Understanding Handicapping for Balancing Exertion Games

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Abstract
Balancing play can be important for engaging people in games since it allows players with different skills to play together and still feel challenged. Balancing play in exertion games has previously been explored by altering the physical effort. To further our understanding of how to design more balanced experiences, we extend this prior work by studying the affect on play of using a score handicap, which gives the less skilled player an initial score advantage. A performance handicap was also studied by asking the most skilled player to play with the non-dominant hand. We studied digital and non-digital table tennis games, which provide different game interactions, as examples of non-parallel, competitive games. Our results show that these different game interactions influenced the impact that the different handicaps had on player's scores. Therefore, we suggest that the game interaction is a key element to understand the suitability of score and performance balancing methods.

Author Keywords
Exertion interfaces; sports; social interaction; play balancing; handicapping; engagement; challenging.

ACM Classification Keywords

H.5.2. [Information Interfaces and Presentation]: User Interfaces; H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems.

Introduction

Sports can improve the quality of life and reduce the risk of obesity and cardiovascular diseases [3, 13, 14]. They can also reduce the negative effects of anxiety and depression and improve people's moods [18]. These are some of the reasons why it is important for people to participate in them.

In sports players can face different challenges. There are physical challenges that include physical effort, capacity and skills; and mental challenges that include mental skills (i.e. concentration, imagery) and mental strategies (i.e. decisions taken during the game) [5]. In games players might also face different challenges such as physical coordination, time pressure and memory [1]. Choosing the right challenge has been shown to be essential to engage people in sports [5] and in games [2, 6-9, 15, 16, 20]. The different skills of players might make the game less enjoyable because the more skilled player might not feel challenged and the less skilled one might feel the activity is too difficult. Play balancing can be used to make the game less strenuous while challenging the participants and facilitating the social character of the experience [12].

Related work

Balancing play exists in some traditional sports already. For example, amateur golf applies different scoring rules to players of different skill in order to equalize the chance of winning. Ladders are used in sports to adjust the competition by making players with similar level compete between each other.

These examples show that in sports mainly static methods have been applied. However, in computer games, balancing has been applied dynamically where the system responds to player's abilities over the course of a game session [4].

Many of the attempts to balance exertion games have focused on the fitness level using the heart rate as the evaluation parameter [11, 17]. For example, in *Jogging over a distance* [11] the system positions the player's avatar according to how close each player's current heart rate is to their target one. These examples show different methods can balance the physical effort of the participants.

Previous work has not formally analyzed how different balancing methods such as score or performance handicapping influence the player experience. For this reason, we studied how handicapping affects player score and if this is dependent on the game interaction.

Study

We decided to study an exertion-based, competitive, non-parallel game where the player's performance is highly dependent on how the opponent allows him or her to play [10]. We decided to evaluate the sport of table tennis and a digital counterpart (Wii Table Tennis from the Wii Sports Resort game) [19] because they provide different game interactions.

We analyzed 16 players with the Wii table tennis within a range of [20-43] years and 30 players with non-digital table tennis within a range of [19-35] years old.

Participants were matched according to how they rated their degree of expertise using a pre-test questionnaire: 0 (low level of expertise) to 100 (high level of expertise). Our objective was to match the participants so that every pair had as large difference skills level as possible.

We asked the participants to play competitively and aim for victory, an 11 point game in three conditions, where a handicap was applied to the most skilled player: (i) score handicap, where the less skilled player started the match with an advantage of six points; (ii) performance handicap, where the most skilled player had to play with the non dominant hand; and (iii) no handicap. We chose these handicaps to compare balancing methods that could be easily applicable to existing digital and non-digital competitive games, so we did not have to re-program the digital game to apply the handicaps. The order of the conditions for each experiment was counter-balanced in order to avoid the order effect. The study investigates if the condition influenced the final game score and how close the score of the players was during the game. That is why we evaluated the following parameters: (i) the final score difference (score of the most skilled player minus the less skilled one); and (ii) the average of the absolute difference scores between the players during the game.

Results

For the table tennis games, we compared the distributions between handicapping conditions of the final score difference. A positive value would indicate that the most skilled player tended to score more than the less skilled one; while a negative value would indicate the less skilled played tended to score more.

We also did an analysis of the average of the absolute difference scores during the game. To compare the means of the distributions we used Friedman test since the data was not-normally distributed and the Wilcoxon test for pairwise comparison.

Physical table tennis

The means of the final score difference were: no handicap=5.19, (σ=3.038); score handicap=-2.38 (σ=4.470); performance handicap=-0.94 (σ=5.615).

The Friedman test showed that at least two means differ significantly ($p<.0001$). The Wilcoxon test showed that the mean of the no handicap distribution significantly differs from the score handicap ($p<.001$) and performance handicap ($p<.002$) ones.

The means of the average of the absolute difference scores during the game were: no handicap=2.79 (σ=1.22); score handicap=4.39 (σ=1.60); performance handicap=2.61 (σ=1.49).

The Friedman test did not show a significant difference between the means ($p<.062$).

Wii table tennis

The means of the final score difference were: no handicap=2.25, (σ=5.04); score handicap=-4.00 (σ=2.98); performance handicap=0.88 (σ=4.05).

The Friedman test showed that at least two means significantly differ ($p<.023$). The Wilcoxon test showed that the mean of the no handicap distribution significantly differs from the score handicap one ($p<.049$); and the mean of the performance handicap distribution significantly differs from the score handicap one ($p<.017$).

The means of the average of the absolute difference scores during the game were: no handicap=2.60 (σ=1.34); score handicap=4.86 (σ=1.90); performance handicap=2.22 (σ=1.10).

The Friedman test showed that at least two means significantly differ ($p<.03$). The Wilcoxon test showed that the mean of the score handicap distribution significantly differs from the performance handicap one ($p<.12$).

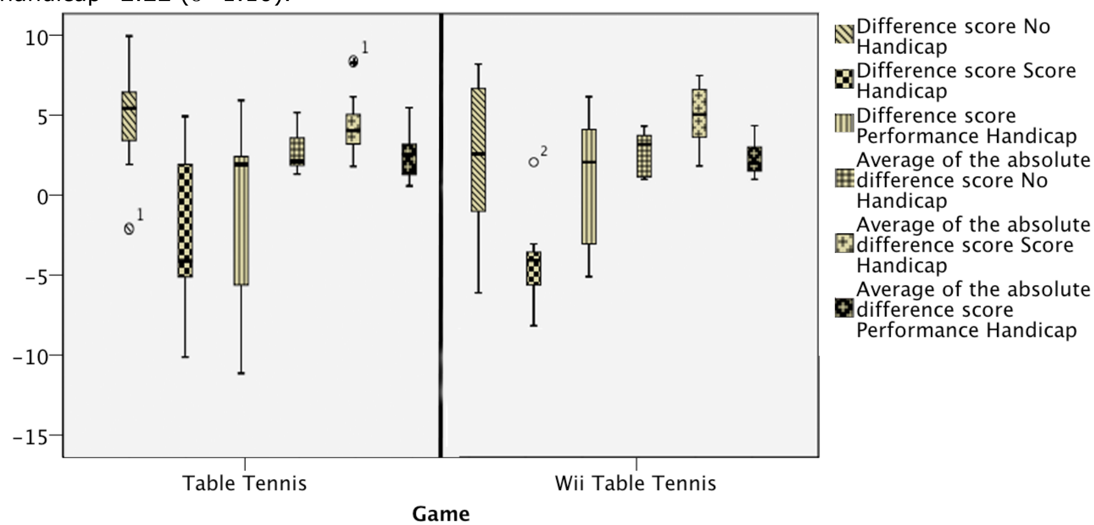

Figure 1. Box plot of the final difference score and average of the absolute difference scores during the game in digital and non-digital table tennis game balancing conditions: no handicap, score handicap and performance handicap

Conclusions and discussion

The handicaps we studied helped counterbalance the advantage the most skilled player had in the no handicap condition, with the exception of the performance handicap in the Wii game.

In Wii table tennis none of the handicaps seemed to be suitable for balancing. Analyzing the final score difference between conditions, the mean of the performance handicap condition differs significantly from the score handicap one, but it does not differ significantly from the mean of the condition played without handicap. This might have happened because players might have found the game interaction in Wii less complex, requiring less expertise to interact, than in the non-digital game. As a consequence, in the digital game: (i) the performance handicap had less effect on participants, and (ii) the game became more challenging for the disadvantaged players in the score handicap condition as it was more likely that participants had a more similar playing level.

In the non-digital table tennis both handicaps helped counterbalance the advantage the most skilled player had in the no handicap condition, since the mean of the final difference score in both handicapping conditions was significant lower than the no handicap condition. When the different skills between players was very large, the performance handicap seemed to be more effective and suitable for balancing the play than the score handicap since it directly affected the skills of the most skilled player.

The results suggest that the complexity of game interaction, that is, the degree of expertise required to play the game, might have an important role in deciding which game balancing method should be used.

We have mainly focused on the mean of the distributions obtained from the evaluated parameters as indication of how well each balancing method worked. However, we believe the standard deviation might also be useful as indicative of the consistency of balancing. For example, the Wii in the score handicap condition, even though it seems the game was more unbalanced than the other conditions, was more consistent as the final difference score between players had less variability. The reasons why we obtained large variability in some conditions might be because of the different skill levels between players and the different impact handicapping had player pairs.

This study was designed to explore the affect of static score and performance handicapping on balancing play and the difference when they are applied to digital and non-digital games. Although this study provided insights about the affect of different handicapping in two different game scenarios, further work is needed in order to have a more complete understanding of how to design for more balanced exertion games.

Limitations

This study provided insights about the affect of a 6-point score handicap on play balancing and playing with the non-dominant hand. We acknowledge that by choosing another score or performance handicapping we could have obtained different results since we would have changed the amount of advantage given to the less skilled player in score handicapping, or the different amount of skills between players in performance handicapping. However, the aim of this study was not to provide an exhaustive analysis of all types of score and performance handicapping, but to provide insights about how two different handicaps might affect digital and non-digital game balancing, and where one might be more suitable than the other.

Future work

We are currently analyzing data from the user survey to inform the perception of challenge and engagement of participants in each game condition. With this analysis we will get more insights about engagement factors such as frustration, enjoyment or focus of attention; and if the physical and mental challenges were affected by the handicapping conditions.

We are also planning future studies to study adaptive methods, which previously have mainly been explored in single player experiences [12]. These studies will help the research of novel balancing methods that could continually challenge players mentally and physically during a competitive exertion game.

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References
[1] Adams, E. *Fundamentals of game design*. New Riders, 2010.

[2] Boyle, E.A., Connolly, T.M., Hainey, T. and Boyle, J.M. Engagement in digital entertainment games: A systematic review. *Computers in Human Behavior*, 28 (3). (2012), 771-780.

[3] Francis, K. Physical Activity in the Prevention of Cardiovascular Disease. *Physical Therapy*, 76 (5). (1996), 456-468.

[4] Hunicke, R. The case for dynamic difficulty adjustment in games. In *Proc. ACE 2005*, ACM (2005), 429-433.

[5] Jackson, S.A. and Csikszentmihalyi, M. *Flow in sports*. Human Kinetics, 1999.

[6] Koster, R. *A Theory Of Fun In Game Design*. Paraglyph press, 2005.

[7] Lazzaro, N. Why We Play Games: Four Keys to More Emotion Without Story. In *GDC*, 2004.

[8] Malone, T.W. Heuristics for designing enjoyable user interfaces: Lessons from computer games. In *Proc. CHI 1982*, ACM (1982), 63-68.

[9] Malone, T.W. What makes things fun to learn? heuristics for designing instructional computer games. In *Proc. of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems*, ACM (1980), 162-169.

[10] Mueller, F.F., Gibbs, M.R. and Vetere, F. Taxonomy of exertion games. In *Proc. OZCHI 2008*, ACM (2008), 263-266.

[11] Mueller, F.F., O'Brien, S. and Thorogood, A. Jogging over a distance: supporting a "jogging together" experience although being apart. In *Ext. Abstracts CHI '07*, ACM (2007), 1989-1994.

[12] Mueller, F.F., Vetere, F., Gibbs, M.R., Edge, D., Agamanolis, S., Sheridan, J.G. and Heer, J. Balancing exertion experiences. In *Proc. CHI 2012*, ACM (2012), 1853-1862.

[13] Organization, W.H. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser*, 894. (2000), i-xii, 1-253.

[14] Pate, R.R., Pratt M., Blair S.N., et.al. Physical activity and public health: A recommendation from the centers for disease control and prevention and the american college of sports medicine. *JAMA*, 273 (5). (1995), 402-407.

[15] Salen, K. and Zimmerman, E. *Rules of play: Game design fundamentals*. MIT Press (2003).

[16] Sherry, J.L., Lucas, K., Greenberg, B. and Lachlan, K. Video game uses and gratifications as predictors of use and game preference. *Playing video games: Motives, responses, and consequences*. (2006), 213-224.

[17] Stach, T., Graham, T.C.N., Yim, J. and Rhodes, R.E. Heart rate control of exercise video games. In *Proc. GI 2009*, 125-132.

[18] Weinberg, R.S. and Gould, D. *Foundations of sport and exercise psychology*. Human Kinetics, 2007.

[19] Wii Sports Resort. http://www.wiisportsresort.com/ - /home.

[20] Yannakakis, G., Hallam, J. and Lund, H.H. Comparative fun analysis in the innovative playware game platform. In *Proc. FnG 2006*, ACM (2006).