# Does Movement Recognition Precision Affect the Player Experience in Exertion Games?

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**Abstract.** A new generation of exertion game controllers are emerging with a high level of movement recognition precision which can be described as the ability to accurately discriminate between complex movements with regards to gesture recognition and in turn provide better on-screen feedback. These controllers offer the possibility to create a more realistic set of controls but they may require more complex coordination skills. This study examines the effect of increased movement recognition precision on the exertion gaming experience. The results showed that increasing the level of movement recognition precision lead to higher levels of immersion. We argue that the reasons why players are more immersed vary on the basis of their individual motivations for playing (i.e. to 'relax' or to 'achieve').

**Keywords:** computer games, control devices, movement recognition precision, exertion games, immersion.

## 1 Introduction

Exertion games can be described as gaming interactions with technology in which users invest significant physical effort, and are believed to have social, mental and physical benefits [1]. In recent years these games have experienced massive commercial success due to the emergence of control devices that allow for a more natural type of interaction (e.g., Nintendo Wii). A new generation of these controllers such as Nintendo's Wii Motion Plus, Sony's PlayStation Move and Microsoft's Kinect have entered the market. These new systems have a higher level of movement recognition precision than the first generation. These controllers offer the possibility to create a more realistic setting, which are then more likely to enhance the gaming experience by meeting up with players' expectations.

This study will examine the impact of movement recognition precision on the gaming experience in exertion games. Increased levels of movement recognition precision should lead to a more realistic set of controls through movements being imposed and afforded.

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## 2 Background

The exertion gaming experience can be split into 3 components: ‘motivations’ that players have when approaching the game, ‘strategies’ (i.e., playing styles) that they employ during the game, and ‘levels of immersion’ that the players reach during the game. We briefly review here the literature on these three components.

Lazzaro [7] identified the four motivations people have when playing computer games; 1. ‘Hard fun’ - gamers enjoy the obstacles and challenges presented in the game. 2. ‘Easy fun’ - gamers are driven by the sense of curiosity and adventure. 3.’Altered states’ - gamers play to experience sensations of excitement and enjoyment. 4. ‘People factor’ - gamers looks for social interaction with others outside or inside the game. Pasch et al. [8] identified two types of motivation that occur in exertion games; 1. ‘Achieving’ - some people play with the motivation to challenge their ability and to find the best way to achieve a high score (i.e., hard fun). 2. ‘Relaxing’ – these people play with the motivation to relax (i.e., mental relaxation) by enjoying their movement skills (i.e., easy fun) without worrying about the scores. The control modality of a game can influence the motivation of the player [15], but it is unclear whether this applies to varying levels of movement recognition precision.

Pasch et al. [8] investigated the relationship between motivation and whole-body playing strategies. They showed that different motivations can lead to different strategies in whole-body sports games. Those whose motivation is to ‘achieve’ will optimize their strategy to obtain the most points by using the minimal movements required. While those whose motivation is to ‘relax’ will try to recreate movements from the actual sport. It is unclear whether this holds for different genre of exertion games and with players of different experience levels. It could be argued that controllers with an increased level of movement recognition precision will lead to a more realistic set of controls through movements being afforded and imposed. This in turn could influence a player’s choice of strategy, regardless of their motivation.

With respect to immersion, several studies [2, 8] have claimed that a player’s motivation or playing style can have an impact on the overall immersion level and/or different factors of immersion. However, this has yet to be explored in detail. An experiment by Bianchi-Berthouze et al. [2] compared a traditional control pad to a motion-sensed guitar shaped controller. Results suggested that an increase in body movement imposed, or allowed, by the game controller results in an increase in the player’s engagement level. The authors argue also that the increased involvement of the body can afford the player a stronger affective experience. Another study from Lindley et al [9] compared a traditional control pad to a set of Bongo drums which afforded natural movements. They showed that an increase in movement afforded by the input device made for a more engaging experience, and that this was not compromised by the increase in social interaction. All these results suggest that by imposing or allowing more movement in the game control can lead to an increased level of immersion. However, it is unclear what factors of immersion are being affected and it is still not clear if this would apply to controllers with better movement recognition precision. It is also unclear what type of imposed movement would facilitate these mechanisms [15, 17].

## 3 Research Focus and Experimental Design

This study will examine the impact of movement recognition precision on the gaming experience in exertion games by taking into account the motivation of the player. This study will investigate if an increased level of movement recognition precision leads to a more realistic strategy and to a higher immersion level, and also explore how the different motivation groups adapt their strategies.

The Nintendo Wii was selected for use in this study, as it supports many exertion games and also supports two movement based controllers with two levels of movement recognition precision, i.e., the Standard Wii Controller (called SC hereafter) and the Motion Plus Controller (called MPC hereafter) which has an increased level of movement recognition precision. The two levels of exertion game chosen were Tennis and Golf. EA Sports Grand Slam Tennis was chosen as it supports both controllers. Two different Golf games were used; Wii Sports (Golf) which supports the standard controller, and Wii Sports Resort (Golf), which is a sequel to Wii Sports that supports the motion plus controller. It is worth noting that both golf games have almost identical interfaces, the exact same courses, choice of clubs and characters, i.e. the only differences are the ones bought on by the motion plus. The user manuals along with the games advertising [12, 19] heavily imply that the motion plus games for both Tennis and Golf are a simulation of the real sport. This may have implications in the expectations raised in the players as further discussed in the conclusions.

From looking at description of the control systems detailed in the user manuals, and also from playing the game/tutorials with both controllers (standard and motion plus), we were able to list the differences (Table 1) that the increased movement recognition precision brings to these games.

**Table 1.** Differences between the Standard (SC) and Motion Plus Controllers (MPC)

| **Differences between SC and MPC** |
|---|
| **Accuracy and Responsiveness** – With MPC, the swing trajectory is more accurately detected and replicated onscreen. |
| **Swing Amplitude** – MPC requires a larger swinging arm movement to initiate a swing. SC requires only a small movement in golf and just a small wrist movement in tennis. |
| **Aiming System** – With SC, aiming in tennis is determined by how early a player swings, whereas with MPC, the swing follow through determines the direction of the ball. |
| **Power** – MPC can detect the swing velocity in tennis. |
| **Spin Shots** – With MPC, a tennis player can add spin to shots by wrist rotations |
| **Wrist Control** – With MPC, a golf player must control wrist movements to perform a successful swing, e.g., twisting the wrist when swinging causes the ball to go off target. |

The participants were split into 3 levels of experience: Beginner, Experienced with Wii, Experienced with Wii and Motion Plus. Each participant would experience both genres of game using both controllers. A counterbalancing table was made to minimise order and practice effects. To ascertain players' motivations for engagement, they were interviewed straight after game play. The reason for interviewing after game play was because they might have not known what their motivation was before playing and it could have also changed during game play. To measure player's strategies they were video recorded during game play and the data was analysed by two evaluators who had experience in playing both Golf and Tennis. The evaluators were shown a series of video clips (44 clips in total) in a random order and then asked to rate both players in the clip on a scale of 1-5 (1 being unrealistic, 5 being realistic) based on their expert knowledge of the sports. Coding sessions were split up in to smaller sessions, to ensure the evaluators did not become too tired. In order to check the inter-rater reliability of the two evaluators, the intra-class correlation coefficient [20] was computed (0.9327) and the scores of the two evaluators were averaged to give each participant an average realism rating for each of the four conditions (2 games x 2 controllers). A motion capture system[1] was also used to obtain a more objective measure of swing and wrist movements (Table 2). Due to time consideration, the metrics were applied to 20 seconds of motion capture data (1200 frames) in order to capture a section of continuous game play, taken randomly from the middle of the game session. Whereas, analysing the full motion capture data would have provided a more accurate response, the fact that the 20 second windows were chosen randomly should provide sufficient accuracy.

**Table 2.** Motion Capture Movement Metrics

| Tennis | Golf |
|---|---|
| **Swing Amplitude** - This refers to how wide/open a player's tennis forehand swings are, i.e. the maximum range of swings, calculated from the rotation of the player's shoulder. The higher the amplitude, the more realism.<br>**Max Speed (Power)** – This refers to how fast a player swings. This metric is interesting because adding power to shots (i.e. by swinging faster) is a new feature in the motion plus condition.<br>**Amount of Wrist Rotation** – It refers at the amount of rotation perform in a spin shot, a new feature in the motion plus condition. | **Swing Amplitude** – This refers to how wide a player's golf swings are, i.e. the maximum range of swings, calculated from the rotation of the player's shoulder. The higher the amplitude, the more realism.<br>**Straightness of Swinging arm**– This refers to how straight a player's swinging arm is i.e. the angular displacement of the swinging arm elbow. The straighter the swinging arm, the more realism.<br>**Amount of Wrist Rotation** – This refers to whether a player is keeping a firm wrist (i.e. by not rotating it). This metric is interesting because the wrist control aspect is a new feature in the motion plus condition. |

To measure immersion, the immersion questionnaire developed by Jennett et al. [10] was chosen as it breaks down immersion into different factors, i.e., person factors (cognitive involvement, real world dissociation, emotional involvement) and game factors (challenge and control). Semi-structured interviews were also conducted as they allow participants to re-tell their game play experience which can reveal further experiential aspects [11]. The final game score was also recorded to measure performance as this was a possible confound that could affect immersion.

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[1] Motion capture system: IGS-190-M with 18 gyroscopes. (http://www.animazoo.com/)

### 3.1 Participants and Procedure

A total of 22 participants were recruited (16 Male, 6 Female) ranging from 22 to 34 years old (average age = 27; st. dev = 3.2). This age range was chosen on the basis of a recent advert for EA Sports Grand Slam Tennis showing that it was marketed at 25-54 year olds [12]. Participants were paired to play the games by experience level, i.e., Beginners (4 pairs), Experienced with Wii (4 pairs), and Experienced in Wii and Motion Plus (3 pairs). Also, the members of each pair were friends. From a pre-trial questionnaire administered during recruitment, we were able to establish that all participants played video games at least once a month, exercised at least once a month and had either played tennis/golf or had an interest in tennis/golf.

On arrival, each pair of participants were asked to read an information sheet, health and safety form and sign a consent form. The experimenter would first load up the first game genre and then explain the first controller condition. As only one motion capture system was available at the time of this study, a member of the pair chosen randomly would wear the motion capture suit. The chosen participant was told that the suit would be capturing all of their movements during the actual experiment. Both participants would then participate in a practice session, where they were given an instructional sheet explaining the controls of the game, which they would be asked to read before the experimenter gave a demonstration of the control system. The participants would then have 5 minutes to get familiar with the controls, before starting the actual experiment which would also last 5 minutes. The participants would then be asked to fill in the immersion and answer questions about their motivations for playing the game. The above procedure would then be repeated for the second controller condition. After the participants had completed both controller conditions for the first game genre, the experimenter would then conduct a semi-structured interview. Finally, the whole procedure would be repeated for the second game genre. Each session lasted approximately 1 hour 30 minutes.

## 4 Controllers, Motivation and Strategy: Results

After each condition, participants were asked what their motivation was whilst playing. Responses were grouped into two categories – ‘Achieving’ and ‘Relaxing’. Responses such as ‘to challenge myself’, ‘to learn and improve’, ‘to beat my opponent’ and ‘to obtain a high score’, were attributed to the ‘Achieving’ group. Responses such as ‘to enjoy myself’, ‘have fun’, and ‘to experience real tennis/golf’ were attributed to the ‘Relaxing’ group. The results showed that each player’s motivations for playing were not affected by the type of the controller used.

A Multivariate Analysis of Variance (MANOVA) [21] using SPSS-18 software was then conducted to see if there was any relationship between player’s motivations and their strategy, i.e. average realism ratings. Even though the strategy realism rating data did not follow a normal distribution, the MANOVA analysis was conducted as it is robust over non-normality. The results showed that players whose motivation is to ‘relax’ use a significantly more realistic strategy than players whose motivation is to ‘achieve’, and this holds across genres and conditions (see Figure 1, first two graphs):

i.e. holds for Tennis in both the standard condition (F=31.347, p=0.000) and motion plus condition (F=27.631, p=0.000), and holds for Golf in both the SC condition (F=5.69, p=0.30) and MPC condition (F=11.74, p=0.03).

We also explored if the level of realism changed within the sample between the two controller conditions. The non-parametric Related-Samples Wilcoxon Signed Rank Test [22] was conducted, as the data did not follow a normal distribution. Players motivated to 'achieve' have a significantly higher realism rating when the level of movement recognition precision increases for both Tennis (W=2.546, p=0.011) and Golf (W= 2.536, p=0.011) (Figure 1, first graph). The players also have a significantly higher swing amplitude (measured with the motion capture) in both Tennis (W=2.023, p=0.043) and Golf (W= 2.023, p=0.043) in the MPC condition. Players motivated to 'relax' have a significantly higher realism rating when the level of movement recognition precision increases for Tennis (W=2.232, p=0.026) and for Golf (W= 2.53, p=0.011) (Figure 1, second graph). These players also have a significantly higher swing amplitude for Golf (W= 1.782, p=0.075) in the MPC condition. However, there was no significant difference for swing amplitude in Tennis for this motivation-group.

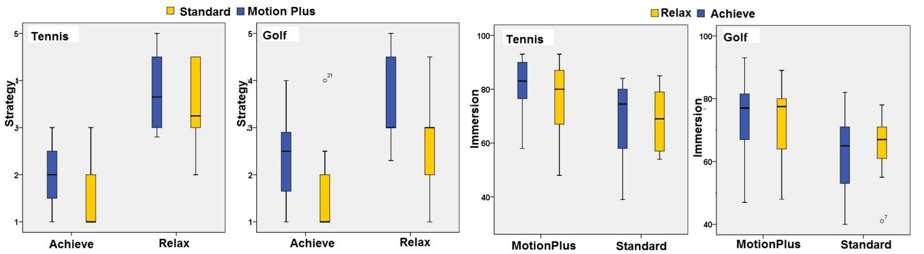


**Fig. 1.** Box-plots showing the effect of the increased Movement Recognition Precision on Strategy (Realism Rating) and Immersion for both motivation groups and games

Players motivated to 'achieve' will also use additional realistic movements (measured by the motion capture), if it will help them to achieve a higher score. For Tennis, these players will use significantly more wrist rotation, i.e. spin shots, when there is an increase in movement recognition precision (W=2.023, p=0.043), even though this movement is not required. This is due to the fact that 'spin shots' are more difficult for their opponent to return, i.e. they maximize all efforts towards achieving a higher score. For Golf, these players will also have significantly less wrist rotation (W=-2.023, p=0.043) and a straighter swinging arm (W=2.023, p=0.043) when there is an increase in movement recognition precision, even though these realistic movements are not required by the game. Keeping the wrist firm and having a straighter swinging arm are important for producing a good swing in the motion plus condition, as well as in real golf. So, these players have adapted their strategy in order to perform better.

Players motivated to 'relax' will overlook additional realistic movements. For Tennis, there was also no significant difference in maximum velocity and amount of wrist rotation between the standard condition and motion plus condition. For Golf, there was no significant difference in the amount of wrist rotation between the conditions. These additional realistic movements all contribute to achieving a higher score in motion plus, but these players are not motivated to achieve, which could explain why there was no significant difference for these metrics.

## 5 Movement Recognition Precision Affects Immersion: Results

Given the importance of motivation, we investigated our hypothesis on each motivation group separately. Since the distribution of the overall immersion scores and factor scores did not follow a normal distribution, the non-parametric Related-Samples Wilcoxon Signed Rank Test was used.

Players motivated to 'achieve' have a significantly higher level of immersion in the MPC condition for both Tennis (W=2.869, p=0.004) and Golf (W=2.938 p=0.003) (Figure 1, last two graphs). For Tennis there was a significant increase in the level of Challenge (W=2.966, p=0.003), Control (W=2.732, p=0.006), Real World Disassociation (W=2.764, 0.006), Emotional (W=2.298, p=0.022) and Cognitive Involvement (W= 1.836, p=0.066) when the level movement recognition precision increased. For Golf there was a significant increase in the level of Challenge (W=1.93, p=0.054), Emotional (W=2.673, p=0.008) and Cognitive Involvement (W=2.236, p=0.025), when the level movement recognition precision increased.

Players motivated to 'relax have a significantly higher level of immersion when the level of movement recognition precision increases and this holds for both genres i.e. for Tennis (W=1.887, p=0.059) and for Golf (W=2.192, p=0.028) (Figure 1, last two graphs). However it is worth noting that these increases are not as significant as the increases shown by players motivated to 'achieve', probably because the effects of the motion plus are not as apparent to players motivated to 'achieve. For Tennis there was a significant increase in the level of Challenge (W=1.851, p=0.064) when the level of movement recognition precision increased. For Golf there was a significant increase in the level of Challenge (W=2.021, p=0.043), Emotional (W=2.565, p=0.01) and Cognitive Involvement (W=2.259, p=0.024), when the level movement recognition precision increased.

The non-parametric Related-Samples Wilcoxon Signed Rank tests were computed to exclude a possible effect of performance over immersion. The tests showed that for Tennis there were no significance differences in performances between controller conditions (p-value = 1.0), whereas for Golf there was a significance difference (p-value = 0.04). However, the correlation coefficients between these two sets of scores in the Golf condition showed very low correlation for both controllers (SC: person= 0.07; MPC: person = -0.1) indicating that the effect of performances on immersion was negligible.

From the analysis of the interviews it is clear that the increase level of movement recognition precision contributes to the level of immersion for both type of players, the ones that want to 'achieve' and the ones that want to 'relax'. In both case, the reason is that the controller fits better their expectations. For the players that are motivated to 'achieve' this means that the controller offers a more complex game (i.e., a large set of shots to make points) and, at the same time, the controller is not a barrier to immersion as it is more intuitive. As a result, players feel more challenged, cognitive and emotionally involved and more dissociated with the real world.

For the players motivated to 'relax', higher recognition precision means less frustration and the possibility to engage with the pleasure of moving. With low movement recognition precision these players reported to become frustrated by the poor accuracy and responsiveness of the controller. Instead, the increased movement recognition precision offers better 'one-to-one' response time between their actions and on-screen feedback. This allows the players to better enjoying their movement by playing more realistically, i.e., creating a better simulation as the controller meets better the players expectations. This decreased control barrier may have eventually brought them to feel more emotionally and cognitively involved in experiencing their movement skills.

## 6 Conclusions

The link between motivation and strategy in exertion games was clear – players whose motivation is to 'relax' will use a more realistic strategy than players whose motivation is to 'achieve', and this holds across genres and different levels of movement recognition precision. These results follow the Pasch et al. [8] study which showed that different motivations can lead to different strategies. Those whose motivation is to 'achieve' are looking to challenge themselves (hard fun), thus they will optimize their strategy to obtain the most points, i.e., an unrealistic 'game' strategy – using the minimal movements required. Instead, those whose motivation is to 'relax' are looking for mental relaxation (easy fun), thus they will try to recreate movements from the actual sport, i.e., a realistic 'simulation' strategy.

We first explored the effect of an increased movement recognition precision on players' strategy. The results showed that players use a more realistic strategy as the level of movement recognition precision increases, and this holds across genres and motivation groups. However, the reason why players use more realistic strategies differs between motivation groups. Those motivated to 'achieve' use a more realistic strategy because the improvement in movement recognition requires them to, but only to a certain extent, i.e., the improved controller does not yet offer a fully accurate simulation. Those motivated to 'relax' will use a more realistic strategy possibly to reach a better simulation of the sport. However, these players overlook additional realistic movements that contribute to them achieving a higher score, as they are not motivated to achieve. Players motivated to 'achieve' become more immersed when the level of movement recognition precision increases. A possible reason for this is that an increased movement recognition precision allows for additional realistic movements which can help the player to 'achieve', i.e., their motivation for engagement. A second reason could be that these additional movements allow for a more exciting game play which allows the player to become more emotionally involved in the game [2, 9, 15]. These additional movements also make the game more challenging and require the player to think more, thus allowing them to become more cognitively involved [13].

Players motivated to 'relax' also become more immersed when the level of movement recognition precision increases, however the increase is not as significant as those motivated to 'achieve'. The reason for higher immersion in this case could be due to the fact that the controller with increased movement recognition is more responsive and accurate at replicating movements allowing the player to focus and enjoying movement per se. The players can play more realistically, thus meeting the player's expectation [4]. Also, from creating a better simulation, the players will use more body movement, which according to various studies [e.g., 11, 15, 16, 18] will afford the player a stronger affective experience. Their movements are also more accurately replicated and it is easier for them to anticipate what will happen next in response to their actions. This is backed up by Slater et al. [14] who state that presence in virtual environments may be enhanced the stronger the match between proprioceptive information from human body movements and sensory feedback from computer generated displays. This in turn facilitates the player's empathy for the character they are playing [6], and increases the emotional involvement. Further support to our conclusion could be obtained by running a longitudinal study to understand the effect of prolonged exposure to the controllers. Also, a more thorough analysis of motion capture data (e.g, segmentation between gestures) could provide further insights on the metrics to evaluate the players' experience in exertion games.

Our study has successfully shown that increasing the level of movement recognition precision will lead to a richer gaming experience with higher levels of immersion. The reason why players are more immersed differs between their individual motivations for engagement, but the underlying core reason is the same. The increased movement recognition precision makes the control system more realistic and therefore is better at meeting up with the players' expectations that they build from the real world. Controllers that match the user's expectation can enhance the gaming experience [3], while inappropriate controllers can create a breakdown in the gaming experience [5, 6]. However, movement recognition precision is still not at a level where it can create an exact simulation of a sport or activity, i.e. completely meeting up to a player's expectation. Further developments in movement recognition precision could facilitate this.

To conclude, this study has further advanced theory which showed that increasing the body movement imposed or afforded by a game controller results in an increase in the player's immersion level [2, 9]. This study also has relevance to exertion game designers and developers, by highlighting how important the design of controls are in shaping the gaming experience, i.e., the set of movement controls need to replicate movements from the actual sport or activity in order to meet players' expectations. Additional movements can be added to create more exciting and challenging game play; however designers need to be aware that these movements will not be used by all players, i.e., those motivated to 'relax'.

## References

1. Mueller, F., Gibbs, M.R., Vetere, F.: Taxonomy of exertion games. In: Proceedings of the 20th Australasian Conference on Computer-Human interaction: Designing For Habitus and Habitat, vol. 287, pp. 263–266. ACM, New York (2008)
2. Bianchi-Berthouze, N., Kim, W.W., Patel, D.: Does Body Movement Engage You More in Digital Game Play? and Why? In: Paiva, A.C.R., Prada, R., Picard, R.W. (eds.) ACII 2007. LNCS, vol. 4738, pp. 102–113. Springer, Heidelberg (2007)
3. Li, N., Moraveji, N., Kimura, H., Ofek, E.: Improving the Experience of Controlling Avatars in Camera-Based Games Using Physical Input. In: Proceedings of the 14th Annual ACM International Conference on Multimedia (2006)

4. Höysniemi, J., Hämäläinen, P., Turkki, L.: Wizard of Oz prototyping of computer vision based action games for children. In: Conference on Interaction Design and Children: Building a Community (2004)
5. Dourish, P.: Where the Action Is - The Foundations of Embodied Interaction. The MIT Press, Cambridge (2001)
6. Rambusch, J.: The embodied and situated nature of computer game play. In: Proceedings of the Workshop on Cognitive Science of Games and Gameplay, Cogsci. (2006)
7. Lazzaro, N.: Why We Play Games: Four Keys to More Emotion Without Story, http://www.xeodesign.com/whyweplaygames/xeodesign_whyweplaygames.pdf (accessed)
8. Pasch, M., Bianchi-Berthouze, N., van Dijk, B., Nijholt, A.: Movement-based Sports Video Games: Investigating Motivation and Gaming Experience. Entertainment Computing 9(2), 169–180 (2009)
9. Lindley, S., Le Couteur, J., Bianchi-Berthouze, N.: Stirring up Experience through Movement in Game Play: Effects on Engagement and Social Behaviour. In: SIGCHI Conference on Human Factors in Computing Systems, pp. 511–514 (2008)
10. Jennett, C.I., Cox, A.L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., Walton, A.: Measuring and Defining the Experience of Immersion in Games. International Journal of Human Computer Studies (2008)
11. Mueller, F., Gibbs, M.R.: Evaluating a distributed physical leisure game for three players. In: Proceedings of the 19th Australasian Conference on Computer-Human Interaction: Entertaining User Interfaces, vol. 251, pp. 143–150. ACM, New York (2007)
12. MCN.com : Case Study – EA Sports Grand Slam Tennis, http://www.mcn.com.au/Resource/CaseStudyDetail.aspx?IdDataSource=102 (accessed)
13. Bereiter, C., Scardamalia, M.: Surpassing ourselves: An inquiry into the nature and implications of expertise. Open Court, Chicago (1993)
14. Slater, M., Usoh, M., Steed, A.: Taking steps: the influence of a walking technique on presence in virtual reality. ACM Trans. Comput.-Hum. Interact. 2(3), 201–219 (1995)
15. Bianchi-Berthouze, N.: Does body movement affect the player engagement experience? In: Conference on Kansei Engineering and Emotion Research, pp. 1953–1963 (2010)
16. Mueller, F., Agamanolis, S., Picard, R.: Exertion interfaces: Sports over a distance for social bonding and fun. In: International Conference on Human Factors in Computing Systems CHI 2003, pp. 561–568. ACM Press (2003)
17. Muller, F., Bianchi-Berthouze, N.: Evaluating Exertion Games Experiences from Investigating Movement Based. Human-Computer Interaction Series, Part 4, pp. 187–207. Springer, Heidelberg (2010)
18. Hoysniemi, J.: International survey on the Dance Dance Revolution game. Computer Entertainment. Section: Games, user interface and performing arts 4(2), 8 (2006)
19. Wired.com: Wii Sports Resort Makes Golfing Real Again (2009), http://www.wired.com/geekdad/2009/08/wii-sports-resort-makes-golfing-real-again/ (accessed)
20. Shrout, P.E., Fleiss, J.L.: Intraclass Correlations: Uses in Assessing Rater Reliability. Psychological Bulletin 86(2) (1979)
21. Stevens, J.P.: Applied multivariate statistics for the social sciences. Lawrence Erblaum, Mahwah (2002)
22. Wilcoxon, F.: Individual comparisons by ranking methods. Biometrics Bulletin 1(6), 80–83 (1945)