Bye-bye Couch Potato: Body Movement in the Gaming Experience

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Abstract

Video game consoles that enable their users to use active body movements as mode of interaction are becoming more and more popular. In fact, the best selling video game console at the time of writing this study is the Nintendo Wii, which is operated by one or two handheld controllers that gamers have to point and swing to operate their games.

There has been plenty of research on how gamers experience non-movement-based games as well as research on experiencing sport and physical exertion. Yet, there is little knowledge on how gamers experience physically active video games.

This study aims at contributing to this research endeavor and embarks from an exploratory approach. Video gamers are interviewed to investigate how they assess and conceptualize their experiences with movement-based games. A Grounded Theory analysis approach reveals two distinct motivations ("achieving" and "relaxing") with which gamers approach such games, together with two respective strategies. Also, control is identified as a crucial factor and the outcomes of the interviews are applied to existing knowledge of the gaming experience.

Existing studies of movement-based games point out the potential of adaptive games that monitor the movements of gamers and steer them towards healthier and more enjoyable interactions. In this light, the focus of the study is in a second step refined to further investigate the motivations and strategies. The aim here is to identify movement patterns that correspond to the motivations and respective strategies of the interview study. Using an inertial gyroscopic motion capture suit, three movement patterns are identified and connected to the strategies.

Foreword

Though I am not a big fan of sentimentalities in a scientific work, I do feel the need to thank some people who made the project that is described in this thesis possible. The project was carried out at the Interaction Centre of the University College London (UCLIC). I am thankful to the people at UCLIC for accepting me as visiting student, supporting me during the project, and showing me a great time in London. I also thank my supervisors for their support as well as everyone else who contributed otherwise to the project. Finally, I want to acknowledge the Twente Mobility Fund, that partially supported my stay in London.

Preliminary results of the research described in this thesis have been presented at the Facial and Bodily Expressions for Control and Adaptation of Games (ECAG '08) workshop that is held on 16 September in Amsterdam. The paper that is also to appear in the proceedings of ECAG'08 can be found in Appendix D.

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Chapter 1
Warm-up

The video game market changes. New game consoles require and enable the gamer to be physically active and control video games via body movements. Physical activity during gameplay seems to hold health benefits and enrich the experience of gamers, though little is known of the relation between physical activity and the gaming experience. This chapter sets the scene for the study by giving an overview of how video games are seen in societal perception and in scientific investigation. Further, potential benefits of physical activity in games for a healthier and more enjoyable interaction are shown, but also health risks are discussed.

1.1 Perception of Video Games in Society and Science

Traditionally, video gamers do not enjoy a good reputation. Playing video games is associated with laziness and the common term couch potato illustrates this sapless and almost asocial image. Several gamers that were interviewed over the course of this study report of having a bad conscience when playing and even feeling guilty for playing video games. It is often seen as a waste of time. Time, that can be better used doing something productive. Video games are thus perceived as an unproductive activity, with little to no beneficial outcomes.

Scientific studies support the bad reputation of video games. Together with other sedentary pastimes (the word activity does not really seem to fit in this context) like watching television or browsing the Internet, playing video games has often been associated with boosting obesity (e.g. Hillier, 2008; Epstein et al., 2008).

There appears to be a strong focus on finding negative effects of computer games in scientific investigations. In a review on studies into social and psychological effects of computers games, Lee and Peng (2006) observe a lack of scientific evidence on effects of video games on gamers. They attest that so far, research into entertainment games has been biased towards identifying negative consequences of gaming. Only for the domain of educational games, research has focused on investigating positive outcomes.

1.2 Physical Activity in Games

Interestingly, the best selling video game console at the time of writing this study is the Nintendo Wii [1]. This is slightly puzzling as it is the console with the lowest graphical performance of the so-called "7th generation" consoles (i.e. Nintendo Wii, Sony Playstation 3, Microsoft Xbox 360). There may be a number of factors contributing to its success, but arguably the main criterion that distinguishes the Wii from its competitors is that it requires gamers to be physically active in their gameplay and use active body movements for interaction.

As pointed out earlier video games are usually seen as contributors to the growing obesity epidemic. Hillier (2008) notes that

> "children today are engaging much less with the world outside their homes in terms of physical activity ... Technological innovations in media have contributed to these changes, keeping children inside and sedentary in their playtime..."
> (Hillier, 2008, 56).

But instead of simply blaming technology for this, she advocates making technology part of the solution. Physical activity promoting video games can be seen as an example for such a technology driven solution.

Initial studies show that physical activity during gameplay increases energy expenditure significantly compared to sedentary games. Lanningham-Foster and colleagues (2006) measure the energy expenditure of children playing sedentary video games and playing active video games like Sony's EyeToy and Konami's Dance Dance Revolution. The energy expenditure more than doubles for Dance Dance Revolution and the authors conclude that such games could be useful for obesity prevention and treatment.

Graves and colleagues (2007) also measure the energy expenditure of children playing active video games as compared to sedentary games, but observe an older group of children. Interestingly, they compare the expenditure values of the Wii Sports Bowling and Tennis with values for actual bowling and tennis. The Wii games require significantly more energy than sedentary activities, but less than the real sports that they simulate. Yet, the measure that the authors employ does not take upper limb movements into account. In a more recent study, Graves and

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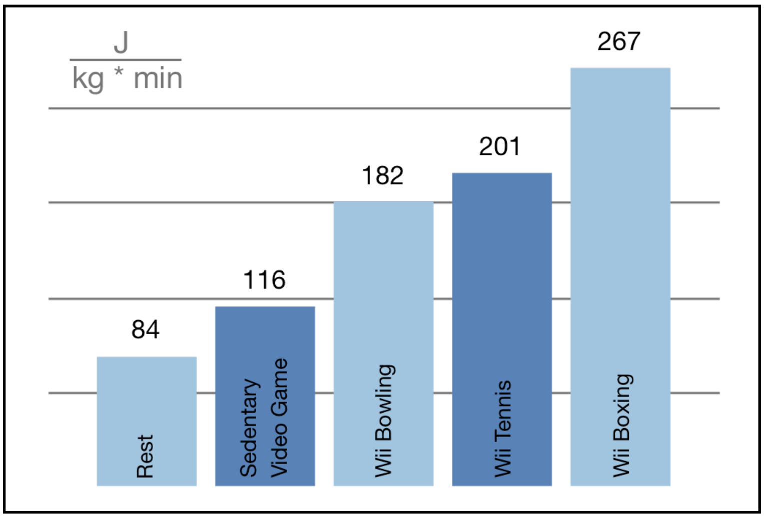
[1] Sanchanta, M.: Nintendo's Wii takes console lead. Financial Times, 12.07.2007. Retrieved from ft.com

colleagues (2008) use a measure for estimating the energy that includes upper limb movements, which form a crucial part of interacting with the handheld controllers of the Wii and that are neglected in the previous study. Including upper limb movements promises more accurate results and indeed, the authors report higher activity levels than in the previous study. Figure 1.1 shows the energy expenditure levels that Graves and colleagues (2008) find for the Wii Sports games, in comparison to a rest value and a sedentary video game on the Microsoft XBOX 360 video game console.

Of all the Wii Sports games (i.e. baseball, bowling, boxing, golf, and tennis), boxing reaches the highest activity levels. The authors conclude that while the intensity of real boxing is much higher, the intensity of the Wii Boxing game exceeds the cut-off for moderate intensity physical activity. It is thus high enough to contribute to daily recommended amounts of physical exercise [2].

Figure 1.1
Energy Expenditure of Adolescents whilst Playing Video Games, from Graves et al. (2008)



Besides in obesity prevention, active video games are also envisioned for use in rehabilitation. The field of Virtual Rehabilitation since longer uses virtual reality technology for the rehabilitation of patients (e.g. Burdea, 2003; Holden, 2005). Recently also physical activity promoting video game consoles are deployed in rehabilitation measures. Morrow and colleagues (2006) present a rehabilitation system which is based on Microsoft's XBox. They advocate the use of entertainment technology for physical rehabilitation, mainly to reduce system costs. Galego and Simone (2007) combine a Wii remote control and Second Life into a Virtual Rehabilitation system. Like Morrow and colleagues, they point out the potential of such low cost rehabilitation approaches. Though there are no

[2] This was confirmed by Lee Graves and Tim Cable in a personal conversation with the author at the "Play Away the Calories" event on 26.03.2008 at the Dana Centre, Science Museum, London, UK.

results of scientific evaluations available yet, therapists have already coined the term "Wiihabilitation" and report of increased motivation of their patients, who are often unmotivated to carry out very repetitive limb movements [3].

While game consoles that employ active body movement are used in rehabilitation therapies, they also appear to bring new patients to rehabilitation institutes: Injuries from playing the Nintendo Wii are reported in popular media and doctors have already introduced the diagnosis "Wiitis" (Bonis, 2007) or "Wii shoulder" (Cowley & Minnaar, 2008). Bonis describes the condition as follows:

> "If a player gets too engrossed, he may 'play tennis' on the video screen for many hours. Unlike in the real sport, physical strength and endurance are not limiting factors" (Bonis, 2007, 2431).

It is also an example for how much the interaction with the Wii is dependent on arm movements. One can speculate that the reason for such injuries is that players do not perceive their video game consoles as a sport devices and consequently do not care about warming up before playing. This is certainly an issue that should be addressed in future research as well as in future game design. Otherwise the health improving effect of the physical activity can degrade.

But not only physical health improves from an increase in physical activity: Riskind and Gotay (1982) find that the sheer posture of a person has influence on the mental state. Subjects that are put in a hunched and threatened posture report greater stress than subjects that are put in a relaxed posture. Fox (1999) reviews studies that investigate the influence of physical activity on mental well-being. He concludes that there is growing evidence that exercise increases mental well-being, largely through improved mood and self-perception.

Returning to a video game context, Bianchi-Berthouze and colleagues (2007) find evidence that body movements as an input device do not only increase the gamer's level of engagement, but also have an influence on the way a gamer becomes engaged. Their results demonstrate that the controller itself plays a critical role in creating a more complete experience for the gamer.

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[3] Tanner, Lindsey (Associated Press). Break a leg? Try 'Wiihabilitation'. msnbc, 08.02.08. Retrieved on 09.08.08 from http://www.msnbc.msn.com/id/23070190/

Whether the increase in engagement in physically active environments is due to the actual physical activity or to a higher perceived level of control remains open for research. Yet, more knowledge is needed about the link between physical activity and engagement.

It can be concluded that video games that promote physical activity have the potential of improving the gamer's health in several ways. Yet, further investigation is necessary for a number of issues. For instance, scientific research can and should assist in solving ergonomic issues, measure the effectiveness of games, and help improving the experience of the gamers, to increase their motivation to use such systems.

Chapter 2

Experiencing Games and Physical Activity

There are several models that explain the experiences that gamers make when playing video games. Similarly, there are models that account for experiencing physical activity. The potential of physical activity in video games for a healthier and more enjoyable interaction has been pointed out in Chapter 1. Yet, the study of experiencing physical activity in games is still in its infancy. It is the aim of this study to extend the knowledge of how physical activity influences the gaming experience.

2.1 Modeling the Gaming Experience

The experiences that users make when using interactive systems have been studied widely and remain an important subject of study (see e.g. Hassenzahl & Tranctinsky, 2006; McCarthy & Wright, 2004; Norman, 2004). To give an overview of theories that capture the user experience in games or gaming experience, immersion, presence, and flow are discussed below.

Csikszentmihalyi (1990) develops his theory of flow while investigating happiness. Flow can be described as "the feeling of complete and energized focus in an activity, with high level of enjoyment and fulfillment" (Chen, 2007, 31). In his original conception, Csikszentmihalyi (1990) reports eight major components of flow:

1. a challenging activity requiring skill,
2. a merging of action and awareness,
3. clear goals,
4. direct, immediate feedback,
5. concentration on task at hand,
6. a sense of control,
7. loss of self-consciousness, and
8. an altered sense of time.

An important flow concept, in particular in a gaming context, is the flow zone. A person is in the flow zone when the person's abilities are matched by a challenge. Too much challenge leads to frustration, too little challenge to boredom (Csikszentmihalyi, 1990). Chen (2007) therefore recommends games to be adaptive to the gamers' skills, in order to keep them in the flow zone.

Based on flow theory, Sweetser and Wyeth (2005) create the GameFlow model. Essentially they map elements from game design literature to the aforementioned components of flow, as can be seen in table 2.1.

Table 2.1
GameFlow: Mapping Elements from Game Literature to Flow (from Sweetser & Wyeth, 2005)

Game Literature	Flow Component
The Game	A task that can be completed
Concentration	Ability to concentrate on the task
Challenge Player Skills	Perceived skills should match challenges and both must exceed a certain threshold
Control	Allowed to exercise a sense of control over actions
Clear goals	The task has clear goals
Feedback	The task provides immediate feedback
Immersion	Deep but effortless involvement, reduced concern for self and sense of time
Social Interaction	n/a

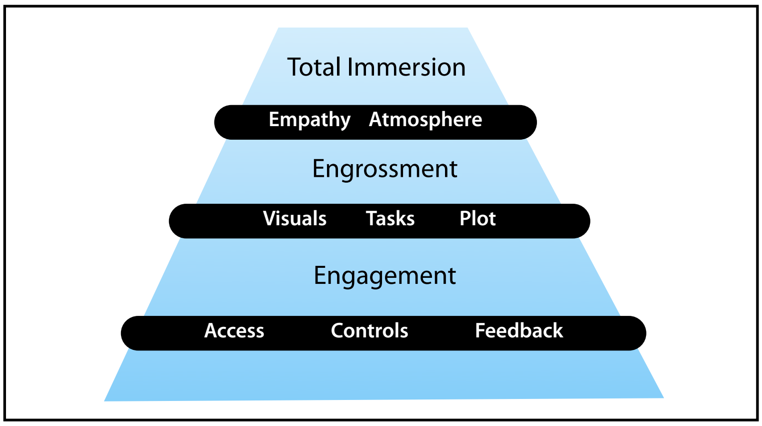
Sweetser and Wyeth describe an initial validation of their model in form of expert reviews. They report the model is able to distinguish high-rated from low-rated games and giving evidence for the success respectively failure of a game. They conclude that the model in its current state is useful for evaluation of games but further research has to be carried out to create tools to assist in designing and evaluate enjoyment in games.

Immersion is another conception used to model the gaming experience. The following definition by Murray is quoted widely (e.g. Ermi & Mäyrä, 2005; Arsenault, 2005; McMahan, 2003) and is described as the most accepted one (McMahan, 2003):

> "The experience of being transported to an elaborately simulated place is pleasurable in itself, regardless of the fantasy content. We refer to this experience as immersion. Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus..." (Murray, 1997, 98).

Despite the rather vague nature of the conception there are several approaches to model immersion in a gaming context. Brown and Cairns (2004) interview gamers regarding their experiences during gameplay and find three levels of immersion, labeled engagement, engrossment, and total immersion. For each level there exist barriers that have to be overcome to reach the level. Figure 2.1 clarifies the relation between levels and barriers.

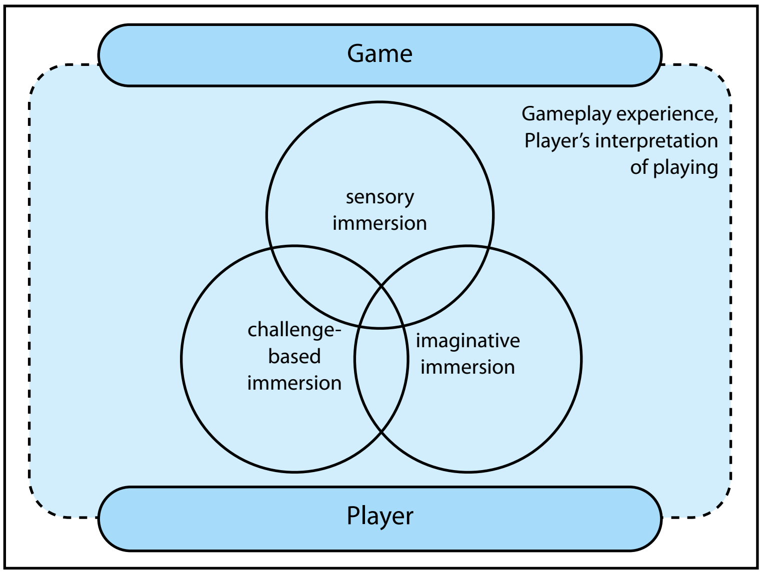
Figure 2.1
Three Levels of Immersion from Brown and Cairns (2004); own depiction



To reach engagement, the first level of immersion, access must be provided. This refers to the gamer's preferences and game controls. The gamer must also be willing to invest time, effort, and attention. Bad game construction is the barrier to engrossment, which in Brown and Cairns' terms refers to visuals, tasks, and plot. Brown and Cairns point out that at this stage the gamers have already invested emotionally into the game and this makes them continue gaming. Total immersion is the final level and it is described as being cut off from the world to an extent where the game is all that matters. Barriers to total immersion are a lack of empathy with game characters or a lack of feeling the atmosphere of the game. In a follow-up study, Cheng and Cairns (2005) investigate the stability of immersion. Here, they attempt to deliberately break the immersion of subjects and find that already low levels of immersion make subjects ignore drastic changes in the games' behavior.

A totally different approach to immersion is reported by Ermi and Mäyrä (2005). Looking into different qualities of immersion they interview gaming children and their non-gaming parents. This way they identify three different types of immersion: sensory, challenge-based, and imaginative (SCI), from which they built their SCI-model, which is shown in Figure 2.2.

Figure 2.2
Three Types of Immersion from Ermi and Mäyrä (2005); simplified



Sensory immersion refers to sensory information during gaming. Large screens and powerful sound are given as examples where sensory information of the real world is overpowered and the gamer entirely focuses on the game. Challenge-based immersion is described as most powerful when a balance between the abilities of the player and the challenge of the game is achieved and as such seems to correspond to the flow concept mentioned earlier. Finally, imaginative immersion happens when the player gets absorbed with the story line and identifies with the game characters.

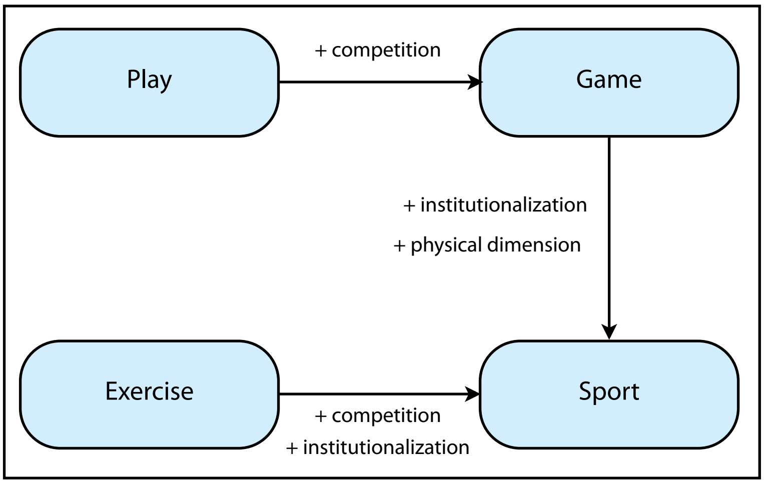
Presence is another term that appears in the literature to describe the gaming experience. The term originates from studies into virtual reality and is often defined as "the feeling of being there" (Ijsselsteijn & Riva, 2003). Cairns and colleagues (2006) argue that presence in virtual reality context corresponds to immersion in a gaming context. Similarly, Ermi and Mäyrä prefer the term immersion as "it more clearly connotes the mental processes involved in gameplay" (Ermi & Mäyrä, 2005, 19). Most scholars seem to agree with this view and see immersion as the appropriate term when speaking of user experience in a gaming context.

The GameFlow model as well as the two models based on immersion allow an assessment of the user experience during gameplay. What lacks in these models is an understanding of how body movements or physical activity during gameplay influences the gaming experience. To get a better understanding of the magnitude of the influence that physical activity can have, the following section looks at psychological and social effects of physical activity in everyday life.

2.2 The Experience of Physical Activity

What motivates people to engage in physical activity? This section gives an overview of theories of enjoyment of physical activity. But it appears reasonable to first disentangle different types of activity, i.e. play, game, sport, and exercise, before focussing on motivation and enjoyment and clarify their relationship. Figure 2.3 illustrates that relationship:

Figure 2.3
Types of Physical Activities



Play can be defined as "behaviour for the purpose of fun and enjoyment with no utilitarian or abstract goal in mind" (Shaw et al. 2005, 2). Shaw and colleagues list 4 reasons why people play: First, play serves relaxation and recuperative purposes. Second, play can be used to reduce surplus energy. Third, play is an opportunity to practice and rehearse skills. Finally, play can be important to reduce anxiety by confronting one's fears in a safe environment.

Play becomes game when competition is involved in the activity. Shaw and colleagues define game as "any form of playful competition whose outcome is determined by physical skill, strategy or chance" (Shaw et al., 2005, 2) and give the following example to illustrate the difference: If one is playing ping pong for fun without keeping score it is play. Once score is kept it is game.

Sport is defined as "institutionalized competitive play involving physical skill, strategy and chance" (Shaw et al., 2005, 2). The two criteria that distinguish sport from game are institutionalization and physical dimension. Shaw and colleagues give 4 forms of institutionalization: First, sport involves a high degree of organization, in terms of governing bodies, leagues, and sponsors. Another form is technological development, which refers to equipment, clothing, and facilities. Ceremonies and rituals add a symbolic dimension to sport. Finally, sport includes educational aspects that are represented by coaches or written manuals. Apart from institutionalization, a physical dimension is required for sport. This does not necessarily require fitness. For instance, dart can still be seen as sport, while bridge hardly qualifies as sport and suits better into the definition of game. Exercise finally is defined as "any form of physical activity carried out for the purpose of health or fitness" (Shaw et al., 2005, 2).

It should be noted that some activities do not fall into one of the categories and can be rather seen as hybrids in this framework. Still, the framework is helpful to get a clearer view on different types of activities and their specific characteristics.

Jackson and Csikszentmihalyi (1999) apply Csikszentmihalyi's (1990) theory of flow to the sport domain. Similar to Sweetser and Wyeth's (2005) adaption of the theory into the gaming domain (as discussed in section 2.1), they relate the components of flow to aspects an athlete should consider in sport. With the limitation of being intended for a broad audience as a guide to better sport experiences, it still gives some valuable insights into the study of sport experiences.

Figure 2.4
Model of the flow state (from Jackson & Csikszentmihalyi, 1999, 37)

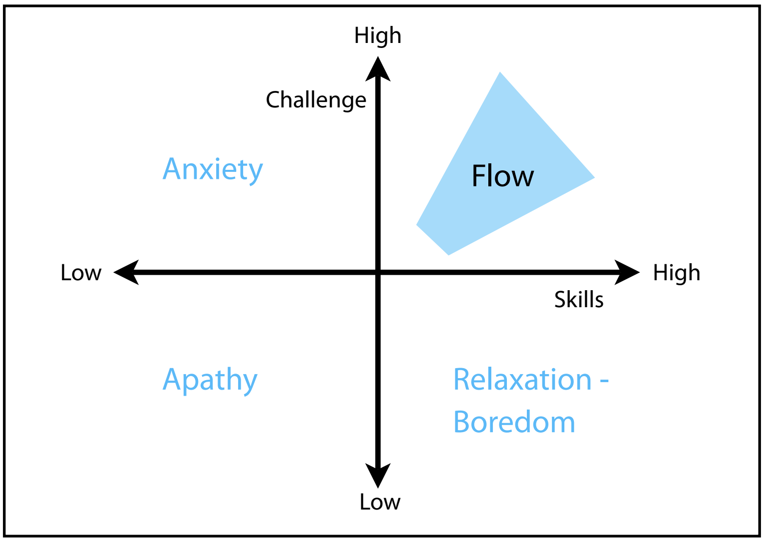


Figure 2.4 shows how flow can only happen when the challenge at hand is matched by a person's skills. When the challenge is too low boredom occurs, if the skills are insufficient a person might experience anxiety. Both low challenge and low skills result in a state of apathy. Only when both the challenge is demanding and the skills are high enough to measure to the task the state of flow can be reached. In this context it should be noted that not an objective measurable challenge is decisive for the experience, but rather how a person subjectively estimates the challenge. The same holds for skills: A person might objectively have sufficient skills for a task,

but if for some reason the person has only little confidence in his abilities then anxiety or apathy are bound to set in.

2.3 State of the Art of Physical Activity in Games

While we have no models of the gaming experience including body movements at present, there are several initial investigations into the area, which are presented in the following.

Table 2.2
Taxonomy of exercise games by game world and user interface (adapted and shortened from Yim & Graham, 2007)

	Game World		
User Interface	Virtual World	Augmented Reality	Reality
Free Motion Interface	Eye Toy, Wii Sports, Dance Dance Revolution	Laser Tag Human Pacman	Football
Equipment based physical interface	GameBike PowerGrid Fitness	*Open for research*	Cycling
Traditional Electronic Interface	-	*Open for research*	Radio Controlled Cars

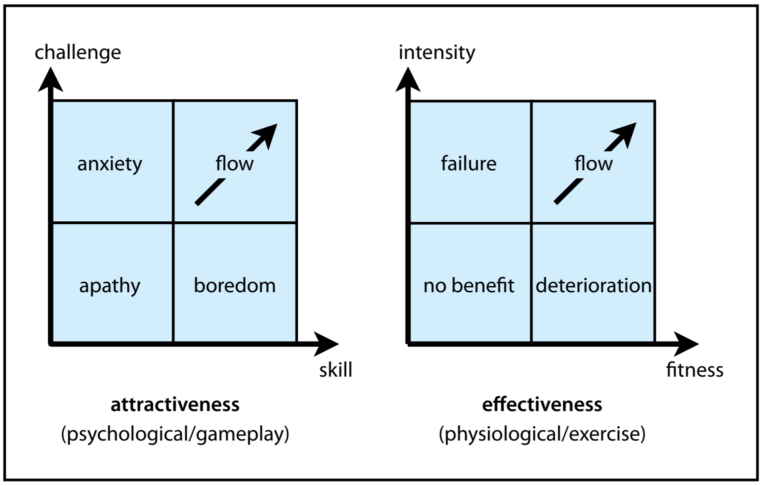
Yim and Graham (2007) present a two-dimensional taxonomy of games that promote physical activity, based on game world and user interface. Table 2.2 categorizes existing exercise games into that taxonomy. As can be seen from the table, the big commercial successes - leaving out real life sports such as soccer or cycling - namely Nintendo Wii, Konami Dance Dance Revolution and Sony EyeToy, are all in the category that is described by free motion allowing interfaces, while taking place in a virtual game world.

The only attempt for a model of body movements in video games so far is described by Sinclair and colleagues (2007). In fact, their work focusses on exergames, a subgroup of movement-based games, which are physically intense games that promote the improvement of fitness levels along with extensive use. Their Dual Flow model bases on flow theory (Csikszentmihalyi, 1990). Figure 2.5 shows the Dual Flow model. It encompasses the two dimensions attractiveness and effectiveness. Attractiveness here is modeled by the standard model of Csikszentmihalyi's flow theory. This model calls for a balance between a gamer's perceived skills and the perceived challenge he is facing. Thus, it can be seen as the mental side of the dual flow model. Effectiveness is modeled as the physical side, calling for a balance between fitness, which is defined as the body's skill in tolerating exercise and intensity, which is defined as the challenge of the exercise of the body.

The left side of Figure 2.5 corresponds to the standard flow model of Csikszentmihalyi (1990) that has been touched on earlier, and its four quadrants that are presented in Figure 2.4. To achieve a state of flow, which Sinclair and colleagues (2007) translate into the attractiveness of movement-based video game, a balance between the perceived skills of a gamer and the perceived challenge must be established. Boredom sets in if the gamers skills outmatch the challenge. If on the other side the challenge is too high for the gamers skills anxiety occurs. A lack of both skills and challenge leads to a state of apathy.

Sinclair and colleagues (2007) again use four quadrants to model the physical side of their dual flow model. Here, a state of flow sets in if the fitness of the gamer matches the intensity of the exercise that is experienced in the game. This leads to an improvement in the gamer's fitness. Whereas when the intensity surpasses the fitness level of the gamer, failure occurs and the gamer cannot continue. Deterioration sets in when the fitness level of the gamer greatly outmatches the intensity, where the fitness levels will drop. If both fitness level and intensity are low, there is simply no benefit to the use of the game.

Figure 2.5
Dual Flow Model (from Sinclair et al., 2007)



In non movement-based games there only has to be match between skills and challenge. Sinclair and colleagues (2007) point out that in commercial development projects this is achieved through extensive testing, which leads to fixed levels of challenge. They claim that in movement-based games this fixed matching is less effective:

> "Tuning each successive level of an exergame to achieve a balance of player skill, level of general fitness, and current physical tiredness becomes problematic." (Sinclair et al., 2007, 294).

While it is relatively save to assume that in traditional games the gamer's skills increase parallel to playing time and difficulty level, this is more complicated for movement-based games. Here, the daily form of the gamers can vary significantly. As a solution Sinclair and colleagues (2007) envision games to monitor the gamers current skill level and modify the difficulty level accordingly:

> "Rather than just the simple feedback of clearly indicating success or failure to the player, feedback from the player relating to fatigue, exercise level, and boredom should be used to infer the player's current physical state and adjust the level of challenge accordingly." (Sinclair et al., 2007, 294).

2.4 Aim of the Study and Approach taken

In their review of studies into social and psychological effects of video games, Lee and Peng (2006) come to the conclusion that there is a lack of research on gameplay as an entertainment experience. They assume that the existing research would be more systematical if it was based on a theoretical understanding of the gaming experience. Their conclusion, that if we really want to understand games then we need to know what happens during gameplay, i.e. how gamers experience their games, is seconded by Ermi and Mäyrä (2005). Lee and Peng (2006) also criticize that most research has been done on media contents, while media forms have been neglected. They quote to Reeves and Nass (1996) who insist that

> "media forms such size, fidelity, cuts, synchrony, and movements are equally important factors for determining psychological impact of media" (Lee & Peng, 2006, 340).

Several models have been proposed to account for the gaming experience, the most prominent ones being immersion (e.g. Brown & Cairns, 2004; Ermi & Mäyrä, 2005) and flow (e.g. Sweetser & Wyeth, 2005; Chen, 2007). But how do gamers experience body movements in their games? The existing scientific models for the gaming experience fail to account for body movements and physical activity during gameplay. The DualFlow model of Sinclair and colleagues (2007) does propose to establish flow on a mental and physical plane, but does not show how this can be achieved.

Understanding how gamers experience games that enable and require physical activity is a basic requirement if we want to inform designers on how to build games for richer and better experiences. Sinclair and colleagues conclude that "the idea of exergaming, is still in its infancy, when it comes to systematic research" (Sinclair et al., 2007, 294).

The existing scientific models of the gaming experience fail to account for body movements and physical activity during gameplay. It is the aim of this study to contribute to the study of movement-based games, which is still at an early stage. As such it is quite difficult to formulate concrete research questions from the very beginning.

The approach of this study is thus an exploratory one: The general aim is to find out more about how gamers experience body movements in their games.

As a first step of investigation an interview study (Chapter 3) is conducted to unravel how gamers experience, conceptualize, and interpret their movements when playing movement-based games. Anticipating the results, this study shows interesting outcomes on what motivates gamers to engage with movement-based games and which strategies they employ, how important the feeling of control is and how movement-related factors relate to our current understanding of the gaming experience.

After completing the first study a decision had to be made which of the three aspects should be investigated further. It was decided to further investigate motivations and strategies. At this stage it is possible to formulate a more precise research question: Can we find the differing motivations and respective strategies back in the movements of the gamer? Identifying behavioral patterns for the differing motivations and strategies would be an important step towards monitoring movements in order to steer the gamer towards a healthier and more enjoyable interaction (as described in Section 2.3).

To answer the research question, a motion capture study is conducted (Chapters 4+5). Conclusions from both studies and pointers to future work are presented in Chapter 6.

Chapter 3

Modeling Physical Activity in the Gaming Experience

As shown in Chapter 2, knowledge about the relation between physical activity and gaming experience is limited. In an exploratory approach, interviews are held with experienced video gamers, with the aim of investigating how they experience, conceptualize, and interpret their movements when playing movement-based video games.

3.1 Setup Interview Study

Interviewees are recruited from graduate students at the UCL Interaction Centre of the University College London. Four experienced video gamers are enlisted for this study. It is not useful to recruit novices, as some level of exposure is required for interviewees to reflect on their experiences with movement-based games. The interview sessions are held in a semi-structured style and initial outcomes are used to update the interview guide for the following interviews. A 20 minutes session of playing the Nintendo Wii Sports games primes the interviewees before the interview. The subjects are asked to play two different games on the Nintendo Wii, each for about 10 minutes. The particular games are changed for the different participants to avoid possible biases due to characteristics of a certain game. Still, in all sessions it is ensured that participants play one fast-paced game (boxing or tennis) and one slow-paced game (bowling, golf or baseball). The intention for this is to ask about differences between the games later in the interview session, i.e., how the amount of physical activity and the type of movement may affect their gaming experience.

While playing the games, participants are video taped. This is done to be able to look for certain patterns in their behaviour. Should questions arise during the analysis of the interviews the video tape might give evidence why a certain statement has been made.

The interviews are transcribed and analyzed using a Grounded Theory approach. Grounded Theory is a methodology for qualitative analysis, developed by Glaser and Strauss (1968). In Grounded Theory, interview data is analyzed by first assigning codes to statements of the interviewee. This coding process and thus the analysis process itself start right after the first interview. Preliminary results are then used to further develop the interview guide for the remaining interviews. But not only the explicit statements of interviewees are used for analysis. In fact, Goulding (2002) recommends using additional observational data in form of memos, that contain impressions that the interviewer had during the interview. In the coding process, labels are assigned to the statements that interviewees made. The next step in Grounded Theory is to identify relations between the labels and structure the codes until concepts appear from it. In big qualitative studies, there can be an additional step that combines the numerous concepts into a theory. In fact, different schools of thought within the Grounded Theory community apply it in different ways and to different extents. The following paragraph presents the approach as it is conducted in this study.

Practically, the first step after conducting an interview is to produce a transcript of the interview. This is done using a trial version of the transcription and subtitling tool Inqscribe[4]. As Grounded Theory demands, transcripts are written right after an interview. Then, open coding is applied to the statements, i.e. labels are assigned to the statements of the interviewees and the observations.

Figure 3.1
Snippet from Open Coding Document

Do you also play to relax, or is challenge the essential ingredient for you?

I find some of the challenges relaxing because it takes you away from your day to day routines. I mean there is relaxing where you just sit in front of the TV and just let things brew over you. But by self I like doing a little bit of bowling, or boxing, or some golf. It's relaxing and takes me away from day to day and I don't take it too seriously and I am not too worried about the scores. It's just a bit of fun and relaxing and I can switch it of after 20 minutes. So I find the challenge relaxing in itself as well. **["Takes you away"]** **[Relaxation]** **[Challenge]**

> **Memo.** He finds challenge relaxing. Because "it takes you away from everyday life". Says he can feel challenged without worrying about scores. Maybe it is just wording, but I should rethink the concept of challenge, at least define it carefully. Same for relaxing.

To further illustrate the analysis process, Figure 3.1 shows a snippet from the open coding document. Just prior to the passage that is shown here, the interviewee states that challenge is his main motivation to engage in leisure activities, be it in sports or video games. Because other

[4] The trial version was obtained from http://www.inqscribe.com

interviewees mention relaxation as a motivation to engage with video games the question here aims at prompting this interviewee to comment on relaxation and compare it to challenge. In fact, he answers that he sometimes finds challenge itself relaxing, because it takes him away from his daily routine. He goes on by dissecting the concept of relaxation and distinguishes two types of relaxation: The first type is passive where one lets "things brew over you". The second type is an active relaxation by doing something that takes you away from daily routine. This view on relaxation is a new occurrence in the data. Therefore a memo is added to the transcript, phrasing the interesting item in own words and noting how it can be further investigated. In this case, it is added to the interview guide, to investigate how other players think about it.

In the open coding process, three codes are assigned to this passage: "Takes you away", "Relaxation". and "Challenge". These codes together with many others are collected. In a next step relations between codes are identified and similar codes combined. This way, concepts emerge from the vastness of interview data. The concepts shall be presented in the following sections. To give the reader a better understanding of how statements result in concepts, some exemplifying statements are added in appropriate places. Backing up every item with statements would expand the sections far beyond their significance for the remainder of the study.

3.2 Outcome on Motivation

A concept that emerges quite early in the data is that gamers have several distinct motivations to engage with movement-based games. In fact, some experienced gamers seem to be aware of their changing motivation and adapt their gaming strategy accordingly:

> "As you play and play you start to realize that you don't really need to swing and it's just a small movement that you need to make - so I tend to play more technically rather than emotionally. [...] When I am playing to relax and I play baseball, I swing like I would with a real baseball bat. But if I am playing to beat somebody else then I do what I need to do to do the movements." (i3)

The statement of interviewee 3 shows he has realized that he does not need to swing his arm with force. For the Nintendo Wii it is sufficient to make a small movement from the wrist. The challenge is thus the timing of the movement. In fact, to achieve a higher score it is often beneficial to only make small movements from the wrist, as this allows a more precise control. Nevertheless, the interviewee states that sometimes he deliberately makes big, forceful movements, when his motivation is not to achieve a high score, but just to relax and immerse into the virtual environment. It can be concluded that a gamer can approach the same movement-based game with different motivations.

It can also be concluded that there are two different strategies that gamers employ when playing a movement-based game and that they derive from different motivations to play in the first place. Figure 3.2 shows a representation of how the motivations relate to the strategies.

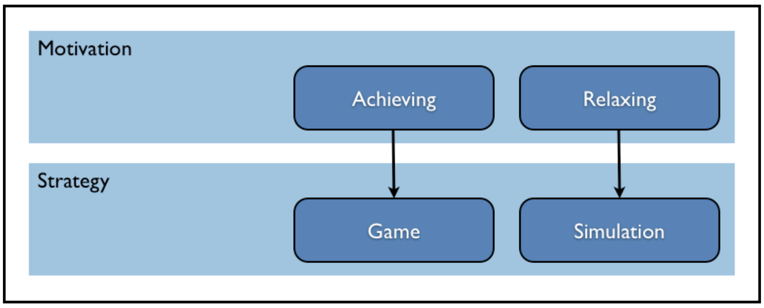


Figure 3.2
Motivations and Strategies of Gamers Engaged in a Physically Active Video Game

In the first case, the gamer is playing a game with the motivation to challenge his/her ability to find the best way to make points and have fun. The aim is to win and to achieve something. The related strategy is thus to maximize all efforts towards achieving a high score.

In the second case, the motivation for playing is to relax by experiencing and/or challenging their movement skills like they would do in a non-competitive sport situation. Relaxation here does not refer to physical relaxation, but rather a mental relaxation that derives from immersing into the game and imagining oneself as playing the actual sport, not just a video game. Gamers that want to relax in such a game employ a different strategy. Instead of optimizing their gameplay towards achieving a high score they rather simulate the actual sport, i.e. they do the same movements as they would in the actual sport or how they think a good player would execute the movement in the real sport.

3.3 Outcome on Control

Control appears to be a major factor in the gaming experience that includes body movements. It is mentioned extensively throughout the interviews. Though the notion is speculative without further investigation, it maybe the case that control is even more important in movement-based games than in other forms of gaming.

How easy the game controls can be understood is also an important point for the interviewees. The learning of the controls can be facilitated by addressing the gamer's experience of similar activities in real life. It is seen as positive when gamers can transfer real world knowledge to learn the necessary movements for the game.

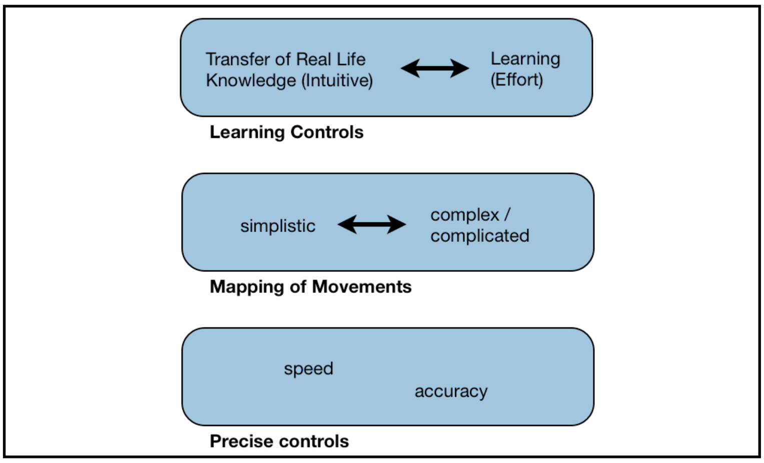


Figure 3.3
The Concept of Control in Movement-based Games

Figure 3.3 gives an overview of the items that are identified in relation to control. Many comments refer to the learning of the controls. This maybe due to relative novelty of movement-based games, but nevertheless gives interesting insights:

> "It is like tennis, I really like playing tennis in real life. And with the Wii I really like playing tennis, but you don't have as much as control, you can't move the players yourself. So I don't really see it as playing in real life. But then again bowling, it sort of involves the same movements [...] With the bowling you are doing the same as you would be doing in a bowling alley, except for the running. You know, the whole arm chucking movement. Whereas tennis, you're hitting a ball but you don't get that sort of feeling as you would have in real life." (i1)

> "The games I liked most so far are the sports games. I don't know why, but the principles are very simple, the controls are very easy and intuitive and it's big fun to play with friends." (i2)

Interviewee 1 describes playing Wii tennis as an incomplete experience. It does not feel like playing real tennis, whereas she gets that feeling from Wii bowling. From the comments of interviewee 2 it seems that games that mimic real life activities should replicate the movements in those activities quite accurate. They should be "intuitive". For scenarios that mimic real life this is quite straight forward, but it also leads to the question of what determines the movements in a fantasy game with no reference to a real world scenario? What are the mental models of users here, what do they expect? How can something be intuitive when users have no connection to something similar that they have already experienced?

> "... But I think with the technology that we have so far it might be limited how it can be really reflected. In boxing for example, what I said earlier, the type of punches that I can do are not really reflecting the diversity that I can have in real life." (i2)

Another important concept relating to control can be described as the mapping of movements. This refers to how well the gamer's movements are replicated on screen and how the game reduces the high degrees of freedom of possible movements that a gamer can make. Interviewee 2 states that he is unsatisfied with the fact that the system does not replicate the movements exactly as he executes them. Still, he acknowledges that there are technical limitations involved. Interestingly, when it comes to the Wii Tennis game, interviewees are positive about the fact, that they cannot steer the movements of the avatar itself, but only execute the swings, stating that this is already difficult enough.

Finally, there are statements that relate to the precision of the Wii controllers:

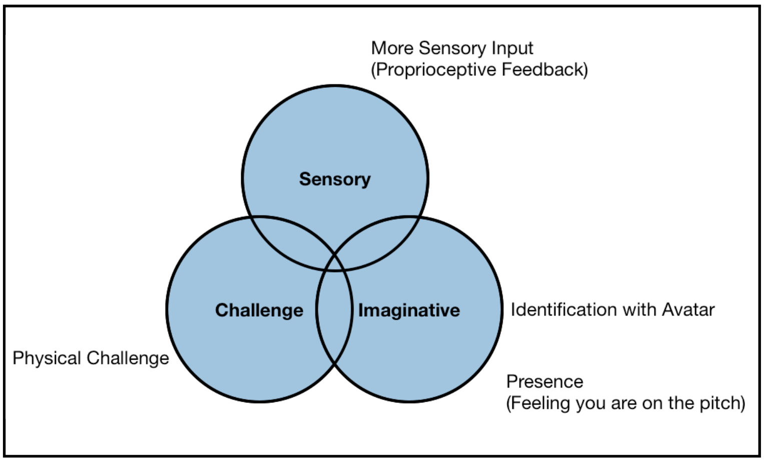
> "Boxing was much more intuitive, especially at the end when I figured out that I had to slow down to stay at the pace of the game and then I could really control it well." (i4)

This is but one reference where the interviewee complains that the game cannot follow the speed of his movements. In particular, it appears, the interviewee is not happy with adjusting to the game, but rather expects the game to adjust to him. In other instances, interviewees are not happy about the accuracy of the controllers. It is speculative if there is an overlap with the item "mapping of movements" and that the game simply limits the amount of movements that are executed on screen.

3.4 Outcome on Immersion

The statements of the interviewees are also analyzed in the context of existing models of the gaming experience. The Grounded Theory approach of before is left for this, as it is not recommended in Grounded Theory to analyze statements against a particular existing theory, but with an open and maybe even blank mind instead. Nevertheless it appears promising here to check the statements for connections to a model of gaming experience. For the very least it might allow to formulate hypotheses as to how body movements in games can influence the gaming experience. The SCI-model of Ermi and Mäyrä (2005) distinguishes three concrete types of immersion, whereas the immersion model of Brown and Cairns (2005) is rather intangible in this respect (see Section 2.2). It is thus investigated how the statements relate to the constituents of the SCI-model, i.e. Sensory Immersion, Challenge-based Immersion, and Imaginative Immersion. Figure 3.4 shows how physicality-related items relate to the SCI-model.

Figure 3.4
Applying physicality-related items to the SCI-model



Sensory Immersion is defined as the extent to which sensory information from the game overpowers sensory information from the real world. In traditional video games sensory immersion is limited to sight, hearing and touch. These senses belong to the so-called exteroceptive senses (i.e. hearing, sight, smell, taste, and touch).

Body Movement as input modality adds another type of sensory information for the gamer in form of proprioceptive feedback. The proprioceptive sense provides information about the relative position of neighboring parts of the body. It is for instance indispensable for moving without looking at where you go, e.g. walking in the dark. Sacks (1998) reports of a patient that lost her proprioceptive sense and can only walk when she looks at her feet.

By adding another sense into the interaction, the use of the proprioceptive sense when interacting via body movement makes interacting with a video game more realistic. It thus offers the potential for a deeper sensory immersion into the game, as it adds another source of sensory feedback into the interaction.

With regards to Challenge-based Immersion it can be said that according to the statements, body movements seem to extend the challenge that is experienced in a video game from only mental to include also physical challenge. In traditional games, the challenge that is sought after is a mental challenge. In movement-based games a physical challenge is added.

Though the Wii Sports games are unanimously not seen as a replacement for real sports, the demand on the gamer's physical skills is mentioned widely by the interviewees. In particular in multiplayer situations, where gamers play together with friends, the physical challenge is mentioned.

Statements that relate to Imaginative Immersion can also be found frequently. The following statements give an idea of how interviewees connect imagination to body movements.

> "Keeping your arms up all the time and trying eagerly to punch and being in a situation where you can virtually be punched as well is maybe more stress than bowling." (i2)

> "The boxing also felt more personal, because it feels like someone is hitting back at you, although thats not the case. So it's more emotionally engaging." (i3)

Interviewee 3 reports about the Wii Boxing game that it "feels like someone is hitting back at you". Though he is immediately reflecting that this is not possible, there seems to be a strong emotional connection to the avatar. The same is true for interviewee 2 who finds a situation where he can be hit, though it is only virtual, as stressful.

As Bailenson and Yee (2005) show, mimicry can lead to increased empathy with a virtual character. In the case of movement-based video games like the Wii Boxing, the avatar copies the movements of a gamer. It is conceivable that this mimicry of the gamer's movements leads to a stronger identification with the avatar, than in non movement-based games.

Also other indicators for high levels of presence or immersion, like time distortion, or bumping into objects are mentioned by interviewees. In fact, interviewees report of feeling they are "on the pitch". Yet again, it remains speculative if this is due to physical activity or other aspects of the Wii Sports games.

3.4 Further Course of Action

The interview study reveals a number of concepts that go into quite different directions. Accordingly, a number of alternatives for further investigation are present at this point.

The concept of motivation could be further researched by investigating if the two identified motivations and respective strategies can be found back in movement patterns that a gamer exhibits when playing movement-based games. This would be step towards adaptive games that can use movement patterns as input with the aim of guiding the user towards a playing style that is as healthy and engaging as possible. As pointed out in Chapter 1, there are a number of reports on Wii-related injuries.

Also Control offers a variety of topics for further investigation. As in all human-computer interaction scenarios the notion of an intuitive operation is an area of interest here. For games that mimic reality, interviewees often prefer when they could execute the same movements as they would do in real life. Yet, in the tennis game, the simplified interaction model is appreciated. When is realism preferred and when simplification? And how can a movement-based interface be intuitive if there is no reference to a real world scenario, e.g. in a fantasy game?

With regards to the SCI-model, all the physicality-related items that can potentially influence Sensory, Challenge-based, and Imaginative Immersion (Figure 3.3) could be further investigated. For instance, do gamers really empathize more with an avatar that mimics their movements? The levels of empathy could be compared for two scenarios (e.g. Wii Boxing), where in the experimental condition the gamer uses movement as input device and a control group uses a traditional gamepad.

All the alternatives that are only touched on briefly here appear interesting for further investigation. Yet, a choice for a further course of action has to be made for the current study. Identifying movement patterns for the differing motivations and strategies would be an important step towards monitoring movements in order to steer the gamer towards a healthier and more enjoyable interaction. Apart from identifying the patterns in itself, the introduction of a new research method also offers the advantage of method triangulation, and thus verifying the results obtained so far.

Chapter 4

Setting up a Movement Analysis Study

The interview study reveals that gamers approach movement-based games with different motivations, which result in different strategies. A motion capture study is conducted to investigate whether the differing motivations for playing and therefore deviating strategies can be found back in movement patterns. In addition to objective measures as motion capture data and video recordings also subjective measures in the form of extensive questionnaires and observer ratings of the video recordings are employed, in an attempt to find more factors that influence movement patterns.

4.1 Procedure

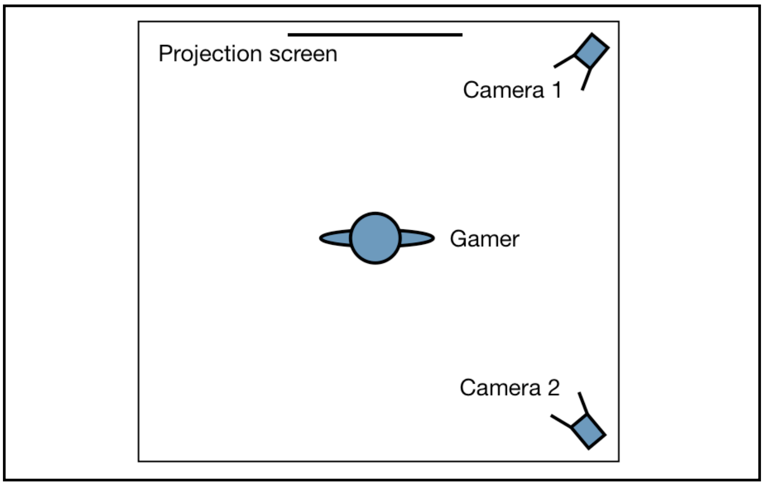
For this experiment, participants are enlisted from graduate students at UCL. They are recruited via personal communication with no incentives given.

After consenting to take part and filling in an initial questionnaire, participants are fitted with an inertial gyroscopic motion capture suit (Gypsy 6, Animazoo, Brighton, UK). They are then given a short introduction to the Wii Boxing game and instructed to play for 15 minutes. Before that, video cameras and the recording of the motion capture data are activated. To avoid biasing the participants, the experimenter leaves the room during the gaming session. After 15 minutes, the experimenter returns and the participants are released from the motion capture suit. Afterwards, participants fill in a second questionnaire.

Figure 4.1 shows the spatial setup of the experiment from a top view. The participant stands in a room with enough space to all sides to move freely during gaming. The output of the Wii is projected onto a screen with a diameter of approximately 2 meters.

The Wii Boxing game is chosen, as it is the game with the highest activity levels within the Wii Sports games, as discussed in Section 1.1. Unfortunately and unforeseeable, it turns out that the boxing scenario puts too much stress on the motion capture suit. The powerful punches of some participants lead to breaks in the mechanical parts of the exoskeleton. The original aim is to have 20 participants to allow a proper statistical analysis. After three incidents that require repairs of the motion capture suit it is decided to stop the experiment at a count of 10 participants (thereof 7 males; mean age: 26 yrs, SD: 2.6).

Figure 4.1
Setup of the Motion Capture Study;



4.2 Questionnaires

Table 4.1 gives an overview of the sub-questionnaires that participants filled in. The complete questionnaire can be found in Appendix B. In general, the aim of employing the questionnaires is to find more factors that influence movement patterns. The approach at this point is still an exploratory one and there are rather assumptions than strong hypotheses behind the selection of the questionnaires. In the following an explanation of the questionnaires chosen and the motivation for choosing the particular questionnaire are given.

Table 4.1
Subjective Measures in the Movement Analysis Study

Before Gaming		
Big Five Inventory	BFI-44	John & Srivastava, 1999
Sports Motivation Scale	SMS-28	Pelletier et al., 1995
Leisure Motivation Scale	LMS-28	Pelletier et al., 1991
Prior Experience with Wii and Boxing	PRE-9	own compilation
After Gaming		
Physicality and Wii specific items	POS-9	own compilation
Rating of Perceived Exertion	RPE-2	Borg & Linderholm, 1967
Self-assessment Manikin	SAM-2	Bradley & Lang, 1994
Immersion Questionnaire	IMM-31	Jennett et al. (unpublished yet)

The first sub-questionnaire given before the gaming session is the Big Five Inventory (John & Srivastava, 1999), a questionnaire assessing personality that consists of 44 items and scores participants on five personal traits (i.e., Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness). The interview study reveals motivation as a decisive factor for the way a gamer engages with a movement-based game. The personality questionnaire is employed to see if personal traits can be correlated to motivation and movement patterns. It is conceivable that an extroverted person will exhibit bigger movements than an introverted person.

The Sports Motivation Scale (Pelletier et al., 1995) and Leisure Motivation Scale (Pelletier et al., 1991) are chosen to further investigate the phenomenon of motivation and how it influences movement patterns. Both scales consist of 28 items that score participants on seven sub-scales: three types of Intrinsic Motivation (i.e. engaging in an activity purely for the pleasure of it), three types of Extrinsic Motivation (i.e. engaging in an activity for reasons outside the activity, a means to an end), and Amotivation (i.e. motivation is lost or there never was motivation for an activity.). Table 4.2 gives an overview of the different types of intrinsic and extrinsic motivations.

Table 4.2
Intrinsic and Extrinsic Motivation (from Pelletier et al., 1995)

Intrinsic Motivation	
To Know	Gaining knowledge within/during the activity is the motivation here
To Accomplish	Reaching a goal, i.e. successfully finishing the activity is the motivation.
To Experience Stimulation	Experiencing stimulation within/during the activity is the motivation.
Extrinsic Motivation	
Identified	One is aware that the activity is only a means to an end, but is still self-determined (e.g. doing sport to loose weight).
Introjected	One is aware that the activity is only a means to an end, and one feels pressure from outside to do the activity (e.g. doing sports for loosing weight).
External	One does an activity only for another purpose (e.g. doing sports to obtain rewards).

The idea behind using the Sports Motivation Scale and Leisure Motivation Scale is to investigate whether motivation-related issues have an influence on the way a gamer moves. It is conceivable that a person that likes accomplishing things will be more physically active in order to achieve victory in a movement-based game.

An additional, self-compiled questionnaire (PRE-9) is given, that asks about participants' prior experience with the Nintendo Wii in general, the Wii Boxing game in particular, and also their prior experience with (and knowledge of) boxing and martial arts. The assumption behind this is that prior experience e.g. with boxing might be found back in the movement pattern of a gamer. Similarly, a gamer with a lot of experience on the Wii might have developed a movement pattern different from a novice. Table 4.3 shows the questionnaire.

Table 4.3
Self-Compiled Questionnaire before Gaming Session (PRE-9)

	Questions PRE-9
1	How often do you play on the Nintendo Wii?
2	How often have you played the Wii Boxing game?
3	How would you describe your skill level for the Wii Boxing game?
4	Do you have experience in real life boxing or similar martial arts?
5	How would you describe your theoretical knowledge of boxing (eg. from TV)?
6	Do you think playing the Wii Sports games is a good way to stay fit?
7	Do you prefer playing the Wii together with friends?
8	Do you think one can loose weight playing the Wii Sports games?
9	Do you think the Wii Sports games are easy to steer / control?

The first questionnaire after the gaming session (POS-9) is also self-compiled, and asks participants about their view on statements about the gamer's experience and movements. The statements are presented in Table 4.4.

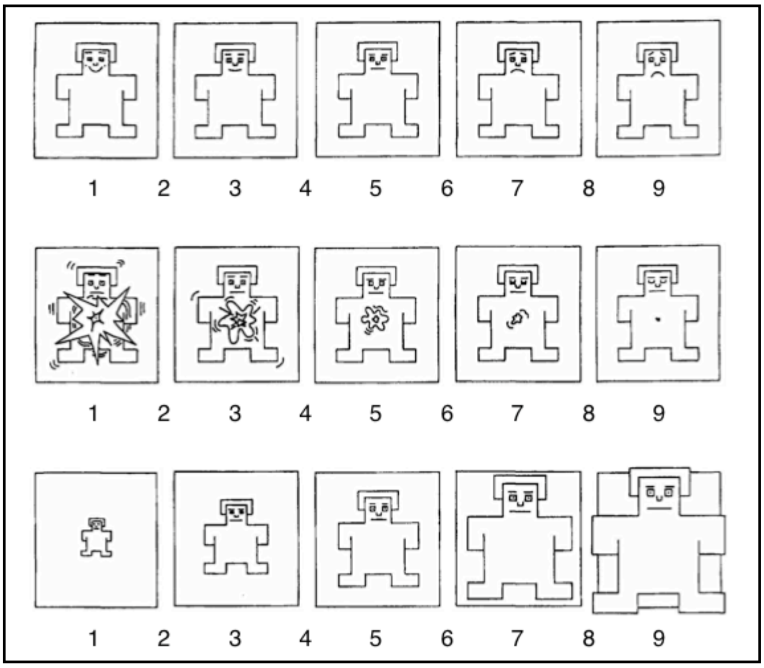
Table 4.4
Self-Compiled Questionnaire after Gaming Session (POS-9)

	Questions POS-9
1	The game responded well to my movements.
2	I didn't know which movements I had to do to steer the game.
3	I had to do the same movements as in boxing in real life.
4	I tried my best to win.
5	I didn't pay attention to the scores.
6	The game challenged me to strive to the limits of my abilities
7	I didn't mind being hit by the opponents.
8	It felt like really boxing someone.
9	When my avatar got hit, it really felt like it was happening to me.

The Rate of Physical Exertion (RPE) is a measure for self-reported exertion, where e.g. athletes rate the exertion they experience on a scale from 6 to 15 (Borg & Linderholm, 1967). At several points on the scale activities with a comparable level of exertion are given as a reference, e.g. walking slowly at one's own pace for some minutes corresponds to a rating of 9. The RPE scale is used here to check if the experience of the gamers influences their perception of exertion.

The Self-Assessment Manikin (Bradley & Lang, 1994) is a measure for self-reported levels of one's emotional state. It shows a rather abstract figure in several instances that visualize varying levels of valence, arousal, and dominance, as shown in Figure 4.2. The manikin is used here as a measure of how gamers rate their own emotional states during gaming and to investigate if there is a connection to their movements.

Figure 4.2
The Self-Assessment Manikin (Bradley & Lang, 1994)



Finally, a questionnaire on immersion is employed. The most advanced immersion questionnaire that could be obtained is developed by Jennett and colleagues [5] . It consists of 31 items that measure the level of total immersion, as well as five distinct factors of immersion: Cognitive Involvement, Real World Dissociation, Challenge, Emotional Involvement and Control. It is employed here to see if deviating levels of immersion can be found back in the movements of the gamers.

4.3 Motion Capture and Video Recordings

The Gypsy 6 (Animazoo, Brighton, UK) motion capture suit is an inertial gyroscopic motion capture suit. It is an exoskeleton that is equipped with 37 potentiometers and 2 gyros that measure the rotations around 16 joints, on both upper and lower body. In addition, the position of the suit in 3D space is measured. The sampling rate of the suit is 120Hz. The data is sent via USB cable or wireless to a PC where the movements can be observed in real-time and are saved in BVH (Biovision Hierarchy) files. Figure 4.3

5 The questionnaire is unpublished yet and was kindly supplied by C. Jennett at UCL Interaction Centre

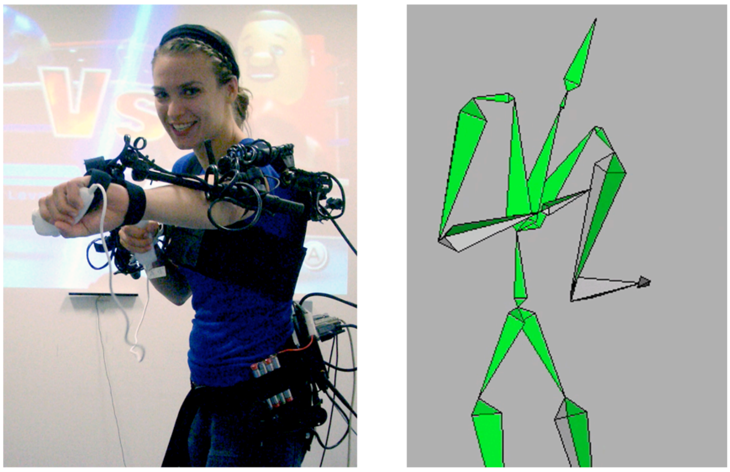
shows a participant wearing the suit and the output of the motion capture data on a model of the human body.

In addition to the motion capture data, video recordings are made from a frontal-lateral angle and from over the shoulder of the gamer, to be able to correlate movements that participants made to game events. The spatial setup of the experiment with the positioning of the video cameras is shown in Figure 4.1.

Figure 4.3
Gypsy Motion Capture System;

Left: Participant in Gypsy 6 Motion Capture Suit;

Right: Output Motion Capture Data on Human Model



4.4 Observer Ratings

Anticipating the results presented in Section 5.2, the immersion questionnaire does not deliver the expected results. There is only little spread in the data, which makes further analysis difficult. It is decided to introduce another measure for assessing the gaming experience: Five observers are asked to rate video clips of the participants. The observers are recruited from students at UCL.

Each observer individually rates 40 video clips, the first 10 being training data that is not used for analysis. The remaining 30 clips consist of 3 clips of each of the original 10 participants, showing them at different points into their gaming session. The clips are shown in a random order. Each clip has a length of 10 seconds and the average rating session takes about 20 minutes. 10 seconds appear as a good compromise between the clips being long enough to allow observers to get a good impression of the participants and short enough to keep the total session time short enough to not tire observers too much. Table 4.5 shows the 7 items to be rated for each clip (a rating sheet can be found in Appendix C). Each question has to be answered on a scale from 1 (total disagreement) to 5 (total agreement).

Table 4.5
Items for Observer Ratings

Rating Item	Question
Concentration of the player	How focused / concentrated is the player?
Eagerness to win	Does the player want to win?
Player enjoyment	Does the player enjoy the game?
Boxing realism	Does it look like the player thinks he/she is really boxing somebody?
Player immersion	How much is the player immersed / "in the game"?
Emotional engagement	How emotionally engaged is the player?
Physical engagement	How physically engaged is the player?

Chapter 5

Identifying Movement Patterns

The aim of the movement analysis study is to find movement patterns and to connect them to items such as personality, motivation for sports or gaming, prior experience with movement-based games or boxing, and gaming experience. A visual inspection of the video footage reveals different playing styles of the participants. An analysis of the various sources of data reveals features that confirm the playing styles and identify corresponding movement patterns.

5.1 Visual Inspection

A first analysis step is the visual inspection of the video footage. This reveals great differences in playing styles. Some participants show extensive arm movements, whereas others only make small arm movements. Table 5.1 shows the subjective impression of playing styles of the participants. Obvious differences exist for punch frequency, punch amplitude, and overall body movement. Roughly, three types of playing style can be observed:

One group of gamers only makes very little extensions of the arms, while punching at a high frequency. Another group of gamers shows big extensions of the arms and also punches at a high frequency, to the extent that it appears they are over pacing themselves. In both groups it appears that the gamers' behaviour is almost independent of game events, i.e. they show only little defensive behaviour, even when their avatar gets hit repeatedly. The third group appears to box realistically, which means they box with big arm extensions and a low to medium frequency of punches. They are also reacting to game events, like moving from punching to defending when their avatar is hit.

Table 5.1
Subjective Impression of Participants Behaviour

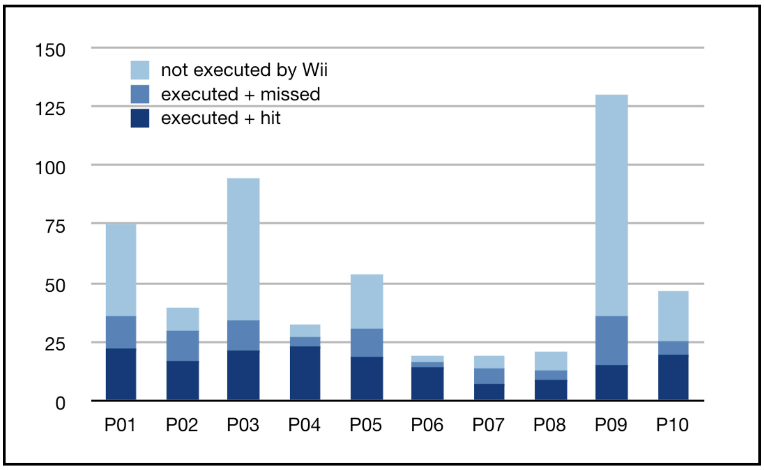
	Impression of gamers experience	Quality of movements	Offensive behaviour	Defensive behaviour
P01	very focused and quite eager to win	fast movements, but not fully extending arms	high frequency of punches	little defensive behaviour, but upper body moves in defense
P02	focused, but appears a bit bored	small, jerky movements, very economic	normal frequency, very regular	shows little defensive behaviour, torso does not move
P03	very focused and very eager to win	very rapid movements	very high frequency of punches	some defensive behaviour, stays long in defensive position, torso does not move
P04	concentrated, but doesn't appear engaged	full extension of arms, very controlled movements	normal frequency, almost seems to wait for 'glove' to come back	no defensive behaviour
P05	eager to win, focussed	full extension, forceful movements	high frequency of big, forceful punches	no defensive behaviour
P06	concentrated, but also smiling occasionally	quite big movements, but still controlled and reading the game	looks like he is waiting for his chance to hit opponent, normal to low frequency	shows some defensive behaviour, torso sometimes moves a bit
P07	was very cautious, didn't want to be hit	punches were slow, but extensive defensive movements	low frequency of punches, slow punches	lots of defensive behaviour, even ducked to avoid punches
P08	was very in the game, really wanted to hit opponent	big, forceful movements, fully extended arms, torso moved in defense	Normal frequency, put the whole body into punches	normal frequency of defense movements, put the torso into movements
P09	looked bored	appeared uncoordinated	very high frequency of punches, only little extensions of arms	very little defense, despite getting hit regularly, torso remained stationary
P10	smiled a lot, looked motivated	fast, fully extending movements	fast, controlled and extensive movements	no defense behaviour

5.2 Quantifying Features

The next analysis step aims at quantifying the features that are deemed important during the visual inspection. Short segments of the video recordings are annotated to measure the punch frequency for each participant. Each segment is taken from the beginning of a new round of boxing towards the middle of the gaming session. The length of each segment is 20 seconds. It is not possible to analyze a longer segment as knock-downs and other game events do not allow longer segments of continuous boxing activity.

Figure 5.1 shows a representation of the punch frequency distinguishing between when a gamer punches but the Wii does not execute the punch in the game, when a gamer punches but misses the opponent ("executed + missed"), and when a gamer punches and hits the opponent ("executed + hit"). The Wii does not execute a punch e.g. when a punch is too soft or when a gamer punches while the avatar is still in the process of executing a previous punch or is recovering from being hit. The respective values can are given in Table 5.2.

Figure 5.1
Number of Punches over a period of 20 seconds



Aside from total punches, Table 5.2 also shows the ratio of punches that actually hit the opponent and the ratio of punches that are executed.

Table 5.2
Results Video Annotation

	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10
Number of Punches	74	39	93	31	53	19	18	20	129	46
Ratio Hit to Total Punches	0.28	0.41	0.22	0.71	0.34	0.68	0.33	0.40	0.11	0.41
Ratio Executed to Total Punches	0.47	0.74	0.35	0.84	0.57	0.84	0.72	0.06	0.27	0.54

The numerical data of the motion capture suit is inspected to reveal more features that can be used to characterize the different playing styles. First, the amount of total movement of the gamers is calculated. It is defined as the accumulation of displacement of the body core, again over a period of 20 seconds. Figure 5.2 shows the total movement values for each participant and in addition shows the movement in each dimension in a graph. A maybe better accessible representation is given in Figure 5.3. Here, the movement of the body core into a forward and lateral direction is depicted from a top-view.

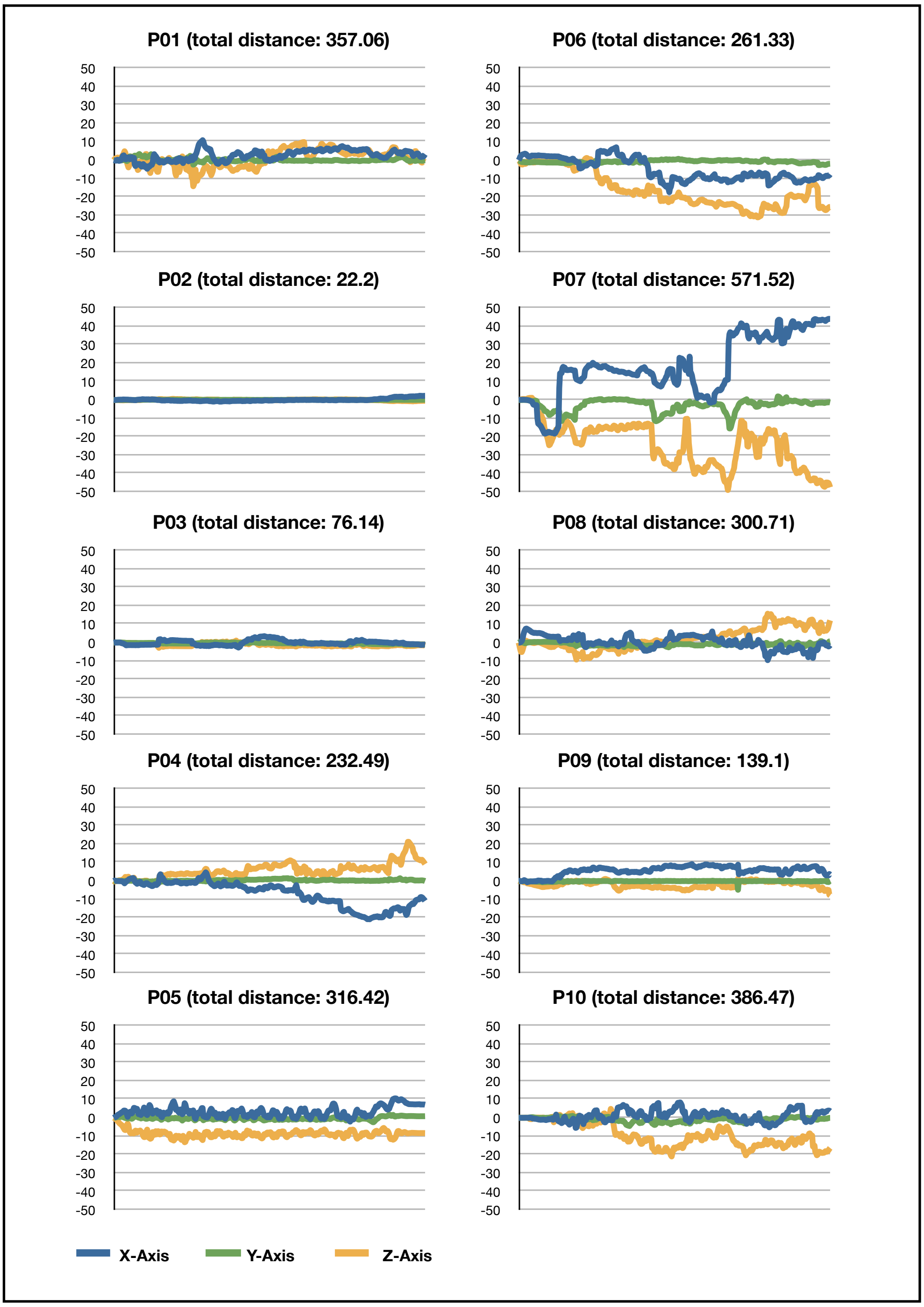


Fig. 5.2

Movement of the Body Core for each Participant over a Period of 20 seconds, in BVH distance units

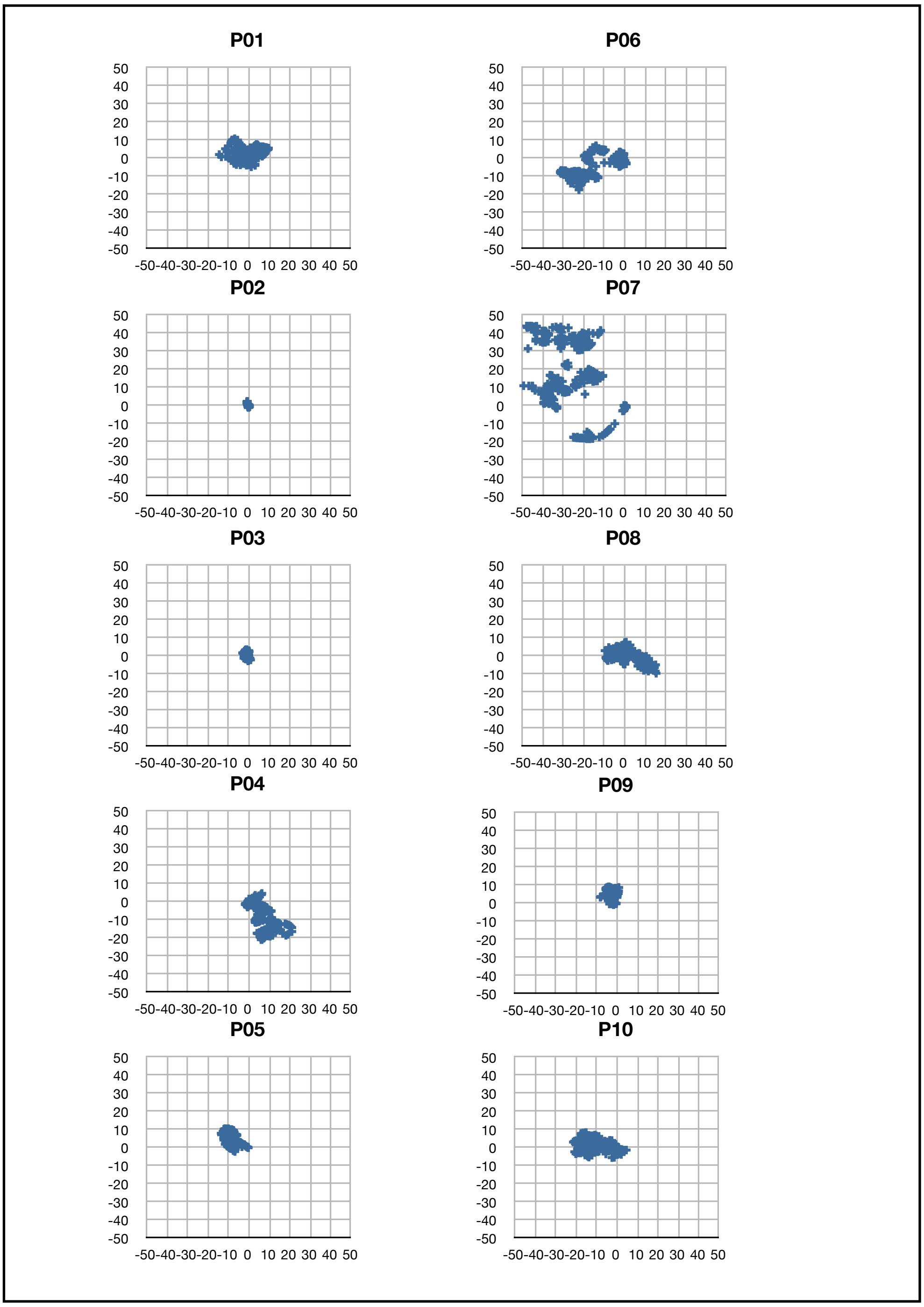


Fig. 5.3

Movement of the Body Core for each Participant over a period of 20 seconds, Top View
(X-Axis: forward/backward movement, Y-Axis: lateral movement)

Another measure that caught attention during the visual inspection is the angular displacement of the elbows. This feature is defined as the accumulation of the angular displacement (in arc degrees) of both elbows combined over a period of 20 seconds. The results are given in Table 5.3 (left).

Table 5.3
Angular Displacement of Elbows over 20 Seconds and Average Punch Amplitude, in °

	Angular Displacement of Elbows	Punch Amplitude (X-Rotation)
P01	55637	95
P02	6539	8
P03	47717	118
P04	37274	160
P05	35786	90
P06	9264	63
P07	14516	90
P08	8190	105
P09	13296	18
P10	15699	75

Also, the average punch amplitude for each participant is measured. Table 5.3 (right) shows the average punch amplitude for the X-Rotation, i.e. the extension of the arm in a forward direction. Figure 5.4 gives an example for a rotation around the X-Axis.

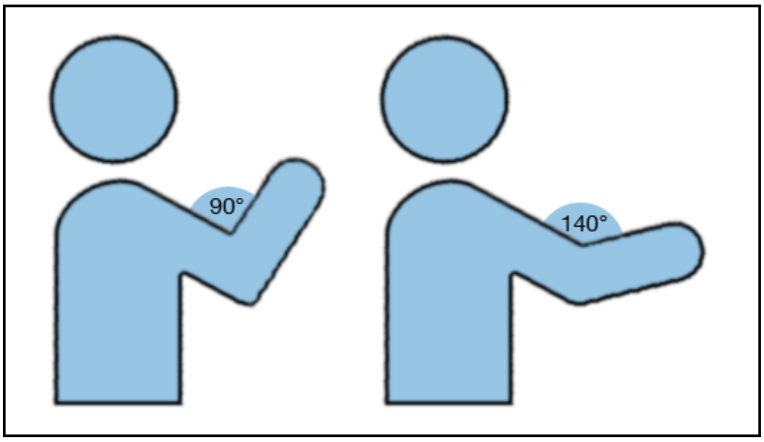


Figure 5.4
Example of the punch amplitude for X-Rotation of the arms: A resting angle of 90° (left) and an extension angle of 140° (right) result in a punch amplitude of 50°

Table 5.4 shows the results of the questionnaires. Except for one value in the Rate of Physical Exertion and two values of the Self-Assessment Manikin, all data sets are complete. As can be seen in the table, the results for immersion only show little spread. This is the reason for adding the observer ratings as an additional measure for the gaming experience.

	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10
Big Five Inventory										
Extraversion	0.72	0.56	0.78	0.81	0.44	0.31	0.47	0.56	0.44	0.41
Agreeableness	0.42	0.44	0.50	0.78	0.64	0.56	0.75	0.56	0.47	0.61
Conscientiousness	0.61	0.53	0.44	0.78	0.53	0.56	0.75	0.28	0.33	0.67
Neuroticism	0.41	0.66	0.50	0.53	0.47	0.69	0.47	0.41	0.53	0.53
Openness	0.65	0.50	0.60	0.50	0.50	0.50	0.65	0.53	0.43	0.63
Sport Motivation Scale										
Intr. Mot. - to know	0.63	0.92	0.33	0.63	0.25	0.17	0.58	0.25	0.79	0.50
Intr. Mot. - to accomplish	0.58	0.71	0.63	0.38	0.42	0.71	0.58	0.54	1.00	0.67
Intr. Mot. - to exp. stim.	0.75	0.71	0.46	0.67	0.50	0.08	0.79	0.29	0.38	0.58
Extr. Mot. - identified	0.21	0.58	0.58	0.25	0.38	0.63	0.50	0.50	0.63	0.63
Extr. Mot - introjected	0.21	0.63	0.75	0.29	0.42	0.96	0.50	0.42	0.79	0.67
Extr. Mot. - external reg.	0.38	0.50	0.63	0.04	0.21	0.13	0.42	0.04	0.21	0.33
Amotivation	0.54	0.08	0.42	0.33	0.08	0.00	0.17	0.21	0.29	0.33
Leisure Motivation Scale										
Intr. Mot. - to know	0.42	0.54	0.33	0.46	0.21	0.63	0.54	0.38	0.75	0.33
Intr. Mot. - to accomplish	0.42	0.75	0.83	0.58	0.50	0.83	0.92	0.33	0.83	0.83
Intr. Mot. - to exp. stim.	0.54	0.33	0.67	0.54	0.33	0.75	0.71	0.21	0.33	0.33
Extr. Mot. - identified	0.21	0.25	0.42	0.13	0.38	0.29	0.42	0.17	0.88	0.04
Extr. Mot - introjected	0.21	0.21	0.08	0.04	0.42	0.25	0.54	0.13	0.38	0.04
Extr. Mot. - external reg.	0.42	0.25	0.42	0.00	0.08	0.25	0.71	0.08	0.25	0.21
Amotivation	0.33	0.38	0.54	0.29	0.00	0.21	0.04	0.21	0.29	0.00
Pre-9										
Wii Experience	0.75	1.00	0.25	0.00	0.75	0.00	0.25	0.25	0.25	0.25
Wii Boxing Experience	0.25	0.75	0.25	0.00	0.75	0.00	0.25	0.25	0.25	0.25
Skill Level Wii Bowing	0.50	0.75	0.25	0.00	0.75	0.00	0.25	0.25	0.25	0.25
Exp. Boxing/Martial Arts	1.00	0.75	0.50	0.00	0.25	0.25	0.25	0.75	0.25	0.75
Theor. Knowledge Box./M.A.	0.75	0.50	0.50	0.00	0.25	0.25	0.75	0.75	0.25	0.00
Wii Sports useful for fitness	0.25	0.50	0.00	0.00	0.75	0.25	0.25	0.50	0.50	0.75
Prefer Wii with friends	1.00	1.00	0.50	1.00	1.00	1.00	1.00	0.50	0.75	0.75
Wii useful for weight loss	0.50	0.75	0.50	0.00	0.50	0.25	0.75	0.50	0.50	0.75
Wii easy to steer/control	1.00	0.75	0.25	0.50	0.75	0.50	0.75	0.00	0.50	0.75
Post-9										
Game response to mov.	0.67	0.83	0.67	0.67	1.00	0.67	0.33	0.17	0.83	0.83
Knew which mov. to do	0.17	0.00	0.17	0.00	0.00	0.17	0.00	0.83	0.17	0.17
Same mov. as real life	0.50	0.00	0.67	0.50	0.33	0.67	0.83	0.17	0.33	0.33
Tried best to win	0.83	1.00	1.00	0.83	1.00	1.00	1.00	1.00	0.83	1.00
Paid attention to scores	0.17	0.33	0.17	0.00	0.00	0.00	0.50	0.17	0.50	0.50
Had to go to limits	0.50	0.17	0.83	0.67	0.33	0.83	0.33	0.33	0.67	0.33
I minded being hit	0.33	0.33	0.00	0.17	1.00	0.17	0.17	0.17	0.67	0.17
Felt like boxing someone	0.33	0.00	0.67	0.00	0.33	0.33	0.33	0.17	0.33	0.17
Hits to avatar felt real	0.67	0.17	0.50	0.00	0.00	0.67	0.33	0.00	0.17	0.33
Rate of Physical Exertion										
After first half	0.50	0.21	0.43	0.21	0.36	0.21	0.29	0.21	0.36	-
End of game	0.57	0.21	0.64	0.43	0.57	0.36	0.36	0.50	0.57	-
Self-Assessment Manikin										
Valence	-	0.25	0.00	0.25	0.00	0.00	0.13	0.25	0.50	0.13
Arousal	-	0.50	0.13	0.75	0.50	0.88	0.50	0.38	0.50	0.88
Dominance	0.75	0.88	1.00	0.50	0.63	0.50	0.75	0.88	0.25	0.88
Immersion Questionnaire										
Total Immersion	0.72	0.60	0.73	0.50	0.64	0.72	0.81	0.48	0.52	0.71
Cognitive Involvement	0.78	0.75	0.90	0.68	0.88	0.95	0.90	0.70	0.50	0.83
Real World Dissociation	0.63	0.38	0.71	0.29	0.54	0.54	0.71	0.17	0.42	0.67
Emotional Involvement	0.73	0.71	0.65	0.52	0.65	0.73	0.81	0.52	0.44	0.69
Challenge Factor	0.55	0.65	0.55	0.45	0.40	0.55	0.45	0.40	0.65	0.50
Control Factor	0.63	0.59	0.63	0.47	0.59	0.66	0.66	0.25	0.50	0.66

Table 5.4 *Questionnaire Results*

Table 5.5 shows the ratings of the observers. The spread of the results is much higher than in the questionnaires and more suited for identifying patterns in the data.

Table 5.5
Results Observer Ratings

	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10
Concentration of the player	4.13	3.27	3.93	3.93	4.40	4.13	4.20	4.13	3.93	4.47
Eagerness to win	3.60	2.40	3.40	3.40	4.27	3.60	3.47	4.07	3.27	4.53
Player enjoyment	2.93	2.40	2.20	2.93	3.00	4.00	2.93	3.13	2.80	4.53
Boxing realism	2.33	1.20	2.27	2.40	2.53	3.60	3.13	3.80	1.73	3.73
Player immersion	4.00	2.60	3.27	3.53	4.33	3.93	3.73	3.87	3.53	4.40
Emotional engagement	3.73	2.00	2.73	3.20	4.07	3.73	3.27	4.13	3.20	4.33
Physical engagement	3.60	2.07	3.80	3.07	4.27	3.80	3.53	4.13	3.00	4.53

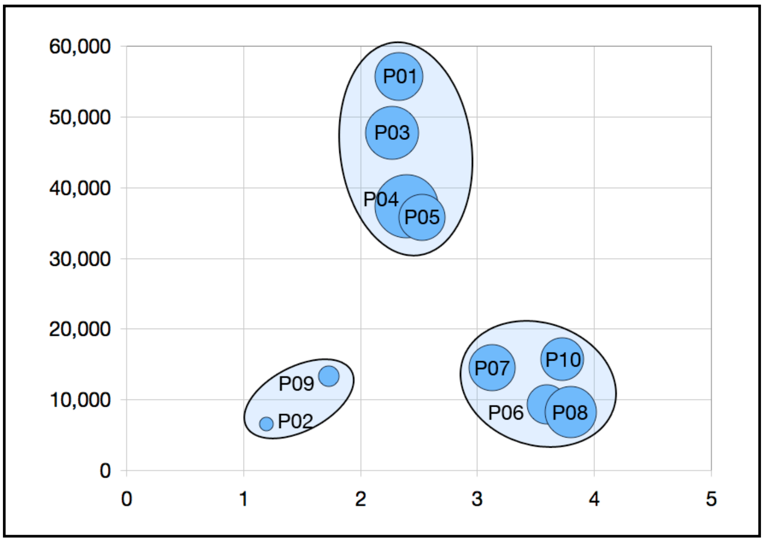
5.3 Movement Patterns for Playing Styles

The quantified features are investigated for correlations. This is again done visually, as a total of only 10 data sets is insufficient for a proper statistical analysis. Probably due to the small sample size, identifying patterns is difficult task at this stage.

But when plotting the observers' ratings of how much they think the gamers are really boxing against the angular displacement of the elbows, three clusters that correspond to the playing styles mentioned above can be identified. Figure 5.5 shows that plot and in addition the average punch amplitude as bubble size.

The first cluster (P02, P09) only gets a low realism rating and is further characterized by low amounts of angular displacements and punch amplitudes. The second cluster (P01, P03, P04, P05) receives medium realism ratings, high angular displacements levels and big punch amplitudes. The group with the highest realism ratings (P06, P07, P08, P10) only shows low amounts of angular displacements. Yet, a look at the size of the bubbles reveals that they show medium to large punch amplitudes. When looking at the video footage one can indeed observe that these gamers react to events that happen in the game, i.e. they wait for a good moment to punch the opponent and they also take a defensive stance while waiting.

Figure 5.5
Observer Ratings of Boxing Realism (X-Axis; Scale 1-5) vs. Angular Displacement of the Elbows (Y-Axis; accumulated over 20 seconds) vs. Average Punch Amplitude (Bubble Size; Size of X-Rotation, i.e. rotation in forward direction)



The results from the questionnaires are compared to the clusters to check for correlations, but no correlations can be found. This is ascribed to the low number of data sets that make finding correlations a difficult task in the whole analysis process. Yet, this does not disprove the assumptions behind employing the questionnaires, and the outcome for this section of the experiment can best be described as inconclusive.

In the interview study, two motivations with which gamers approach the Wii Sports games are identified: "Achieving" and "Relaxing". Also, corresponding strategies are identified: "Game" and "Simulation". In the movement analysis study, three patterns, i.e. the clusters shown in Figure 5.5 are found: One pattern corresponds to the strategy "Simulation". For the strategy "Game", there appear to be two different patterns. The connections between the strategies and patterns are discussed below.

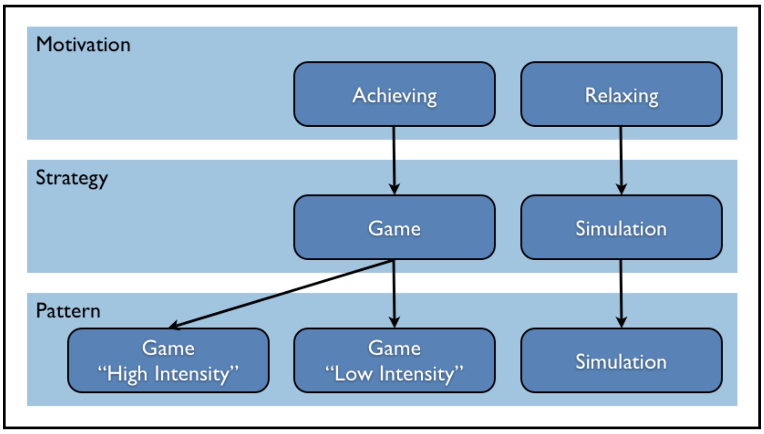
The first pattern corresponds to the lower left cluster in Figure 5.5 and can be described as "game with a low intensity", i.e. gamers show only little physical engagement. The body core remains stationary and there are only very small arm extensions. Yet, the gamers that exhibit this pattern show a high punch frequency. Apparently these gamers have learned that for the Nintendo Wii the punch amplitude is irrelevant and that a short impulse is enough to perform a punch. The high punch frequency leads to a good performance in terms of total hits, even if many punches do not hit or are not executed at all. Still, the level of physical activity remains low and the video recordings show they do not appear to be emotionally engaged and almost look bored.

The second pattern is represented by the upper cluster in Figure 5.5 and can be described as "game with high intensity". These gamers are quite active, i.e. they move around and show high arm extensions and punch amplitudes. The punch frequency varies from medium to high.

The pattern "simulation", which corresponds to lower right cluster of Figure 5.5, is characterized by gamers that observe the action on the screen and react to it. They have a lower number of punches as they wait their turn and do not punch blindly. But when they punch they do so with big arm extensions, as is done in real boxing, which they simulate. The result is a lower value for the angular displacement of the elbows.

Figure 5.6 gives an overview of the three patterns and how they correspond to the motivations and strategies of the interview study.

Figure 5.6
Motivations, Strategies, and Movement Patterns of Video Gamers Playing Nintendo Wii Boxing



The following features appear thus important for identifying the gamer's movement behaviour. The average punch amplitude gives a good indicator for distinguishing between the low intensity pattern of "Game" and the pattern "Simulation". This becomes obvious when comparing the bubble sizes of the lower left cluster with the lower right cluster in Figure 5.5. The bubble sizes and accordingly average punch amplitudes are much bigger for "Simulation" (lower right cluster) than for the low intensity pattern of "Game". Yet, it seems not sufficient to distinguish the high intensity pattern of "Game" (upper cluster) from "Simulation". The punch amplitudes are too similar here. Instead, the angular displacement of the elbows appears suited here. For the high intensity pattern of "Game", angular displacements are much higher than for "Simulation" (see Figure 5.5).

In theory both the average punch amplitude and the angular displacement of the elbows should be quite easily obtainable via the Wii controllers which are equipped with accelerometers. Alternatively, another sensor attached to the arms could deliver the information to calculate both measures. This means that it should be quite easily to observe patterns and from this deduce the strategy and the motivation of the gamer.

Chapter 6

Conclusions and Future Research

Gamers approach movement-based games with two distinct motivations and two respective strategies. These can be found back in three distinct movement patterns. This chapter concludes the study. The relevance and implications of the findings are discussed. Also, pointers to promising lines of future research are given, departing from the outcomes of the motion capture study, but also from topics discontinued after the interview study.

6.1 Conclusions

The aim at the beginning of this study is to investigate how gamers experience body movements in video games. Since there is little existing knowledge on the link between physical activity and gaming experience, an exploratory approach is chosen.

An interview study identifies two motivations with which gamers approach movement-based games ("Achieving" and "Relaxing") and two related strategies ("Game" and "Simulation"). There are currently no models that explain and describe the motivation of gamers and the strategies that they employ in a movement-based game. As such, this outcome of the interview can be seen as a first step towards such a model.

Also, control is identified as playing a crucial role in how gamers experience movement-based games. This outcome raises the question whether physicality leads to a higher need of "feeling in control" than in non movement-based games. In games that are based on a real life scenario, gamers expect to be able to execute movements identical to real life. This might be due to the fact that everyone has experience in moving in real life, while in traditional games the necessity to learn the controls of a game is realized easier.

Finally, statements of the interviewees are evaluated against the SCI-model of immersion in games. This reveals a number of movement-related factors that can potentially influence the gaming experience. In the beginning of the study, it is assumed that existing models of the gaming experience do not account for physical activity in games. It turns out that the models are in general compatible to movement-based games, but simply have not been extended to include movement-specific items yet.

With the results from the interview study the objectives of the study are refined. The aim of a second investigation is to identify playing styles and corresponding movement patterns for gamers of physically active games. As a scenario, the boxing game of the wide-spread Nintendo Wii Sports games is chosen, as it leads to the highest activity levels of all the Wii Sports games.

In the first identified strategy ("Game") gamers are aiming for a high score. To achieve this they reduce their movements to what is necessary. This can result in two different movement patterns, one with low punch amplitude and corresponding low physical intensity and one with a high punch amplitude and high physical intensity. Both patterns have in common that gamers punch at a high frequency and neglect events in the gameplay like their avatar being hit. Gamers that want to relax and to immerse into the game use a different strategy, called "Simulation". In the corresponding movement pattern they appear to imitate real-life boxing, i.e. they observe the opponent, try to block punches and wait for good opportunities to attack.

The potential of games that adapt to the movements of the gamer and steer towards a healthier and richer interaction is described in the beginning of the study. The movement patterns that are identified here show that a few features are sufficient to recognize the way a gamer is engaged with the Wii Boxing game. Other games probably require different features, but the practicability is clear. Practically, this is an important step towards adaptive, movement-based games. Theoretically, it extends existing knowledge to model the gamer and to explain gamers' behaviour.

The significance of the findings of this study must be qualified by the rather small size of the pool of subjects. The exoskeleton of the motion capture suit employed turns out to be too frail for the boxing scenario and experiments have to be discontinued with only 10 completed experiments. Because of this, the outcome of the questionnaires employed to investigate the influence of personality, motivation for sports or gaming, prior experience with movement-based games or boxing, and gaming experience on movement patterns are inconclusive. The assumptions that lead to the selection of the questionnaires cannot be proven, but also not rejected.

The results of this study can be interpreted best as showing interesting trends that should be investigated in future studies. Recommendations for such future research are presented in the following section.

6.2 Future Research

In a next step to the work presented here, the movement features that are identified as important should be validated in a quantitative study, with a significantly higher number of participants that allows for statistical analysis. Since the boxing scenario puts too much stress on the exoskeleton of the motion capture suit, the setup of the experiment should be changed. An optical motion capture system is probably less sensitive to the powerful and jerky movements of boxing. Yet, optical systems can suffer from occlusion, which should be taken into account when setting up an experiment. Another possible solution is to change the game scenario and to choose a game with less powerful and less jerky movements.

Investigating other game scenarios is in itself an important point for future research. In this study, a sports game with a particular emphasis on arm movement is investigated. It is highly probable that the identified patterns are only specific to this particular scenario. Investigating other scenarios would give valuable information on the validity of the results of this study for other game types.

As in all game research, a critical issue is the artificial setting of laboratory studies. This makes it hard to get a good and reliable measure for the gamers' experience. The use of a motion capture suit in this study is also quite intrusive and potentially influences the gamers' experience. The identification of relevant features should in future limit the amount of necessary technology to record the movements of the gamer and help towards designing future studies into a more natural setting.

Reports from the interview study lead to the speculation of changes in the gamers' behaviour as they gain expertise in a game. It is also found that a gamer can approach a game with changing moods and motivations. A longitudinal study could investigate how motivations, strategies, and movement patterns change over time and exposure.

Another important factor is a social one. From the interviews it is learned that in particular for playing movement-based games, gamers appear to meet with friends to play, as sort of a social event. Interviewees report of a preference for playing in a social setting. Social aspects are not considered in this study, but they should be addressed in future research.

Basically all the outcomes discontinued after the interview study appear promising for future investigation. The feeling of control is crucial for the enjoyment of games and should be investigated beyond the factors that are identified here. Further investigating movement-based factors of influence on existing models of gaming experience is certainly an important area of interest.

The knowledge about the link between physical activity and the gaming experience is still limited. It offers many interesting topics for future research, some of them are mentioned above. Extending this knowledge should lead towards a new generation of games, that adapt to the movement patterns of the gamer and steer towards a healthier and richer interaction.

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Appendix A

Information Sheets and Consent Forms

Information Sheet

UCLIC
UCL Interaction Centre
University College London
Remax House, 31-32 Alfred Place
London, WC1E 7DP, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

Body Movements in the Gaming Experience

RESEARCHER

Marco Pasch

You are being invited to take part in a research study. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take as long as you like to decide whether or not you wish to take part.

PURPOSE OF THE STUDY

The aim of this study is to understand the role of physical movements on how players experience their games.

WHY YOU?

At the current stage of the research we wish to get views and experiences from a broad audience. As such the only requirement for participating is physical health.

It is up to you to decide whether or not to take part.

If you are pregnant, suffer from heart, respiratory, back, joint or orthopedic problems, have high blood pressure, or if your doctor has instructed you to restrict your physical activity or if you have any other medical condition that may be aggravated by physical activity, or you are receiving treatment for any injury or disorder involving the fingers, hands or arms, or if you suffer from epilepsy, we kindly suggest you to not participate.

For further information, please read Nintendo Wii™ Health and Safety precautions attached to these sheets carefully.

PROCEDURE

If you agree to take part, you will be asked to play video games on a Nintendo Wii™ for about 20 minutes. You will be video taped during gaming, unless you object to this. After the gaming session you will be asked to participate in an interview about how you experienced the gaming. The interview session will also take about 20 minutes.

You can withdraw from the study at any time and without giving reason.

The overall study will take place over several months, but your own input will be relatively brief. No data that would enable anyone else to identify you will be collected.

Interview Study, Information Sheet, Page 1/2

Appendix A

Information Sheets and Consent Forms

PROTECTION OF PRIVACY

Any data collected during the session will be kept anonymous and confidential and recorded videos will be kept in a locked cabinet. No information will be circulated that would make it possible to identify any particular individual's views. However, if you give us your consent we would like to use pictures and video of you during the experiment in the thesis and articles to be published in academic journals, conference proceeding and other equivalent articles or academic presentations.

FURTHER INFORMATION

This research is contributing to the MSc thesis of Marco Pasch, a visiting student from the University of Twente (The Netherlands). It is not externally funded.

You can discuss this study with the person who gave you this information sheet, or contact Dr Nadia Berthouze at University College London:

Dr Nadia Bianchi-Berthouze
UCL Interaction Centre, University College London
Remax House, 31-32 Alfred Place, London WC1E 7DP, UK
Tel: +44 (0) 20 7679 5216, Fax: +44 (0) 20 7679 5295
email: n.berthouze@ucl.ac.uk
http://www.cs.ucl.ac.uk/staff/n.berthouze/

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for taking part in this study.

Marco Pasch
m.pasch@cs.utwente.nl
Tel: +44 79 42471916

Interview Study, Information Sheet, Page 2/2

Appendix A

Information Sheets and Consent Forms

Health and Safety Information

UCLIC
UCL Interaction Centre
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London, WC1E 7DP, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

Body Movements in the Gaming Experience

RESEARCHER

Marco Pasch

Please read the following excerpt from the Nintendo Wii™ manual carefully.

Health and Safety Information

IMPORTANT SAFETY INFORMATION – READ THE FOLLOWING WARNINGS BEFORE SETUP OR USE OF THE Wii. IF THIS PRODUCT WILL BE USED BY YOUNG CHILDREN, THIS MANUAL SHOULD BE READ AND EXPLAINED TO THEM BY AN ADULT. FAILING TO DO SO MAY CAUSE INJURY.

⚠ WARNING - Seizures

Some people (about 1 in 4000) may have seizures or blackouts triggered by light flashes or patterns, and this may occur while they are watching TV or playing video games, even if they have never had a seizure before.

Anyone who has had a seizure, loss of awareness, or other symptom linked to an epileptic condition should consult a doctor before playing a video game.

Parents should watch their children play video games. Stop playing and consult a doctor if you or your child has any of the following symptoms:

Convulsions	Eye or muscle twitching	Loss of awareness
Altered vision	Involuntary movements	Disorientation

To reduce the likelihood of a seizure when playing video games:

- Sit or stand as far from the screen as possible.
- Play video games on the smallest available television screen.
- Do not play if you are tired or need sleep.
- Play in a well-lit room.
- Take a 10 to 15 minute break every hour.

⚠ WARNING - Radio Frequency Interference

The Wii console and Wii Remote can emit radio waves that can affect the operation of nearby electronics, including cardiac pacemakers.

- Do not operate the Wii console or remote within 9 inches of a pacemaker.
- If you have a pacemaker or other implanted medical device, do not use the Wii console or remote without first consulting your doctor or the manufacturer of your medical device.

⚠ WARNING - Repetitive Motion Injuries and Eyestrain

Playing video games can make your muscles, joints, skin or eyes hurt. Follow these instructions to avoid problems such as tendinitis, carpal tunnel syndrome, skin irritation or eyestrain:

- Avoid excessive play. Parents should monitor their children for appropriate play.
- Take a 10 to 15 minute break every hour, even if you don't think you need it.
- If your hands, wrists, arms or eyes become tired or sore while playing, or if you feel symptoms such as tingling, numbness, burning or stiffness, stop and rest for several hours before playing again.
- If you continue to have any of the above symptoms or other discomfort during or after play, stop playing and see a doctor.

⚠ WARNING - Electric Shock

To avoid electric shock when you use this system:

- Do not use the Wii during a lightning storm. There may be a risk of electric shock from lightning.
- Use only the AC Adapter that comes with your system.
- Do not use the AC Adapter if it has damaged, split or broken cords or wires.
- Make sure that the AC Adapter cord is fully inserted into the wall outlet or extension cord.
- Always carefully disconnect all plugs by pulling on the plug and not on the cord. Make sure the Wii power button is turned OFF before removing the AC Adapter cord from an outlet.

⚠ CAUTION - Motion Sickness

Playing video games can cause motion sickness in some players. If you or your child feel dizzy or nauseous when playing video games, stop playing and rest. Do not drive or engage in other demanding activity until you feel better.

⚠ CAUTION - Laser Device

The Wii console is a Class I laser product. Do not attempt to disassemble the Wii console. Refer servicing to qualified personnel only.
Caution: Use of controls or adjustments or procedures other than those specified herein may result in hazardous radiation exposure.

Specifications:
Laser Type: Semiconductor laser
Laser power: Max. 0.9mW
Laser wave length: 662nm (typ.)(647nm~687nm)
Numeric aperture: 0.6

Interview Study, Health and Safety Information, Page 1/1

Appendix A

Information Sheets and Consent Forms

Consent Form

UCLIC
UCL Interaction Centre
University College London
Remax House, 31-32 Alfred Place
London, WC1E 7DP, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

Body Movements in the Gaming Experience

RESEARCHER

Marco Pasch

DECLARATION OF CONSENT (Please tick each checkbox if you consent)

1. I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask any questions and have received sufficient answers. ☐
2. I confirm that I have read and understood the Nintendo Wii™ health and safety precautions and that I do not have any particular physical condition which can be affected by the experiment. ☐
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected. ☐
4. I agree for the researcher to video record me during the experiment. ☐
5. I understand that any data collected during the session will be kept anonymous and confidential and recorded videos will be kept in a locked cabinet. ☐
6. I agree for the researcher to use pictures and video of me during the experiment to be included in academic articles and presentations. ☐
7. I agree to take part in the above study. ☐

Participant's Name	Signature	Date
Marco Pasch Researcher's Name	Signature	Date

FEEDBACK

Would you like to receive a brief report on the findings of the study? If yes, please write down your email address:

Email

Interview Study, Consent Form, Page 1/1

Appendix A

Information Sheets and Consent Forms

Information Sheet

UCLIC
UCL Interaction Centre
University College London
Malet Place Engineering Building, 8th floor
London, WC1E 7DE, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

Body Movements in the Gaming Experience

RESEARCHER

Marco Pasch

You are being invited to take part in a research study. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take as long as you like to decide whether or not you wish to take part.

PURPOSE OF THE STUDY

The aim of this study is to understand the role of physical movements on how players experience their games.

WHY YOU?

The only requirement for participating is physical health.

It is up to you to decide whether or not to take part.

If you are pregnant, suffer from heart, respiratory, back, joint or orthopedic problems, have high blood pressure, or if your doctor has instructed you to restrict your physical activity or if you have any other medical condition that may be aggravated by physical activity, or you are receiving treatment for any injury or disorder involving the fingers, hands or arms, or if you suffer from epilepsy, we kindly suggest you to not participate.

For further information, please read Nintendo Wii™ Health and Safety precautions attached to these sheets carefully.

PROCEDURE

If you agree to take part, you will be asked to first fill in short questionnaire. You will then be fitted with a motion capture suit and asked to play the Wii Boxing game for about 15 minutes. If you are new to the game you will receive instructions first. You will be video taped during gaming, unless you object to this. After the gaming session you will be asked to fill in another questionnaire.

You can withdraw from the study at any time and without giving reason.

Movement Analysis Study, Information Sheet, Page 1/2

Appendix A

Information Sheets and Consent Forms

PROTECTION OF PRIVACY

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FURTHER INFORMATION

This research is contributing to the MSc thesis of Marco Pasch, a visiting student from the University of Twente (The Netherlands). It is not externally funded.

For this study ethical approval has been given under number STF/2007/8/031.

You can discuss this study with the person who gave you this information sheet, or contact Dr Nadia Berthouze at University College London:

Dr Nadia Bianchi-Berthouze
UCL Interaction Centre, University College London
Malet Place Engineering Building, 8.24, London WC1E 7JE, UK
Tel: +44 (0) 20 7679 0690
email: n.berthouze@ucl.ac.uk
http://www.cs.ucl.ac.uk/staff/n.berthouze/

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for taking part in this study.

Marco Pasch
m.pasch@cs.utwente.nl
Tel: +44 79 42471916

Movement Analysis Study, Information Sheet, Page 2/2

Appendix A

Information Sheets and Consent Forms

Health and Safety Information

UCLIC
UCL Interaction Centre
University College London
Remax House, 31-32 Alfred Place
London, WC1E 7DP, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

Body Movements in the Gaming Experience

RESEARCHER

Marco Pasch

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Some people (about 1 in 4000) may have seizures or blackouts triggered by light flashes or patterns, and this may occur while they are watching TV or playing video games, even if they have never had a seizure before.

Anyone who has had a seizure, loss of awareness, or other symptom linked to an epileptic condition should consult a doctor before playing a video game.

Parents should watch their children play video games. Stop playing and consult a doctor if you or your child has any of the following symptoms:

Convulsions	Eye or muscle twitching	Loss of awareness
Altered vision	Involuntary movements	Disorientation

To reduce the likelihood of a seizure when playing video games:

- Sit or stand as far from the screen as possible.
- Play video games on the smallest available television screen.
- Do not play if you are tired or need sleep.
- Play in a well-lit room.
- Take a 10 to 15 minute break every hour.

⚠ WARNING - Radio Frequency Interference

The Wii console and Wii Remote can emit radio waves that can affect the operation of nearby electronics, including cardiac pacemakers.

- Do not operate the Wii console or remote within 9 inches of a pacemaker.
- If you have a pacemaker or other implanted medical device, do not use the Wii console or remote without first consulting your doctor or the manufacturer of your medical device.

⚠ WARNING - Repetitive Motion Injuries and Eyestrain

Playing video games can make your muscles, joints, skin or eyes hurt. Follow these instructions to avoid problems such as tendinitis, carpal tunnel syndrome, skin irritation or eyestrain:

- Avoid excessive play. Parents should monitor their children for appropriate play.
- Take a 10 to 15 minute break every hour, even if you don't think you need it.
- If your hands, wrists, arms or eyes become tired or sore while playing, or if you feel symptoms such as tingling, numbness, burning or stiffness, stop and rest for several hours before playing again.
- If you continue to have any of the above symptoms or other discomfort during or after play, stop playing and see a doctor.

⚠ WARNING - Electric Shock

To avoid electric shock when you use this system:

- Do not use the Wii during a lightning storm. There may be a risk of electric shock from lightning.
- Use only the AC Adapter that comes with your system.
- Do not use the AC Adapter if it has damaged, split or broken cords or wires.
- Make sure that the AC Adapter cord is fully inserted into the wall outlet or extension cord.
- Always carefully disconnect all plugs by pulling on the plug and not on the cord. Make sure the Wii power button is turned OFF before removing the AC Adapter cord from an outlet.

⚠ CAUTION - Motion Sickness

Playing video games can cause motion sickness in some players. If you or your child feel dizzy or nauseous when playing video games, stop playing and rest. Do not drive or engage in other demanding activity until you feel better.

⚠ CAUTION - Laser Device

The Wii console is a Class I laser product. Do not attempt to disassemble the Wii console. Refer servicing to qualified personnel only.
Caution: Use of controls or adjustments or procedures other than those specified herein may result in hazardous radiation exposure.

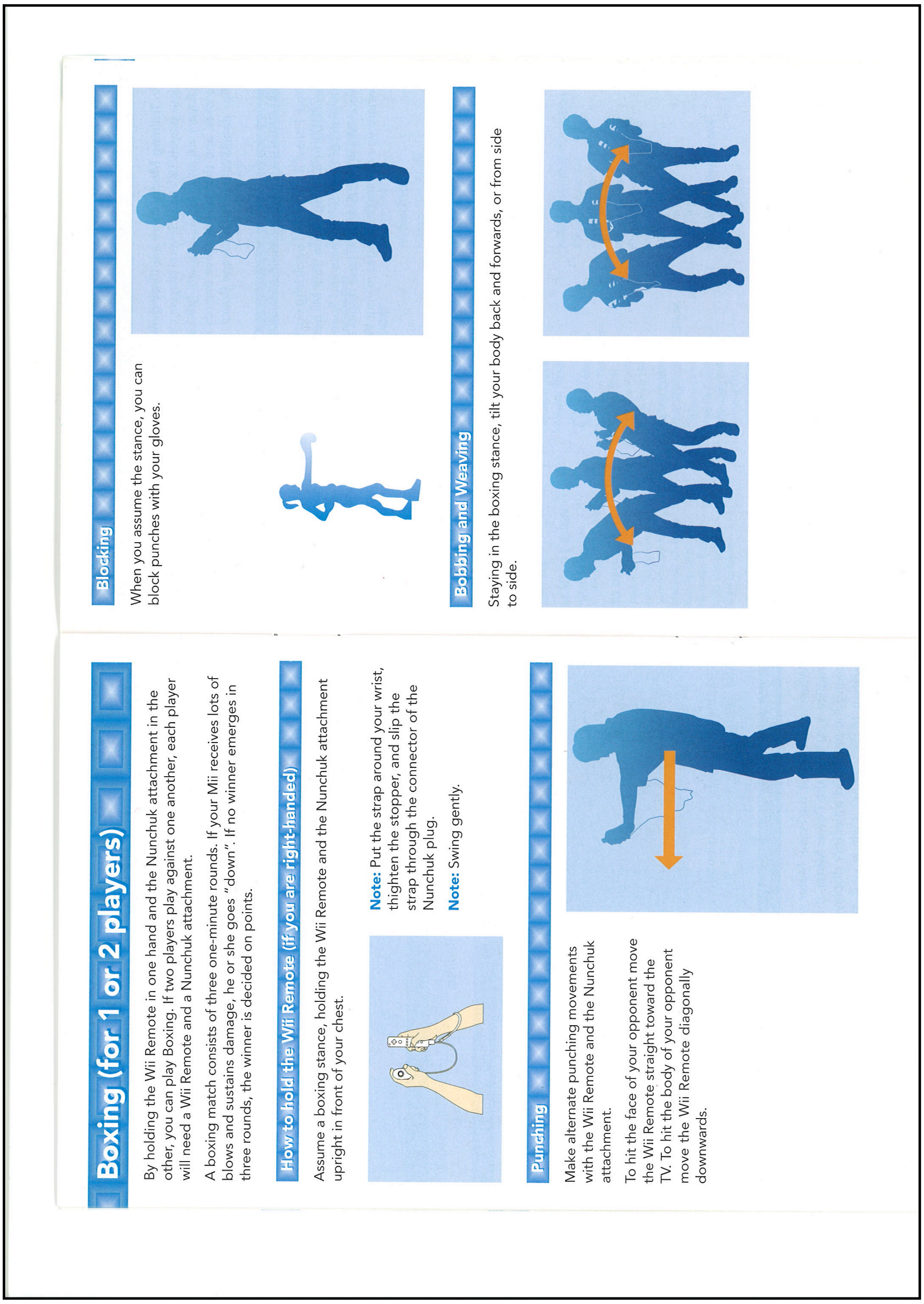
Specifications:

Laser Type: Semiconductor laser	Laser wave length: 662nm (typ.)(647nm~687nm)
Laser power: Max. 0.9mW	Numeric aperture: 0.6

Movement Analysis Study, Health and Safety Information, Page 1/1

Appendix A

Information Sheets and Consent Forms



Boxing (for 1 or 2 players)

By holding the Wii Remote in one hand and the Nunchuk attachment in the other, you can play Boxing. If two players play against one another, each player will need a Wii Remote and a Nunchuk attachment.

A boxing match consists of three one-minute rounds. If your Mii receives lots of blows and sustains damage, he or she goes "down". If no winner emerges in three rounds, the winner is decided on points.

How to hold the Wii Remote (if you are right-handed)

Assume a boxing stance, holding the Wii Remote and the Nunchuk attachment upright in front of your chest.

Note: Put the strap around your wrist, thighten the stopper, and slip the strap through the connector of the Nunchuk plug.

Note: Swing gently.

Punching

Make alternate punching movements with the Wii Remote and the Nunchuk attachment.

To hit the face of your opponent move the Wii Remote straight toward the TV. To hit the body of your opponent move the Wii Remote diagonally downwards.

Blocking

When you assume the stance, you can block punches with your gloves.

Bobbing and Weaving

Staying in the boxing stance, tilt your body back and forwards, or from side to side.

Movement Analysis Study, Wii Boxing Instruction Sheet, Page 1/1

Appendix A

Information Sheets and Consent Forms

Consent Form

UCLIC
UCL Interaction Centre
University College London
Remax House, 31-32 Alfred Place
London, WC1E 7DP, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

Body Movements in the Gaming Experience

RESEARCHER

Marco Pasch

DECLARATION OF CONSENT (Please tick each checkbox if you consent)

1. I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask any questions and have received sufficient answers. ☐
2. I confirm that I have read and understood the Nintendo Wii™ health and safety precautions and that I do not have any particular physical condition which can be affected by the experiment. ☐
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected. ☐
4. I agree for the researcher to video record me during the experiment. ☐
5. I understand that any data collected during the session will be kept anonymous and confidential and recorded videos will be kept in a locked cabinet. ☐
6. I agree for the researcher to use pictures and video of me during the experiment to be included in academic articles and presentations. ☐
7. I agree to take part in the above study. ☐

____________	____________	____________
Participant's Name	Signature	Date
Marco Pasch	____________	____________
Researcher's Name	Signature	Date

FEEDBACK

Would you like to receive a brief report on the findings of the study? If yes, please write down your email address:

____
Email

Movement Analysis Study, Consent Form, Page 1/1

Appendix A

Information Sheets and Consent Forms

Information Sheet

UCLIC
UCL Interaction Centre
University College London
MPEB 8th floor
Malet Place
London WC1E 7JE, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

An investigation of movement in game playing

RESEARCHERS

Marco Pasch, Vidhi Parekh

You are being invited to take part in a research study. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take as long as you like to decide whether or not you wish to take part.

PURPOSE OF THE STUDY

The aim of this study is to understand the role of physical movements on how players experience their games.

WHY YOU?

There are no particular requirements for participation.

It is up to you to decide whether or not to take part.

PROCEDURE

If you agree to take part, you will be asked to watch a number of video clips that show players of video games. Your task will be to fill in short questionnaires in which you assess the experience of the player. The whole procedure should not take longer than 30 minutes.

You can withdraw from the study at any time and without giving reason.

FURTHER INFORMATION

For this study ethical approval has been given under number MSC-HCI/2007/8/016.

You can discuss this study with the person who gave you this information sheet, or contact Dr Nadia Berthouze at University College London:

Dr Nadia Bianchi-Berthouze
UCL Interaction Centre, University College London
Malet Place Engineering Building, 8.24, London WC1E 7JE, UK
Tel: +44 (0) 20 7679 0690
email: n.berthouze@ucl.ac.uk
http://www.cs.ucl.ac.uk/staff/n.berthouze/

You will be given a copy of the information sheet and a signed consent form to keep.

Thank you for taking part in this study.

Observation Study, Information Sheet, Page 1/1

Appendix A

Information Sheets and Consent Forms

Consent Form

UCLIC
UCL Interaction Centre
University College London
MPEB 8th floor
Malet Place
London WC1E 7JE, UK
http://www.uclic.ucl.ac.uk

TITLE OF THE STUDY

Body Movements in the Gaming Experience

RESEARCHER

Marco Pasch, Vidhi Parekh

DECLARATION OF CONSENT (Please tick each checkbox if you consent)

I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask any questions and have received sufficient answers. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected. ☐

I agree to take part in the above study. ☐

Participant's Name	Signature	Date
Researcher's Name	Signature	Date

FEEDBACK

Would you like to receive a brief report on the findings of the study? If yes, please write down your email address:

Email

Observation Study, Consent Form, Page 1/1

Appendix B

Questionnaire

Questionnaire 1

Participant Number _____ **Age: _____** **Sex: M / F**

Please indicate your view on the following statements:

I see myself as someone who...	Strongly disagree		Neither agree nor disagree		Strongly agree
1. is talkative	1	2	3	4	5
2. tends to find fault in others	1	2	3	4	5
3. does a thorough job	1	2	3	4	5
4. is depressed, blue	1	2	3	4	5
5. is original, comes up with new ideas	1	2	3	4	5
6. is reserved	1	2	3	4	5
7. is helpful and unselfish with others	1	2	3	4	5
8. can be somewhat careless	1	2	3	4	5
9. is relaxed, handles stress well	1	2	3	4	5
10. is curious about many different things	1	2	3	4	5
11. is full of energy	1	2	3	4	5
12. starts quarrels with others	1	2	3	4	5
13. is a reliable worker	1	2	3	4	5
14. can be tense	1	2	3	4	5
15. is ingenious, a deep thinker	1	2	3	4	5
16. generates a lot of enthusiasm	1	2	3	4	5
17. has a forgiving nature	1	2	3	4	5
18. tends to be disorganized	1	2	3	4	5
19. worries a lot	1	2	3	4	5
20. has an active imagination	1	2	3	4	5
21. tends to be quiet	1	2	3	4	5
22. is generally trusting	1	2	3	4	5
23. tends to be lazy	1	2	3	4	5
24. is emotionally stable, not easily upset	1	2	3	4	5
25. is inventive	1	2	3	4	5
26. has an assertive personality	1	2	3	4	5

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Appendix B

Questionnaire

27. can be cold and aloof	1	2	3	4	5
28. perseveres until the task is finished	1	2	3	4	5
29. can be moody	1	2	3	4	5
30. values artistic, aesthetic experiences	1	2	3	4	5
31. is somewhat shy, inhibited	1	2	3	4	5
32, is considerate and kind to almost everyone	1	2	3	4	5
33, does the things efficiently	1	2	3	4	5
34, remains calm in tense situations	1	2	3	4	5
35, prefers work that is routine	1	2	3	4	5
36, is outgoing, social	1	2	3	4	5
37, is sometimes rude to others	1	2	3	4	5
38, makes plans and follows through with them	1	2	3	4	5
39, gets nervous easily	1	2	3	4	5
40, likes to reflect, play with ideas	1	2	3	4	5
41, has few artistic interests	1	2	3	4	5
42, likes to cooperate with others	1	2	3	4	5
43, is easily distracted	1	2	3	4	5
44, is sophisticated in art, music and literature	1	2	3	4	5

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Appendix B

Questionnaire

Please indicate to what extent each of the following items presently corresponds to one of the reasons for which you practice <u>sports and exercise</u>:

	Does not correspond at all			Corresponds moderately			Corresponds exactly
1. For the pleasure I feel in living exciting experiences.	1	2	3	4	5	6	7
2. For the pleasure it gives me to know more about the sport that I practice.	1	2	3	4	5	6	7
3. I used to have good reasons for doing sports, but now I am asking myself if I should continue doing it.	1	2	3	4	5	6	7
4. For the pleasure of discovering new training techniques.	1	2	3	4	5	6	7
5. I don't know anymore; I have the impression that I am incapable of succeeding in my sport.	1	2	3	4	5	6	7
6. Because it allows me to be well regarded by people I know.	1	2	3	4	5	6	7
7. Because, in my opinion, it is one of the best ways to meet people.	1	2	3	4	5	6	7
8. Because I feel a lot of personal satisfaction while mastering certain difficult training techniques.	1	2	3	4	5	6	7
9. Because it is absolutely necessary to do sports if one wants to be in shape.	1	2	3	4	5	6	7
10. For the prestige of being an athlete.	1	2	3	4	5	6	7
11. Because it is one of the best ways I have chosen to develop other aspects of myself.	1	2	3	4	5	6	7
12. For the pleasure I feel while improving some of my weak points.	1	2	3	4	5	6	7
13. For the excitement I feel when I am really involved in the activity.	1	2	3	4	5	6	7
14. Because I must do sports to feel good about myself.	1	2	3	4	5	6	7
15. For the satisfaction I experience while I am perfecting my abilities.	1	2	3	4	5	6	7
16. Because people around me think it is important to be in shape.	1	2	3	4	5	6	7
17. Because it is a good way to learn lots of things which could be useful to me in other areas in my life.	1	2	3	4	5	6	7
18. For the intense emotions that I feel while I am doing a sport that I am doing.	1	2	3	4	5	6	7
19. It is not clear to me anymore; I don't really think my place is in sports anymore.	1	2	3	4	5	6	7
20. For the pleasure that I feel while executing certain difficult movements.	1	2	3	4	5	6	7
21. Because I would feel bad if I was not taking time to do it.	1	2	3	4	5	6	7

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Appendix B

Questionnaire

22. To show others how good I am at my sport.	1	2	3	4	5	6	7
23. For the pleasure that I feel while learning training techniques that I have never tried before.	1	2	3	4	5	6	7
24. Because it is one of the best ways to maintain good relationships with my friends.	1	2	3	4	5	6	7
25. Because I like the feeling of being totally immersed in the activity.	1	2	3	4	5	6	7
26. Because I must do sports regularly.	1	2	3	4	5	6	7
27. For the pleasure of discovering new performance strategies.	1	2	3	4	5	6	7
28. I often ask myself; I can't seem to achieve the goals that I set for myself.	1	2	3	4	5	6	7

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Appendix B

Questionnaire

Please indicate to what extent each of the following items presently corresponds to one of the reasons for which you play games (<u>all kinds of games</u>):

	Does not correspond at all		Corresponds moderately				Corresponds exactly
1. To avoid doing other tasks.	1	2	3	4	5	6	7
2. Because I experience a lot of pleasure and satisfaction in learning new things.	1	2	3	4	5	6	7
3. Because in my opinion, it is a good way to develop social, physical or intellectual abilities that will be useful to me later.	1	2	3	4	5	6	7
4. For the pleasure I feel in living exciting experiences.	1	2	3	4	5	6	7
5. I can't come to see why I play games, and frankly I don't really care.	1	2	3	4	5	6	7
6. For the satisfaction I feel when I try to overcome interesting challenges.	1	2	3	4	5	6	7
7. Because it is very important for me to fill my free time.	1	2	3	4	5	6	7
8. Because I don't like to appear as someone who does nothing.	1	2	3	4	5	6	7
9. For the pleasure of knowing more about subjects that appeal me.	1	2	3	4	5	6	7
10. Because it's one of the ways that I have chosen to make improvements on a personal level.	1	2	3	4	5	6	7
11. For the sense of freedom that I experience while doing the activity.	1	2	3	4	5	6	7
12. I don't really know; I don't think that games suit me.	1	2	3	4	5	6	7
13. For the pleasure I feel when I outdo myself in interesting activities.	1	2	3	4	5	6	7
14. Because in life you absolutely need games to be happy.	1	2	3	4	5	6	7
15. Because sometimes it allows me to be appreciated by others.	1	2	3	4	5	6	7
16. Because it allows me to deepen my understanding of subjects that interest me.	1	2	3	4	5	6	7
17. Because it's the way I've chosen to acquire abilities in other areas that are important to me.	1	2	3	4	5	6	7
18. Because my playing games gives me a real "high".	1	2	3	4	5	6	7
19. I don't really know; I have the impression that there isn't any activity that I could do very well.	1	2	3	4	5	6	7
20. For the pleasure of surpassing myself while doing activities that are challenging for me.	1	2	3	4	5	6	7
21. Because I absolutely must feel busy.	1	2	3	4	5	6	7

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Questionnaire

22. To show others that I am a dynamic person.	1	2	3	4	5	6	7
23. Because it allows me to explore many interesting domains.	1	2	3	4	5	6	7
24. Because playing games is one of the ways that allows me to develop other aspects of myself.	1	2	3	4	5	6	7
25. For the simple of pleasure of feeling deeply relaxed.	1	2	3	4	5	6	7
26. Honestly, I don't know; I have the impression that I'm wasting my time when I play games.	1	2	3	4	5	6	7
27. For the satisfaction I get while trying to master complex activities.	1	2	3	4	5	6	7
28. Because I absolutely must play games to be in a good mood.	1	2	3	4	5	6	7

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Appendix B

Questionnaire

Please answer a few questions about your experience with the Wii and boxing:

	Never		Some-times		A lot
1. How often do you play on the Nintendo Wii?	1	2	3	4	5
	Never		Some-times		A lot
2. How often have you played the Wii Boxing game?	1	2	3	4	5
	Never done it		Average		Expert/ Pro
3. How would you describe your skill level for the Wii Boxing	1	2	3	4	5
4. Do you have experience in real life boxing or similar martial arts?	1	2	3	4	5
	Non-existent		Average		Expert
5. How would you describe your theoretical knowledge of boxing (eg. from TV)?	1	2	3	4	5
	Disagree strongly		Neither agree nor disagree		Strongly agree
6. Do you think playing the Wii Sports games is a good way to stay fit?	1	2	3	4	5
7. Do you prefer playing the Wii together with friends?	1	2	3	4	5
8. Do you think one can loose weight playing the Wii Sports games?	1	2	3	4	5
9. Do you think the Wii Sports games are easy to steer / control?	1	2	3	4	5

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Appendix B

Questionnaire

Questionnaire 2

Please indicate how you experienced the game:

	Disagree strongly			Neither agree nor disagree			Strongly agree
1. The game responded well to my movements.	1	2	3	4	5	6	7
2. I didn't know which movements I had to do to steer the game.	1	2	3	4	5	6	7
3. I had to do the same movements as in boxing in real life.	1	2	3	4	5	6	7
4. I tried my best to win.	1	2	3	4	5	6	7
5. I didn't pay attention to the scores.	1	2	3	4	5	6	7
6. The game challenged me to strive to the limits of my abilities	1	2	3	4	5	6	7
7. I didn't mind being hit by the opponents.	1	2	3	4	5	6	7
8. It felt like really boxing someone.	1	2	3	4	5	6	7
9. When my avatar got hit, it really felt like it was happening to me.	1	2	3	4	5	6	7

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Appendix B

Questionnaire

Rating of Perceived Exertion

We want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue. Do not concern yourself with any one factor such as leg pain or shortness of breath, but try to focus on your total feeling of exertion.

Try to appraise your feeling of exertion as honestly as possible, without thinking about what the actual physical load is. Your own feeling of effort and exertion is important, not how it compares to other people's. Look at the scales and the expressions and then give a number.

Hints: 9 corresponds to "very light" exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes.

13 on the scale is "somewhat hard" exercise, but it still feels OK to continue.

17 "very hard" is very strenuous. A healthy person can still go on, but he or she really has to push him- or herself. It feels very heavy, and the person is very tired.

19 on the scale is an extremely strenuous exercise level. For most people this is the most strenuous exercise they have ever experienced.

Please indicate how you perceived your exertion <u>in the first half</u> of playing:

No exertion at all			Very light		Light		Somewhat hard
6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	
	Hard (heavy)		Very hard		Extremely hard	Maximal exertion	

Please indicate how you perceived your exertion <u>at the end</u> of the gaming session:

No exertion at all			Very light		Light		Somewhat hard
6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	
	Hard (heavy)		Very hard		Extremely hard	Maximal exertion	

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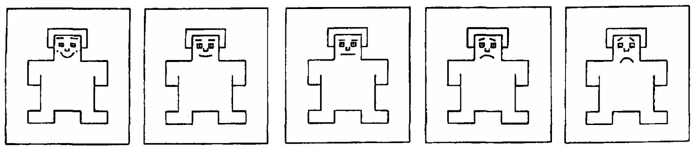
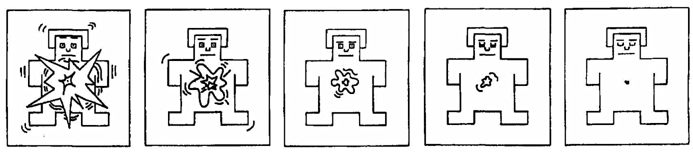
Appendix B

Questionnaire

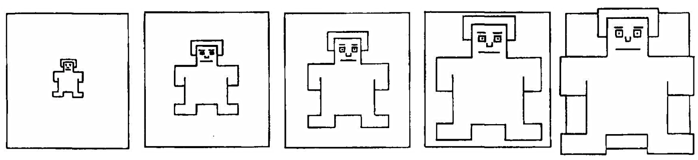
Please indicate how you felt <u>towards the end of the game</u> by circling the relevant number:



1 2 3 4 5 6 7 8 9



1 2 3 4 5 6 7 8 9



1 2 3 4 5 6 7 8 9

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Appendix B

Questionnaire

Please indicate how you felt <u>towards the end</u> of the game:

1. To what extent did the game hold your attention?

Not at all	1	2	3	4	5	A lot

2. To what extent did you feel you were focused on the game?

Not at all	1	2	3	4	5	A lot

3. How much effort did you put into playing the game?

Very little	1	2	3	4	5	A lot

4. Did you feel that you were trying your best?

Not at all	1	2	3	4	5	Very much so

5. To what extent did you lose track of time?

Not at all	1	2	3	4	5	A lot

6. To what extent did you feel consciously aware of being in the real world whilst playing?

Not at all	1	2	3	4	5	Very much so

7. To what extent did you forget about your everyday concerns?

Not at all	1	2	3	4	5	A lot

8. To what extent were you aware of yourself in your surroundings?

Not at all	1	2	3	4	5	Very aware

9. To what extent did you notice events taking place around you?

Not at all	1	2	3	4	5	A lot

10. Did you feel the urge at any point to stop playing and see what was happening around you?

Not at all	1	2	3	4	5	Very much so

11. To what extent did you feel that you were interacting with the game environment?

Not at all	1	2	3	4	5	Very much so

12. To what extent did you feel as though you were separated from your real-world environment?

Not at all	1	2	3	4	5	Very much so

13. To what extent did you feel that the game was something you were experiencing, rather than something you were just doing?

Not at all	1	2	3	4	5	Very much so

14. To what extent was your sense of being in the game environment stronger than your sense of being in the real world?

Not at all	1	2	3	4	5	Very much so

15. At any point did you find yourself become so involved that you were unaware you were even using controls?

Not at all	1	2	3	4	5	Very much so

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Appendix B

Questionnaire

16. To what extent did you feel as though you were moving through the game according to you own will?

Not at all 1 2 3 4 5 Very much so

17. To what extent did you find the game challenging?

Not at all 1 2 3 4 5 Very difficult

18. Were there any times during the game in which you just wanted to give up?

Not at all 1 2 3 4 5 A lot

19. To what extent did you feel motivated while playing?

Not at all 1 2 3 4 5 A lot

20. To what extent did you find the game easy?

Not at all 1 2 3 4 5 Very much so

21. To what extent did you feel like you were making progress towards the end of the game?

Not at all 1 2 3 4 5 A lot

22. How well do you think you performed in the game?

Very poor 1 2 3 4 5 Very well

23. To what extent did you feel emotionally attached to the game?

Not at all 1 2 3 4 5 Very much so

24. To what extent were you interested in seeing how the game's events would progress?

Not at all 1 2 3 4 5 A lot

25. How much did you want to "win" the game?

Not at all 1 2 3 4 5 Very much so

26. Were you in suspense about whether or not you would win or lose the game?

Not at all 1 2 3 4 5 Very much so

27. At any point did you find yourself become so involved that you wanted to speak to the game directly?

Not at all 1 2 3 4 5 Very much so

28. To what extent did you enjoy the graphics and the imagery?

Not at all 1 2 3 4 5 A lot

29. How much would you say you enjoyed playing the game?

Not at all 1 2 3 4 5 A lot

30. When interrupted, were you disappointed that the game was over?

Not at all 1 2 3 4 5 Very much so

31. Would you like to play the game again?

Definitely not 1 2 3 4 5 Definitely yes

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Appendix C

Rating Sheet

Observer No.______

Please answer the following questions for each video clip according to this scale:

Not at all				Very much so
1	2	3	4	5

	Clip 01	Clip 02	Clip 03	Clip 04	Clip 05	Clip 06	Clip 07	Clip 08	Clip 09	Clip 10	Clip 11	Clip 12
How focused / concentrated is the player?												
Does the player want to win?												
Does the player enjoy the game?												
Does it look like the player thinks he/she is really boxing somebody?												
How much is the player immersed / "in the game"?												
How emotionally engaged is the player?												
How physically engaged is the player?												

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Motivations, Strategies, and Movement Patterns of Video Gamers Playing Nintendo Wii Boxing

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Abstract

Video game consoles that employ physical activity as an interaction mode can benefit from using the gamer's movement as feedback and adapt to it. But to be able to design such systems we need to know how gamers actually move and what we can infer from this. This paper reports preliminary, qualitative results of a study that aims at identifying playing styles and related movement patterns of gamers that play the Nintendo Wii Boxing game. Interviews of video gamers revealed that they approach the game with two different motivations (to achieve and to relax) that lead to different strategies (game and simulation). A movement analysis study using motion capture data, video recordings, and observer ratings identified three different movement patterns that relate to these strategies.

1. Introduction

A new generation of video game consoles enables video gamers to employ active body movements as interaction mode. Initial studies show that usage of such movement-based consoles reaches exertion levels that increase physical health and appear promising for reducing obesity [10], [11], which is at least partly the result of a sedentary lifestyle [12].

Presently, there is a fair amount of research done to develop intelligent interfaces [16], i.e. interfaces that employ the user's behaviour as input and adapt to it. Such interfaces usually act on affective cues that are inferred from the users. But with the advent of movement-based interaction, intelligent interfaces also have to analyze the movement patterns of their users. For instance, what does the force when swinging a baseball bat or the number of punches when boxing say about the gamer's experience? How can we detect a gamer over pacing himself or moving in an unhealthy way?

Apart from the challenge of developing technology that can detect movement patterns of the user, another important task - and one that should precede the development of technology - is to investigate and identify the movement patterns that users display. If we want to build systems that react on the user's behaviour we must know what we can observe and what it means in the first place. This is not a trivial task as the human body is complex with a large number of degrees of freedom,. These are usually represented by joint rotations (e.g. around the shoulder joint or elbow joint) to describe the movement that one carries out.

Some approaches to intelligent, movement-based interfaces circumvent joint rotations and just consider the amount of movement in an image or track the head or the hands. But also here the task of identifying patterns in the movement and what they mean remains.

It is the goal of this paper to contribute to the search for behavioural patterns and their meanings. In the study described here we attempt to identify movement patterns of video gamers that are playing on the Nintendo Wii. The Wii is a popular video game console that gamers steer by using one or two handheld controllers that are fitted with accelerometers and that allow the console to detect the location of the controllers in 3D space.

In a first step we conducted interviews with video gamers to investigate how they conceptualize and interpret their movements when playing movement-based games. This revealed two different motivations and corresponding strategies for playing. In a second step we investigated if the two strategies can be found back in movement patterns that gamers exhibit while playing. For this, we fit gamers with an inertial gyroscopic motion capture suit and observed their movements while they played the Wii Sports Boxing game. The Wii Boxing game was chosen because the Wii is presumably the most widely distributed movement-based video game console at present and Wii Boxing reaches the highest activity levels of the Wii Sports games [10].

The paper is organized as follows: We first discuss potential benefits of movement-based games as opposed to sedentary games and outline areas where adaptive interfaces could improve the interaction. We then present the outcome of the interviews with video gamers. The movement analysis study is described next. Finally, we discuss the results of both studies and give pointers to future research.

2. Potential Benefits of Intelligent, Movement-based Video Games

A video game that employs both active body movements as interaction mode and can adapt to the gamer's behaviour, offers several potential benefits. Before moving on to our findings, we want to discuss two domains of potential benefits, arising from such games: (a.) a healthier interaction, and (b.) a richer, more enjoyable interaction.

2.1. Healthier Interaction

Video games are usually seen as contributors to the growing obesity epidemic [5]. Hillier [12] notes that "children today are engaging much less with the world outside their homes in terms of physical activity ... Technological innovations in media have contributed to these changes, keeping children inside and sedentary in their playtime..." (p. 56). Yet, instead of simply blaming technology, she advocates making technology part of the solution. Physical activity promoting video games can be seen as an example of such a technology driven solution.

Initial studies show that physical activity during gameplay increases energy expenditure significantly compared to sedentary games. Lanningham-Foster and colleagues [14] measured the energy expenditure of children playing sedentary video games and playing active video games like Sony's EyeToy and Konami's Dance Dance Revolution. The energy expenditure more than doubles for Dance Dance Revolution and the authors conclude that such games could be useful for obesity prevention and treatment.

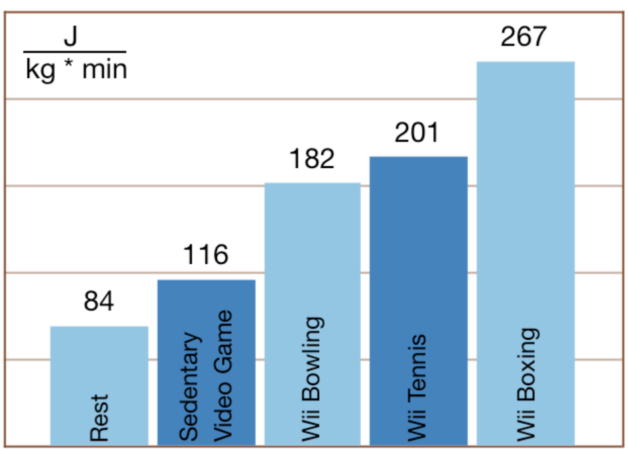

Fig. 1: Energy Expenditure of Adolescents whilst Playing Video Games, from Graves and colleagues [10]

Graves and colleagues [11] also measured the energy expenditure of children playing active video games as compared to sedentary games, but observed an older group of children. Interestingly, they compare the expenditure values of the Wii Sports Bowling and Tennis with values for real Bowling and Tennis. The Wii games require significantly more energy than sedentary activities, but less than the real sports that they simulate. Yet, the measure they employ does not take upper limb movements into account. In a more recent study Graves and colleagues [10] use a measure for estimating the energy that includes upper limb movements, which form a crucial part of interacting with the handheld controllers of the Wii and that were neglected in [11]. Including upper limb movements promises more accurate results and indeed, they report higher activity levels than in the previous study. Figure 1 shows the energy expenditure levels that Graves and colleagues [10] found for the Wii Sports games, in comparison to a rest value and a sedentary video game on the Microsoft XBOX 360 video game console.

Of all the Wii Sports games (i.e. baseball, bowling, boxing, golf, and tennis) boxing reaches the highest activity levels. The authors conclude that while the intensity of real boxing is much higher, the intensity of the Wii Boxing game exceeds the cut-off for moderate intensity physical activity. It is thus high enough to contribute to recommended amounts of exercise.

Besides in obesity prevention, active video games have also been envisioned for use in rehabilitation. The field of Virtual Rehabilitation has used virtual reality technology for some time now for the rehabilitation of patients [3][13], [17]. Recently, also physical activity promoting video game consoles have been deployed in rehabilitation measures. Morrow and colleagues [15] present a rehabilitation system, which is based on Microsoft's XBOX. They advocate the use of entertainment technology for physical rehabilitation, mainly to reduce system costs. Galego and Simone [7] combined a Wii remote control and Second Life into a Virtual Rehabilitation system. They also point out the potential of such low cost rehabilitation approaches. Though there are no results of scientific evaluations available yet, therapists have already coined the term "Wiihabilitation" and report of increased motivation of their patients, who are often unmotivated to carry out the very repetitive limb movements common in rehabilitation [19].

All this gives evidence for the benefits of video games that require the gamer to be physically active as compared to sedentary games. Still, they also expose gamers to new threats: Injuries from playing the Nintendo Wii have been reported in popular media and physicians have already introduced the diagnosis "Wiitis" [2] or "Wii shoulder" [4]. Bonis [2] describes the condition as follows: "If a player gets too engrossed, he may 'play tennis' on the video screen for many hours. Unlike in the real sport, physical strength and endurance are not limiting factors" (p. 2431). It is also an example for how much the interaction with the Wii is dependent on arm movement. One could also speculate that a further reason for such injuries is that gamers do not perceive their video game consoles as sport devices and consequently do not care about warming up before playing [17]. This is certainly an issue that should be addressed in future research as well as in future game design. Otherwise the health improving effect of the physical activity can degrade.

By enabling game technology to monitor body movement and movement patterns, the game could be adapted at run time in order to foster a more positive and personal experience by encouraging healthier body movement. Once a threat is identified the game can then steer the gamer towards a healthier behaviour. Also, an adaptive game could monitor the exertion level of a gamer and steer the gamer towards recommended exertion levels.

2.2. Richer Interaction

The second domain we discuss is the promotion of a richer and more enjoyable interaction. Riskind and Gotay [18] found that the sheer posture of persons has influence on their mental state. Subjects that were put in a hunched, threatened posture reported greater stress than subjects that were put in a relaxed posture. Fox [6] reviewed studies that investigate the influence of physical activity on mental well-being. He concludes that there is growing evidence that exercise increases mental well-being, largely through improved mood and self-perception. Returning to a video game context, Bianchi-Berthouze and colleagues [1] found evidence that body movements not only increase the gamers' level of engagement, but also have an influence on the way a gamer becomes engaged. Their results demonstrate that the controller itself plays a critical role in creating a more complete experience for the gamer.

Whether the increase in engagement in physically active environments is due to the actual physical activity or to a higher perceived level of control remains open for research. Yet, more knowledge is needed about the link between physical activity and engagement in order to develop adaptive games that steer the gamer's movements towards a more enjoyable interaction.

Movement patterns can for examples shed light on the affective states and motivations of the gamer. A game technology able to capture such information and exploit it to adapt the game would provide a more natural and richer experience that could facilitate a sense of presence. If a gamer becomes aware that the game is reacting to his or her body movement, this may motivate the gamer to further exploit this channel of communication. This would offer a much richer set of strategies for challenging the opponent or communicate with possible teammates.

3. Interviewing Video Gamers

Interviews with video gamers were held to investigate how they experience, conceptualize, and interpret their movements when playing movement-based games.

3.1. Setup

Four experienced video gamers were recruited for this study. It did not appear useful to recruit novices, as some level of exposure is required for interviewees to reflect on their experiences with movement-based games. Interview sessions were held in a semi-structured style and initial outcomes were used to update the interview guide for the following interviews. Before the interview, subjects were primed by a 20 minutes session of playing the Nintendo Wii Sports games, during which they were videotaped. Subjects were instructed to play a game with a slow pace (i.e. bowling, golf, baseball) and a game with a fast pace (i.e. boxing, tennis) with the idea of asking about differences between the games, i.e., how the amount of physical activity and the type of movement may affect their gaming experience.

The interviews were transcribed and analyzed using a Grounded Theory approach, a qualitative methodology developed by Glaser and Strauss [8]. Aside from the statements of the interviewees, also observational data in form of memos was used in the analysis, as recommended by Goulding [9].

Open coding was applied to the data, i.e. labels were assigned to the statements of the interviewees and the observations. Then, relations between the labels were identified and finally put into concepts.

3.2. Results

A concept that emerged early in the data was that gamers have several distinct motivations to engage with movement-based games. In fact, some experienced gamers seem to be aware of their changing motivation and adapt their gaming strategy accordingly:

"As you play and play you start to realize that you don't really need to swing and it's just a small movement that you need to make - so I tend to play more technically rather than emotionally. [...] When I am playing to relax and I play baseball, I swing like I would with a real baseball bat. But if I am playing to beat somebody else then I do what I need to do to do the movements." (i3)

The statement of interviewee 3 shows he has realized that he does not need to swing his arm with force. For the Nintendo Wii it is sufficient to make a small movement from the wrist. The challenge is thus the timing of the movement. In fact, to achieve a higher score it is beneficial to only make small movements from the wrist, as this allows more precise control. Nevertheless, the interviewee states that sometimes he deliberately makes big, forceful movements, when his motivation is not to achieve a high score, but just to relax and immerse into the virtual environment.

Gamers seem to appreciate the reduced complexity of the Wii compared to a real sport: "*Playing tennis in real life is harder*" (i4). Yet, there were also statements that

Table 1: Results from Video Annotation, Motion Capture, and Observer Ratings

	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10
Video Annotation Data										
Number of Punches*	74	39	93	31	53	19	18	20	129	46
Ratio Hit to Total Punches*	0.28	0.41	0.22	0.71	0.34	0.68	0.33	0.4	0.11	0.41
Ratio Executed to Total Punches*	0.47	0.74	0.35	0.84	0.57	0.84	0.72	0.6	0.27	0.54
Motion Capture Data										
Displacement Body Root (Hip)*	357	22	76	232	316	261	572	301	139	386
Angular Displacement of Elbows*	55637	6539	47717	37274	35786	9264	14516	8190	13296	15699
Punch Amplitude (X-Rot., in Deg.)	95	8	118	160	90	63	90	105	18	75
Observer Ratings										
Boxing Realism**	2.3	1.2	2.2	2.4	2.5	3.6	3.1	3.8	1.7	3.7

* accumulated over 20 seconds, sample taken from middle of gaming session
** scale: 1 (low) – 5 (high)

gamers felt exhausted after playing on the Wii. Further, physical fitness was hardly mentioned by the interviewees and only as nice byproduct, but not as a motivation to engage with the game.

3.3. Discussion

We can conclude that there are two different strategies that gamers employ when playing a movement-based game and that they derive from different motivations to play in the first place. In the first case, the gamer is playing a game with the motivation to challenge his/her ability to find the best way to make points and have fun. The aim is to win and to achieve something. The related strategy is thus to maximize all efforts towards achieving a high score.

In the second case, the motivation for playing is to relax by experiencing and/or challenging their movement skills like they would do in a sport situation. Relaxation here does not refer to physical relaxation, but rather a mental relaxation that derives from immersing into the game and imagining oneself as playing the actual sport, not just a video game. Gamers that want to relax in such a game employ a different strategy. Instead of optimizing their gameplay towards achieving a high score they rather simulate the actual sport, i.e. they do the same movements as they would in the actual sport or how they think a good player would execute the movement in the real sport.

4. Movement Analysis Study

We conducted a motion capture study to investigate whether different motivations for playing and therefore deviating strategies identified from the interviews can be found back in movement patterns.

4.1. Setup

10 participants (thereof 7 males; mean age: 26 yrs, SD: 2.6) were fitted with an inertial gyroscopic motion capture suit (Gypsy 6, Animazoo, Brighton, UK) and their movements were recorded while they played the Wii Sports Boxing game for 15 minutes. To avoid biasing the participants, the experimenter left the room during this period.

In addition to the motion capture data, video recordings were made from a frontal-lateral angle and from over the shoulder of the gamer, to be able to correlate movements to game events.

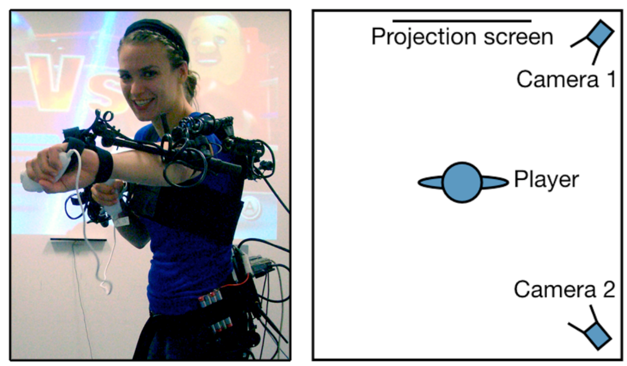

Fig. 2: Setup of the Motion Capture Study; Left: Participant in Gypsy 6 Motion Capture Suit; Right: Camera Positioning

Figure 2 shows the setup of the experiment. A third measure comes from five observers that rated video clips of the participants on boxing realism. Three 10-second video clips of each participant were shown in a random order to the observers. The results from all three measures are given in Table 1.

4.2. Results

A first analysis step was a visual inspection of the video footage. This revealed great differences in playing styles, i.e. differences in punch frequency, punch amplitude, and overall body movement. Roughly, three types of playing style were observed: One group of gamers only made very little extensions of the arms, while punching at a high frequency. Another group of gamers showed big extensions of the arms and also punched at a high frequency, to the extent that it appeared they were over pacing themselves. In both groups it appeared that the gamers' behaviour was almost independent of game events, i.e. they showed only little defensive behaviour, even when their avatar was hit repeatedly.

The third group appeared to box realistically, i.e. with big arm extensions, a low to medium frequency of punches and reacting to game events.

In a next step we quantified the features that were deemed important during the visual inspection. The punch frequency was measured for each participant by annotating a short segment of the video recordings.

Figure 3 shows a representation of the punch frequency distinguishing between when a gamer punches but the Wii does not execute the punch in the game, when a gamer punches but misses the opponent ("executed + missed"), and when a gamer punches and hits the opponent ("executed + hit"). The Wii does not execute a punch e.g. when a punch is too soft or when a gamer punches while the avatar is still in the process of executing a previous punch or is recovering from being hit.

Aside from total punches, Table 1 also shows the ratio of punches that actually hit the opponent and the ratio of punches that are executed.

From the numerical data of the motion capture suit we obtained the total movement of the gamers, as the displacement of the body core over a period of 20 seconds. Another measure is the angular displacement of the elbows. This is an accumulation of the angular displacement (in arc degrees) of both elbows combined over a period of 20 seconds. Also, we obtained the average punch amplitude for each participant. Table 1 shows the punch amplitude for the X-Rotation, i.e. the extension of the arm in a forward direction. Figure 4 gives an example for a rotation around the X-Axis.

When plotting the observers' ratings of how much they thought the gamers are really boxing against the angular displacement of the elbows, we can easily identify three clusters that correspond to the playing styles that were mentioned above. Figure 5 shows that plot and in addition the average punch amplitude as bubble size.

The first cluster (P02, P09) only gets a low realism rating and is further characterized by low amounts of angular displacements and punch amplitudes. The second cluster (P01, P03, P04, P05) receives medium realism ratings, high angular displacements levels and big punch amplitudes. The group with the highest realism ratings (P06, P07, P08, P10) only shows low amounts of angular displacements. Yet, if we look at the size of the bubbles, we see that they show medium to large punch amplitudes. When looking at the video footage one can indeed observe that these gamers react to events that happen in the game, i.e. they wait for a good moment to punch the opponent and they also take a defensive stance while waiting.

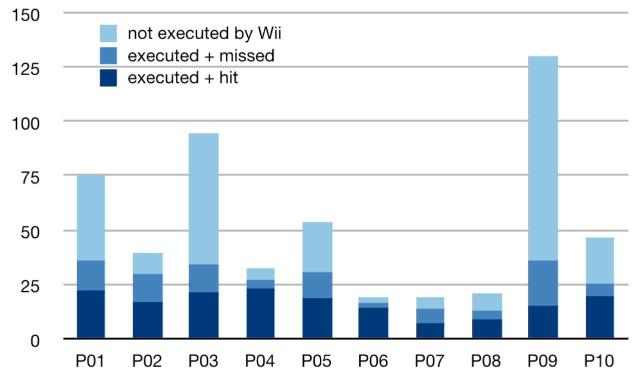

Fig. 3: Number of Punches over a period of 20 seconds.

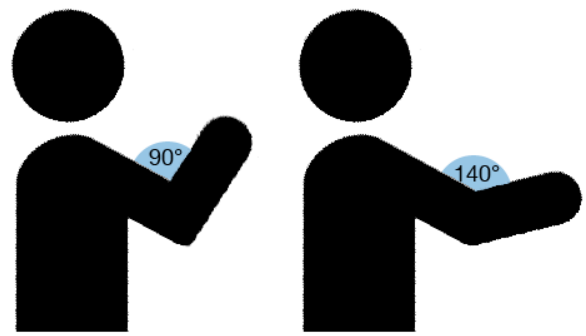

Fig. 4: Example of the punch amplitude for X-Rotation of the arms: A resting angle of 90° (left) and an extension angle of 140° (right) result in a punch amplitude of 50°

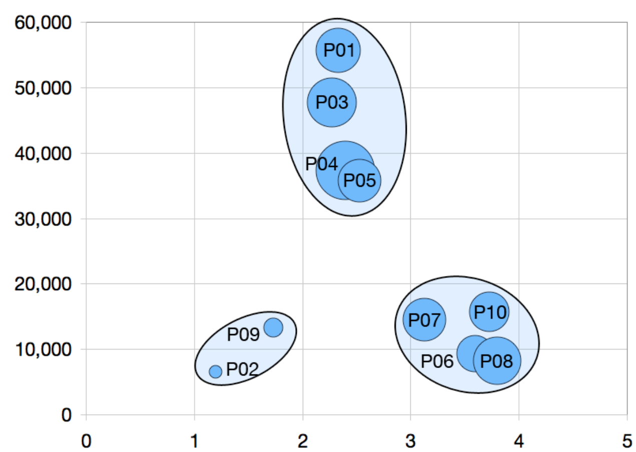

Fig. 5: Observer Ratings of Boxing Realism (X-Axis; Scale 1-5) vs. Angular Displacement of the Elbows (Y-Axis; accumulated over 20 seconds) vs. Average Punch Amplitude (Bubble Size; Size of X-Rotation, i.e. rotation in forward direction)

4.3. Discussion

In the interview study, we identified two motivations with which gamers approach the Wii Sports games: "Achieving" and "Relaxing". Also, corresponding strategies were identified: "Game" and "Simulation". In the movement analysis study we found three patterns, i.e. the clusters shown in Figure 5: One pattern corresponds to "Simulation", while we have to differentiate for "Game". Here, there appear to be two different patterns.

The first pattern can be described as "game with a low intensity", i.e. gamers show only little physical engagement. The body core remains stationary and there are only very small arm extensions. Yet, they show a high punch frequency. Apparently these gamers have learned that for the Nintendo Wii the punch amplitude is irrelevant and that a short impulse is enough to perform a punch. The high punch frequency leads to a good performance in terms of total hits, even if many punches do not hit or are not executed at all. Still, the level of physical activity remains low and on the video recordings they do not appear to be emotionally engaged and almost look bored.

The second pattern can be described as "game with high intensity". These gamers are quite active, i.e. they move around and show high arm extensions and punch amplitudes. The punch frequency varies from medium to high.

The pattern "simulation" is characterized by gamers that observe the action on the screen and react to it. They have a lower number of punches as they wait their turn and do not punch blindly. On the other hand they show big arm extensions, as is done in real boxing, which they simulate.

Figure 6 gives an overview of the motivations, strategies, and movement patterns that were identified for video gamers playing Wii Boxing.

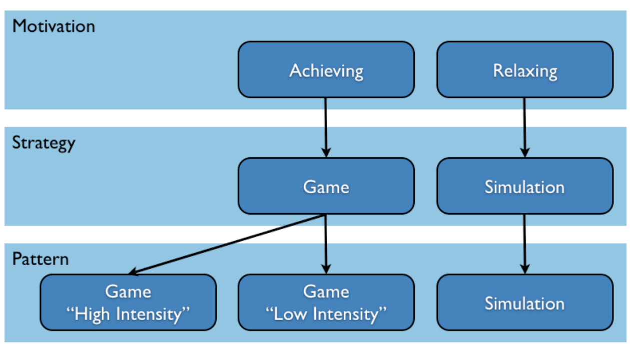

Fig. 6: Motivations, Strategies, and Movement Patterns of Video Gamers Playing Nintendo Wii Boxing

The following features appear thus important for identifying the gamer's movement behaviour. The average punch amplitude gives a good indicator to distinguish between the low intensity pattern of "Game" and the pattern "Simulation". Yet, it seems not sufficient to distinguish the high intensity pattern of "Game" from "Simulation". For this, the angular displacement of the elbows appears suited (see Figure 5).

5. Conclusions

The aim of this paper was to identify playing styles and corresponding movement patterns for gamers of physically active games, in this case the boxing game of the Nintendo Wii Sports games.

We identified two motivations with which gamers approach the Wii Boxing game ("Achieving" and "Relaxing") and two related strategies they employ ("Game" and "Simulation"). In the first one ("Game") gamers are aiming for a high score and to achieve this reduce their movements to what is necessary. This can result in two different movement patterns, one with low punch amplitude and corresponding low physical intensity and one with a high punch amplitude and high physical intensity. In common for both patterns is that gamers punch at a high frequency and neglect events in the gameplay like their avatar being hit.

Gamers that want to relax and to immerse into the game use a different strategy, which we call "Simulation". In the corresponding movement pattern they appear to imitate real-life boxing, i.e. they observe the opponent, try to block its punches and wait for good opportunities to attack.

The significance of the findings reported in this paper must be qualified by the rather small size of the pool of subjects. Still, our results identify trends and can help reduce the complexity of information that we obtain from movement data.

In a next step, the features that we identified here should be validated in a quantitative study. Also, other game scenarios should be investigated.

Reports from the interview study lead us to speculate of changes of the gamers' behaviour as they gain expertise in a game. We also found that a gamer can approach a game with changing moods and motivations. A longitudinal study could investigate how motivations and movement patterns change over time and exposure.

Another aspect of this new type of physically active games is a social one. From our interviews we learned that for this type of game, gamers appear to meet with friends to play, as a sort of social event. Interviewees reported of a preference to play in a social setting. We did not consider social aspects in this study, but they should be addressed in future research.

As in all game research, a further critical issue is the artificial setting of laboratory studies. This makes it hard to get a good and reliable measure for the gamers' experience. The use of a motion capture suit in this study was also quite intrusive and potentially influences the gamers' experience. The identification of relevant features should limit the amount of necessary technology to record movement of the gamer and help towards designing future studies into a more natural setting.

All this should enable us to inform the design of user-adaptive active games that steer the gamer towards a healthier and richer interaction.

Acknowledgements

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