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Strong and Loose Cooperation in Exergames for Older Adults with Parkinson's Disease

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Abstract

Physical training games – so-called *exergames* – might complement traditional physiotherapy to help older adults suffering from Parkinson's disease to slow the progress and ease symptoms of this non-reversible disease. Adding social aspects, such as multiplayer gaming, could potentially increase the motivation to play and thereby exercise. This paper investigates two design options for cooperative multiplayer exergaming, called *strong* and *loose* cooperation. Employing a specifically developed "window washer" game, a user study with 22 patients with Parkinson's disease was conducted, indicating that strong cooperation entails benefits such as increasing communication and coordination between the players, resulting in higher overall scores. Nevertheless, 50% of the participants preferred the loose cooperation mode.

1 Introduction

Parkinson's disease (PD) is a progressive and non-reversible neurodegenerative disorder that affects many older adults. Specific and sustained physical exercises can help to slow the progress and ease a range of symptoms of the disease (de Goede et al. 2001). Physical training games, so-called *exergames*, might complement traditional physiotherapy in this regard. Such games aim at combining the motivational component of computer games with the health benefits of regular physical training. However, in order to design effective games, more research is needed on the specific requirements of this application area in conjunction with the special audience that is not usually familiar with digital games. This work focuses on the aspect of simultaneous multiplayer gaming. It is motivated by the fact that traditional physiotherapy for PD patients is often performed within a group and training – just as gaming – can be more fun in a group setting. Yet, many older adults and especially people suffering from PD are very conscious about their limitations and can be intimidated by training or playing in front of, or together with, other people. This paper investigates the impact of *strong* versus *loose* cooperation on the player experience and performance of PD patients playing an exergame. Strong cooperation (SC) within the scope of this paper is defined as designing the game in such a way that the players have to work together in order to success-

fully complete the game. Loose cooperation (LC) means that it can be beneficial for the players to work together but that cooperation is not absolutely necessary. A conducted user study with 22 PD patients revealed that even though SC encouraged communication between the players and increased their overall performance, many players still prefer LC.

2 Related Work

Over the recent years, a number of research projects have reported encouraging findings regarding the potential of utilizing full-body motion-based games to motivate people who are in need of physical therapy or rehabilitation to carry out their often repetitive exercise routines (Assad et al. 2011; Anderson-Hanley 2012; Gerling et al. 2012). Following the model of Rigby and Ryan (2011), which is rooted in self-determination theory, games are so successful in intrinsically motivating people to be active, because they can satisfy the needs of feeling competency, autonomy and relatedness. While many games excel in fostering competency and autonomy by providing a broad selection of compelling and adequately challenging tasks with dense and rewarding feedback, relatedness is a basic human need which is most strongly satisfied by games that support social play (Rigby & Ryan 2011). This motivates explorations in multiplayer games in the context of the application area of this work. Older adults appear to prefer co-located (Nap et al. 2009) cooperative play (Gajadhar et al. 2010) which results in increased player experience and well-received conversations of players (Aarhus et al. 2011) and bystanders alike that focus on helping and supporting each other, rather than on competitiveness. Thus, co-located (cooperative) social play can help improve social bonds between players (Alankus et al. 2010) and long-term motivation (De Schutter & Vanden Abeele 2010). However, game design for co-located cooperative play can take many forms, as Mueller and Gibbs highlight when differentiating between *parallel play*, which means that players do not influence each other during their game interactions and *non-parallel* play, in which one player can act as an obstacle [or facilitator] to the other (Mueller and Gibbs 2007). While they conclude that non-parallel play promotes social play stronger than parallel play, the aspects of SC and LC, as framed above, have not yet been studied and further research in this area can help game designers to make more informed decisions which, in turn, can lead to more adequate exergames for target groups which can greatly benefit from regular guided physical exercises.

3 Game Design

The exergame prototype we developed to compare SC and LC is called *Window Washers*. It can be played by two players simultaneously by standing in front of a large screen and moving their hands. For tracking the players, the Microsoft Kinect in conjunction with the provided Kinect SDK[1] is used. The goal of *Window Washers* is to reveal a photograph by cleaning a dirty window and to identify the pictured object. Therefore, the players have to collect water and wipe over dirty areas. The game implements two different cooperative game

[1] https://www.microsoft.com/en-us/kinectforwindows/, last viewed 2013-07-09

modes. While both game modes include the same tasks, these are differently distributed among the two players (see below).

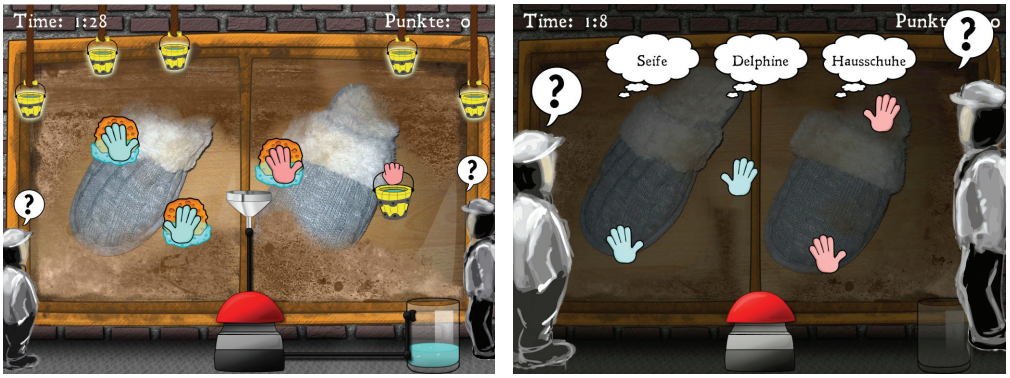

Figure 1: Main game screen with partially cleaned windows (left) and answer screen

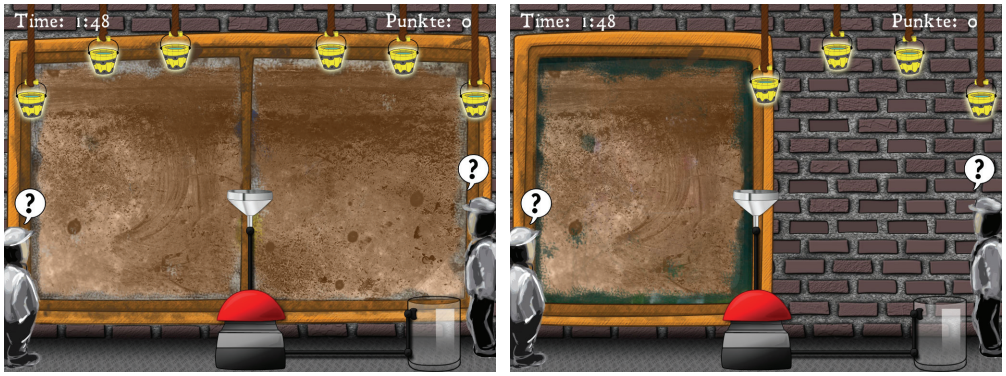

Figure 2: Loose cooperation mode (left) and strong cooperation mode (right)

In both cooperation modes the players have to collect water first. To do so, they have to grasp water buckets by moving their hands to them and to drop the water in a glass tank by moving the buckets to one of the window washer figures at the sides of the screen or the cone in the middle. With a filled tank the players are able to clean the window by wiping over dirty areas (figure 1, left). Each movement cleans the touched area and reveals the underlying photograph but consumes water and empties the tank. When there is no more water left in the tank, the players have to collect water buckets again. At any time the players are allowed to hit a buzzer and guess the object on the photograph out of three possible answers (figure 1, right). They are awarded 100 points for each correct answer. The two different games modes of LC and SC are realized through a different distribution of the three games roles *water collector*, *window cleaner* and *guesser* to the players. In the LC mode both players are able to collect water, to clean the window and to guess the object (figure 2, left). In the SC mode only one player is able to grasp the water buckets while task of the other one is the wipe over the window (figure 2, right). Both players are allowed to hit the buzzer and guess the object.

4 User Study

A user study was conducted in order to compare the different game modes regarding user preference and performance. We were also interested in any effects on the social interaction between the two players, i.e., verbal and non-verbal communication behavior. Participants were recruited through local physiotherapists, who also provided the rooms for conducting the experiments. A pre-test was conducted in order to investigate potential difficulties with our prototype and evaluation setup. The final evaluation consisted of nine sessions over three months. Each session lasted about two hours and took place in conjunction with the normal meetings of the local therapy groups. The order of game modes was counter-balanced to reduce potential learning effects. In addition to the normal player controls, we implemented special keyboard controls for the experimenter to enable Wizard-of-Oz intervention in order to prevent unintended activation of the buzzer and/or selection of answers by the participants as the pre-tests showed that this posed a problem for some participants. The main game tasks, i.e., cleaning windows and collecting water, were not affected by these special controls. For each session, teams of two participants were randomly selected and led to a separate room where we set up the equipment for playing the game. After introducing them to the planned procedure, the general task and asking them for their informed consent, participants were introduced to the first game mode they would play. The introduction always consisted of two test rounds to introduce the two basic game mechanics, i.e., window cleaning and water collecting. When the participants agreed to feeling ready, we initiated the testing phase with the first game mode. After participants played the first game mode, we collected subjective feedback on the respective mode before repeating the procedure for the second game mode. The playing phase lasted four minutes in total for each game mode, however, in the SC game mode, players were asked to switch roles/sides after two minutes. We expected that the SC game mode would be more efficient, i.e., result in higher game scores. Furthermore, we expected to observe more non-verbal and verbal communication and a higher level of coordination between the participants for the SC mode. Since many of the established therapy approaches for PD patients are group exercises, we also expected that SC would be the preferred mode of the majority of patients as it actively encourages communication and social interaction.

5 Results and Discussion

In total, 11 groups (22 participants) from three different local therapy groups participated in the evaluation. The average age was 72.32 (SD 7.13) years, ranging from 57 to 86 years with an equal distribution of men and women. Of the 11 groups, five consisted of only men, five of only women and one group was mixed. 46% of the participants had no former experience with exergames while 45% had some experience with other games from our lab and 9% had some experience with other exergames. A Wilcoxon test for dependent groups revealed that on average the participants scored significantly ($p < 0.01$) higher in the SC (472.72, SD 198.04) than in the LC game mode (336.36, SD 100.22). During the evaluation sessions we counted how often the participants would talk to each other. This “chatting value” was higher for the SC condition with an average of 4.98 (SD 3.87) compared to the LC condition with

an average of 3.36 (SD 2.01), although very narrowly not significantly so, as revealed by a Wilcoxon test ($p = 0.07$). Qualitative observations revealed that in the SC mode, the participants were more inclined to give specific "commands" to their team members and in general observed more closely what the other was doing. A shortened version of the Games Experience Questionnaire (GEQ) for collecting subjective feedback revealed no significant differences between the game modes regarding tension, immersion, fun, movements, and complexity (IJsselsteijn et al. 2008). Regarding fun, both modes received high ratings with an average score of approx. 3.5 (4 being the best possible score). Regarding the subjective feeling of success, participants felt significantly more successful ($p < 0.05$) in the SC condition with an average value of 2.5 (SD 1.01) than in the LC condition with an average of 2.05 (SD 1.05). This finding is consistent with the average achieved scores as an objective performance measure presented above. We also collected subjective feedback on how important and/or disturbing the participants judged playing together in a team for each game condition. In both conditions the participants did not feel irritated by the other player and found him/her to be moderately important for the game. When asked for their preferred game mode, 50% of the participants preferred LC, 27% SC, and 23% found both to be equally appealing. Compared to our initial expectations the results clearly support our assumptions that the SC mode is the more efficient mode, resulting in higher scores and overall game success, which was not only observed by us but also recognized by the participants. As expected, the participants also communicated more and more specifically for SC. However, the greater success and increased social interaction unexpectedly did not make the SC mode the preferred game mode. Regarding the context of this study, it can be hypothesized that this is an effect to the more independent gameplay in the LC condition, while anxiety of underperforming and being a burden for one's teammate may also play a role.

6 Conclusion

This paper investigated the impact of different types of simultaneous multiplayer interaction on player experience, performance and preference. A comparative study was conducted and the results indicate that the SC mode encourages the players to talk to each other more frequently and also changes the character (more "commands") of the verbal communication. For the SC mode the subjective and objective performance of the players measured by the game score was significantly higher. Although both game modes were rated very positively regarding fun by the participants, 50% of the participants preferred the LC mode, while only 27% clearly favored the SC mode. The results have several implications for future games and research in this area. It could be demonstrated that multiplayer exergames are possible and work for this target group as participants were not irritated by teammates in both conditions. It could further be demonstrated that asymmetric roles can encourage communication and lead to a better game performance in this context. Further research is needed to investigate the observed preference for the LC mode, i.e., looking at anxiety versus relatedness.

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