($r = -.029$, $p = .812$, $n.s.$). However, with increasing age people were significantly less inclined to immerse into a game ($r = . - 239$, $p = .046 < .05$). With age the inclination towards board games seem to decrease ($r = -.214$, $p = .073 < .1$, $n.s.$). Liking of computer games decreases with age ($r = -.633$, $p < .001$). Also, movement games seem to be preferred more by the young than by the older ($r = -.386$, $p < .001$). The general, inclination towards games seem to decrease with age ($r = . - 386$, $p = .001 < .05$). It is an interesting finding that Bartles Achievement score and the performance motivation score did not correlate ($r = .000$ sic!), $p = .997$, $n = 67$) showing that both individual facets do measure independent constructs.

In summary, the young are more inclined than the old to play games in which they can immerse and which are either computer based or physical movement. Furthermore, the inclination towards gaming is independent of gender.

4 Results

This section is structured as follows. First, the effects of age and gender on task performance and evaluation of the usefulness of the game are reported. Then we describe the effects of the game playing on perceived physical fitness (comparing ratings before and after the study). Finally, we relate individual factors (technical expertise, performance motivation, health status) in order to understand the power of using of serious games in a health context.

4.1 Employed Statistical Tests

The data was analyzed using bivariate correlations, χ^2-tests, uni- and multivariate analyses of variance (ANOVA/MANOVA), multiple linear regressions, and repeated measure analysis. Type 1 error rate/significance level was set to $\alpha = .05$. (within the less restrictive level of $\alpha = .1$, findings are referred to as marginal significant). Type II error rates/power were set to $(1 - \beta) = .8$ (Power results are only reported if below this threshold). Pillais values were used for omnibus F-tests in the MANOVAs. Ordinal-scaled data were analyzed with the Wilcoxon Rank test and the Friedman test. Furthermore multiple linear regression analysis (enter method) was used. Predictors with low standardized beta values were removed between runs. F-Values and degrees of freedom are omitted, because all reported models explained more variance than respective scale means. Only significant predictors are used in the reported models. Models that show high inflation factors ($VIF >> 1$) are also not reported. Effect sizes are reported as Cohens d and as Pearsons r for non-parametric tests. Because parametric tests are robust against small violations in assumptions, non-parametric test are only used to verify the effects. In our case only slight changes in effects sizes could be reported when switching from parametric to non-parametric tests, and only if variances differed to a large extent. Missing values were deleted listwise on a per test basis. If a smaller sample is used for a test, sample size is reported.

4.2 Evaluation of the Game, Raising of Health Awareness

The participants of the user study evaluated the prototype very well. All participants (100%, $n = 70$) had no difficulties to control the in-game avatar and over 94% of the users ($n = 66$) stated that they had fun playing the game. Likewise, 78% of the participants stated that they would like to play the game again. The majority of the users stated that this Exergame would increase their motivation to exercise on a regular basis (27% of the users disagreed, while 72% agreed).

No significant gender ($n.s.$) or age ($n.s.$) differences were found regarding the aforementioned questions. Although no significant overall effect of age was found, we exploratory peeked into the relationship of age and game rating and carried out four one-way ANOVAs. These showed that age influences the perceived fun of the game ($F(2, 67) = 3.14$, $p = .049 < .05$) with elderly having more fun ($M = 4.8$) than the middle aged ($M = 4.3$) and young ($M = 4.0$) users. Also, the desire to play the game again depends on age ($F(2, 67) = 3.74$, $p = .029 < .05$), with elderly being more inclined to replay the game again ($M = 4.4$) than middle aged ($M = 3.6$) and young users ($M = 3.6$). No age differences showed up regarding the difficulty of the game ($n.s.$) and the motivation to exercise more often ($n.s.$). See Fig. 3 for details.

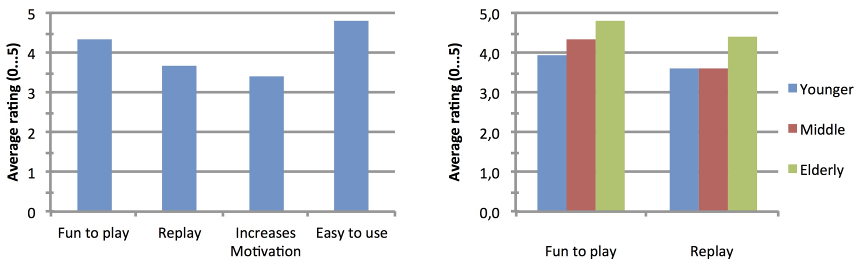

Fig. 3. Overall rating of the game and age differences in the rating of the game

4.3 Effects on Task Performance

Task performance in our study refers to the amount of apples and carrots participants could pick per second. Participants picked on average, 0.12 ($SD = .16$) apples per second in level 1 (stretching task), 0.16 ($SD = .26$) carrots per second in level 2 (bending task) and 0.22 ($SD = .37$) carrots and apples in level 3 (stretching and bending). The tasks were slightly different across the levels. Still, as level 1 and 2 are subsets of level 3, the performance is comparable and we found that the average task performance in level 3 is higher than in the previous levels ($F(2, 63) = 85.5$, $p < .05$).

In the first level task performance differs significantly between men and women ($F(169) = 4.17$, $p = .45 < .05$), with men being faster ($M = .18 objects/sec.$, $SD = .07$) than women ($M = .14 objects/sec.$, $SD = .06$).

As expected, age has a strong impact on task performance with younger participants being faster than older participants. On average young participants picked $M = 0.3$ ($SD = 1.16$) objects/sec. in level 3 of the game, whereas old participants were half as fast with $M = 0.15$ ($SD = .26$) objects/ sec. Participants from the middle-aged group scored $M = 0.26$ ($SD = .86$) objects/sec. The difference between the age groups is significant ($F(2, 68) = 12.87, p = .000 < .0$). A post-hoc test shows that the performance of the elderly differed significantly from both younger groups (see Fig. 4).

Gender did not affect learnability, but there was a marginal significant influence of age ($F(3, 63) = 2$, $p = .1$), showing that age groups did not learn equally fast. Though, as pictured in Figure 4, all age groups considerably increase their performance from the first trial (bending) to the last trial (mix).

There is a significant main effect of performance motivation on task performance in the first level ($F(1, 67) = 4.701$, $p = .034 < .05$). In the beginning (level 1) participants with low performance motivation were faster ($M_{low} = 0.16 objects/sec.$, $SD = .35$) than participants with high performance

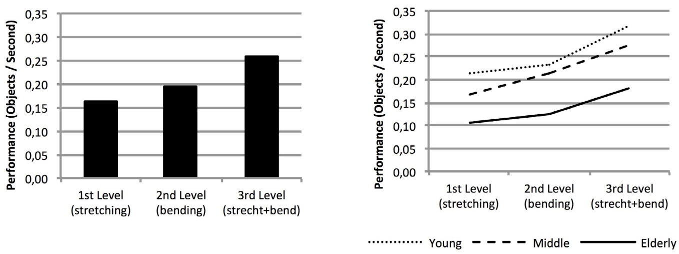

Fig. 4. Performance for the three levels (left). Performance increases with levels indicating learnability of the game. Performance increases differ for the age groups (right).

motivation ($M_{high} = 0.11 objects/sec.$, $SD = .16$), which is counter intuitive on a first sight. Though, this effect fades out after the first level. While participants with lower performance motivation are, on average, still faster than participants with high performance motivation, this effect is no longer significant for the second ($F(1, 66) = 2.334$, $p = .131 > .05$, $M_{low} = 0.18 obj/sec.$, $M_{high} = 0.15 obj/sec.$) and the third level ($F(1, 66) = 1.399$, $p = .241 > .05$) of the game ($M_{low} = 0.25 obj/sec.$, $M_{high} = 0.21 objects/sec.$).

When looking at correlational data for performance many variables influence performance. In particular age ($r = -.65$), computer self-efficacy ($r = .49$), Technology PEU ($r = .51$), Technology UF ($r = .26$), general inclination towards gaming ($r = .56$) and gaming motivation ($r = .31$) correlated significantly with performance (i.e. in level 3). Since almost all of these measures correlated with each other we first tried to disentangle their individual influences by running a linear regression on age.

Age is most strongly predicted with a double predictor model using both Technology PEU and UF explaining over 50% more variance (adjusted $r^2 = .50$) than the scale mean ($F(2, 54) = 29.53$, $p < .01$) with PEU being a four times stronger predictor (standardized slope = -.85) than UF (standardized slope = .26). Adding computer self-efficacy (CSE) to the model could only increase explained variance to 55%. Age seems to be a satisfactory explanation of the three concepts CSE, PEU and UF.

In order to understand what independent variables have the strongest impact on performance multiple linear regression analysis was performed using the enter method with the variables that showed an impact either in correlational or ANOVA analysis on performance. Each level was individually analyzed.

Interestingly, analysis of both initial levels (bend and stretch) showed that age alone was the strongest predictor for performance. In level 1 age showed a standardized slope (β) of -.6 ($B = -0.002$, $SEB = 0$, $t = -6.18$, $p < .01$, constant $B = 0.26$, $SEB = 0.016$, $t = 15.73$, $p < .01$). The model was able to predict 35% more variance (adjusted $r^2 = .35$) than the scale mean ($F(1, 69) = 38.14$, $p < .01$). No other predictor showed a similarly high rate of prediction. All models using more than one predictor were unable to increase the explained variance against the scale mean. For level 2 results were very similar (standardized slope

$\beta = -.59$, constant $B = 0.29$, $F(1, 68) = 35.89$, $p < .01$) with age being the only predictor explaining 34% more variance than the scale mean. For level 3 a two-predictor model was found to increase explained variance. Age and gaming motivation were able to explain 43% more variance (adjusted $r^2 = .43$) than the scale mean ($F(2, 64) = 25.67$, $p < .01$) with age being a twice as strong predictor as gaming motivation (see Tab. 1). Excitingly, performance motivation showed no influence in any linear regression.

Table 1. Linear Regression table for performance in Level 3

Model	B	SE B	β	t
(constant)	0.326	0.026		12.556**
Age	-0.002	0	-.593	-6.344**
Gaming Motivation	0.023	0.008	.254	2.714*

$* = p < .05$, $** = p < .01$.

4.4 Effects on Perceived Health Status (Pre-Post Comparison)

Using repeated measures analysis we found that perceived health status improved during the intervention. On a scale from 0 (no pain) to 4 (severe pain) the level of pain decreased significantly from $M = 0.69$ ($SD = .86$) to $M = 0.37$ ($SD = .75$) ($F(1, 64) = 19.186, p < .01$). Adding the age group into the repeated measures as a between subjects effect improves the model ($F(2, 63) = 3.859$, $p < .05$) showing that the decrease in level of pain is strongest in the oldest user group (see Fig. 5).

Since level of pain was highest in the old participants group multiple linear regression analysis was conducted to disentangle the effect of initial level of pain and age on the change between before and after the intervention. The change in level of pain could be predicted using a two-predictor model with both initial level of pain (before intervention) and age, explaining 32% more than the scale mean (adjusted $r^2 = .323$). The initial level of pain was twice as strong in predicting the change than age (see Table 2). This shows that the intervention is helpful to decrease the level of pain and in particular for the elderly.

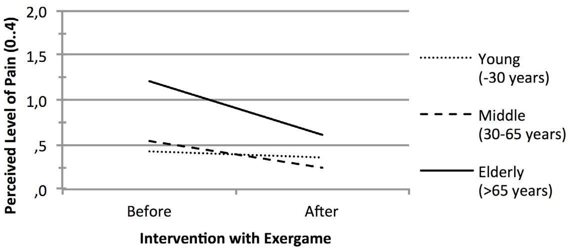

Fig. 5. Perceived Level of Pain for the three age groups before and after the intervention

Table 2. Linear regression table for change in level of pain

Model	B	SE B	β	t
(constant)	0.278	0.152		1.826*
Level of Pain (before)	-0.002	0	-.593	-3.87**
Age	-0.008	0.003	-.28	-2.563**

$* = p < .05$, $** = p < .01$.

4.5 Influence on Liking of the Game

Liking of the game differs significantly across the age groups ($F(2, 69) = 3.153$, $p = .049 < .05$). On average older adults like the game more (M = 4.75, SD = .71) than middle aged adults (M = 4.23, SD = 1.07) and young adults (M = 3.95, SD = 1.16). Furthermore, we found no significant difference between the group with low (M = 4.2, SD =1.1) and the group with high performance motivation (M = 4.4, SD = 1.0) ($F(1, 66) = .709$, $p = .403 > .05$) on liking of the game. Participants with high performance motivation are slightly more inclined to play the serious game again (M = 3.9, SD = 1.3) than participants with low performance motivation (M = 3.3, SD = 1.7). However, this difference is not significant ($F(1, 66) = 2.807, p = .099 > .05$). Regarding the recommendation score (NPS) both groups differ significantly ($F(1, 67) = 4.69$, $p = .034 < 0.05$). The participants with low performance motivation are less likely to recommend the serious game (M = 6.3, SD = 2.2) than the participants with high performance motivation (M = 7.4, SD = 1.8).

4.6 Qualitative Results

Most participants reported that they enjoyed playing the game. However, they criticized the premature ending of the game and they would have liked to play more levels. In contrast to many other studies several participants demanded to play the game again after the experiment had finished. We learned that the pause gesture used in the game (raising both arms horizontally) to pause and resume the game was found confusing for some users. The gesture was added to the game to allow users to rest for a few seconds without reducing their game score. We observed however, that the pause function was never triggered by intention, but that a few users triggered the function accidentally and repeatedly.

5 Discussion

We examined the usefulness of Exergames regarding their potential to increase physical activity and to decrease the level of physical strain by comparing the reported scores before and after the experiment. Assuming that fun and personal involvement increases participants overall motivation to play again, we assessed also the NPS score, thus the willingness of participants to recommend the prototype to its peers. This measure reflects the "intention to use" evaluation which had been originally used in Davis' technology acceptance model[21].

In order to understand, which individual characteristics might modulate not only the willingness and the effort to play, but also the performance level and the individual feeling after the experiment, we studied users of both gender in a wide age range (20-86 years of age) As psychometrically the performance motivation, the Bartles game typology, and the technical self-efficacy had been measured, we were able to relate these individual traits to performance and the evaluation of the general useful-ness of Exergames.

Recapitulating the main outcomes, results were very promising. Though performance level did reveal a significant effect of age (with a higher performance in the younger group), all age groups showed a significant increase in performance over the three game levels, thus showing a sustainable physical activity and an increasing motivation to optimize performance. The game was specifically designed for elderly, still it was unclear whether and to what extend elderly like the game. We assumed that only a share of the participants actually enjoy the game. Hence, an astounding finding it that most participants from the oldest age group reported fun during playing and willingness to play again. More so, the level of reported health strain/pain was reduced to the largest extent in the older groups, corroborating the appropriateness of the gaming approach also in the senior group.

The fact that we did not find a significant correlation between the levels of performance motivation (measuring the general willingness of individuals to engage for performance increase) and the Bartles gaming score (measuring the individual inclination to engage in games) was not expected. On the present data basis we cannot fully resolve this finding. On the one hand we could have examined an extraordinarily highly motivated group in both components, thus reflecting a kind of ceiling effect. On the other hand this also could reflect a specificity of the power of Exergames for older adults. Pearce found that old adults play for fun rather than to hone skills and to overcome challenges, but need a gaming environment in which they might feel their own effort as a mediator to fun and achievement[22]. In the health context it therefore seems of high impact to foster the whole spectrum between intrinsic and extrinsic motivation. The number of successfully grabbed fruits might be the external rewards that increase the immediate engagement with the gaming surrounding, but the intrinsic component to feel well during the game and to feel to be a successful player is also an exigent component what may have caused the high evaluations of fun and the wish to play again in the senior group. Both components are therefore to be considered for Exergames in the health context.

Beside the gestures in the game (picking fruits and vegetables, placing them into a basket) the application may also requires a set of meta-gestures to control the state of the game (pause/resume), to skip a level, to get to configuration menus etc. In the current prototype we implemented a gesture for the action pause/resume. This gesture however was frequently triggered unintentionally by some users. Especially elderly users had difficulties to understand the connection between their current posture from within the game and the trigged pause screen. Therefore, games must consider that gestures should be intuitive and unequivocally distinguishable from each other[23].

The Exergame was evaluated very well regardless of age and gender. All participants stated that they had fun playing the game and they found the game easy to use. Regardless of age and gender users got faster with each level of the game. Although slower in the first level of the game, women quickly increased their performance in the 2nd and 3rd level to a greater extend then men.

6 Summary and Outlook

The current game prototype offers various starting points for further improvements. First, many users complained that the game ended too soon. Therefore additional levels have to be developed. To sustain long-term motivation we also need an understanding which kind of motivation forms might be especially suitable for the senior group. Also, as we only know the effects of the single play mode so far, we should also examine the usefulness of collaborative play, which could also enhance older adults needs of social activities and the interaction with friends, family and younger generations, but also peers[12].

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