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 and abilities to play together and still feel challenged. Balancing play in exertion games has mainly been explored by challenging the physical effort. To further our understanding of how to design for more balanced experiences, we extend this prior work by studying the affect on player's score by a score handicap. This 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 the different handicaps had on player's scores. Therefore, we suggest the game interaction is a key element to understand the suitability of score and performance balancing methods.

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

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces.

Introduction

Sports can improve the quality of life and reduce the risk of obesity and cardiovascular diseases [3, 13, 14]. Moreover they can reduce the negative effects of anxiety and depression and improve people's moods [18]. These are 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, self-talk) 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]. This is important as 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 and abilities between athletes or players might make the sport or game not enjoyable because the more skilled player might not feel challenged and the less skilled one might feel the activity too strenuous or difficult. Balancing exertion games can be used to make exertion activities not too strenuous while challenging the participants and facilitating the social character of the experience [12].

Related work

Balancing play exists in some traditional sports already, from which we can learn. For example, amateur golf applies different scoring rules to different skill level players in order to equalize the chance of winning. Ladders are used in sports and games 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. In computer games, on the other hand, balancing has been applied dynamically where the system responds to player's abilities over the course of a game session [4].

Most 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 to balance the physical effort of the participants.

Previous work has not formally analyzed how different balancing methods such as score or performance handicapping influence player experience or score balancing. That is why, we studied how score and performance handicapping affect player's score and if this impact is dependent on the game interaction.

Study

We decided to study an exertion-based, competitive, non-parallel game where an athlete'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. In both games the participants were matched according to how they rated their degree of expertise using a pretest 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. The reason we chose these handicaps is because we wanted to compare balancing methods affecting skills and scores that could be easily applicable to existing digital and non-digital competitive games. That is, we did not have to re-program the digital game to apply the handicaps. The order of the conditions for each experiment was randomized in order to avoid the order effect. The study was designed to investigate 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 (final score of the most skilled player minus final score of the less skilled one); and (ii) the average of the absolute difference scores between the players during the game.

Results

For the digital and non-digital table tennis games, we compared the distributions between handicapping conditions of the final score difference. According to how this parameter was calculated, a positive mean would indicate that the most skilled player tended to score more than the less skilled one; a negative mean would indicate the less skilled played tended to score more. We also did an analysis of the other parameter: 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 ($p<.0001$). Wilcoxon test showed that the mean of the no handicap distribution significantly differ 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: 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 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).

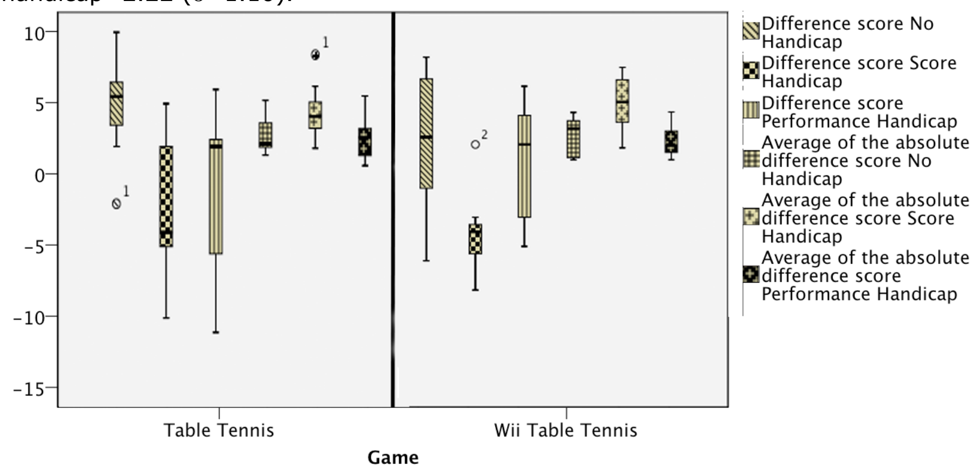

Figure 1. Box plot of the final difference score and average of the absolute difference scores during the game in digital and non-digital table tennis game balancing conditions: no handicap, score handicap and performance handicap

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).

Conclusions and discussion

The handicaps we studied helped counterbalancing 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 with 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 participants had more similar level.

In the non-digital table tennis both handicaps helped counterbalancing 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 that is 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 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, it 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 on different players.

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 6-point on play balancing of score handicapping 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 in which situations one might be more suitable than the other.

Future work

We are currently analyzing additional data from the user questionnaires to inform the perception of challenge and engagement of participants in each game condition. With this analysis we will get more insights about which factors of engagement 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 have mainly been explored in single player experiences [12]. These studies will help the research of novel balancing methods that could challenge players mentally and physically during a competitive exertion game.

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