Assessing the perception of motion capture technology in exergames

Alistair Wood

Project report submitted in part fulfilment of the requirements for the degree of Master of Science (Human-Computer Interaction with Ergonomics) in the Faculty of Life Sciences, University College London, [2011].

ACKNOWLEDGMENTS

ABSTRACT

New motion capture technology developed for video games consoles comes in two competing forms, worn physical sensors (Wii) and controller free sensors (Kinect). How these different motion capture methods influence the player experience and what level of feedback precision is required to produce a satisfactory game experience are questions that still need to be answered. This study assess the effect of motion capture technology in exergames, and examined how worn and controller free sensors affects the perception of being monitored and how limitations in the precision of feedback provided by motion capture technology can produce a barrier to the creation of a positive player experience. An experimental design was used with two independent variables, controller type which had two levels (Kinect and worn motion capture sensors) and exercise type which had two levels (slow and fast exercises). The dependent variables were perception of motion capture precision, body awareness, exercise difficulty and affective experience, which were measured using a questionnaire and semi-structured interview analysed using grounded theory and affective frameworks. Sixteen participants were used in total (6 female and 10 male) with an average age of 31. The results showed that people were more aware of being monitored when wearing sensors than when having their movement measured by the Kinect. The reasons for this were that wearing sensors increased levels of body awareness and the perception of being physically attached to the technology. The results also demonstrated that delays and inaccuracies in how player movement was represented on screen were linked to negative experiences. These results have academic significance as they further the research in the area of motion capture, exergaming and rehabilitation, and are commercially relevant to companies producing motion capture systems and exergames.

CONTENTS

CHAPTER 1.   INTRODUCTION

The phrase 'exergames' derives from the combination of 'exercise' and 'games' and relates to computer games that involve deliberate intense physical activity (Mueller, Agamanolis, and Picard, 2003). Computer games have long been considered a sedentary activity associated with the increasingly poor health of many people, but exergames aim to involve the use of larger muscle groups instead of simply pressing buttons on a game controller, and are designed to involve high levels of physical exertion and exercise. Consequently these games have been seen as a useful tool in different areas such as tackling obesity and for rehabilitation.

The development of exergames has been intrinsically linked to the development of games consoles that detect body movement, the most prominent impact being made by the Nintendo Wii (Nintendo, 2011) and the use of the Wii remote (Nintendo, 2011) and the Wii balance-board (Nintendo, 2011). More recently the Xbox Kinect (Xbox, 2011) and Sony Playstation Move (Playstation, 2011) have joined the market to provide all major games consoles with the capacity to include body movement into the game experience.

These new motion capture game consoles provide different methods for capturing body movement. The Wii and Sony Playstation Move involve the use of held or worn motion sensors that rely on camera tracking and inertial sensors, and the Xbox Kinect provides a controller free whole body motion capture device which employs a method of 3D infrared scanning (Wikipedia, 2011). The ability of these consoles has led to the development of games where body movement is an integral part of the game design.

The genre of exergames began in the 1980s but came of age with the Nintendo Wii Fit (Nintendo, 2011), a computer game that provides a wide variety of exercise activities and is also a mix of serious and fun gaming with the aim of introducing proper exercise into the home game console market. More recently the serious exergames market has seen a variety of titles launched which focus on serious exercise such as EA Sports Active 2 (EA, 2011) and dance related exercise game like Zumba Fitness (Majesco, 2011).

Early games like Wii Sport started by providing interactive sports such as golf and tennis and were more oriented to sports that the Wii remote was able to replicate. The advent of the Xbox Kinect and the worn body sensors available for games like EA Sports Active 2 and Wii Fit now means games are being developed that can track the entire body and are not restricted to activities that are related to hand movement.

The development of motion capture systems and exergames has seen them studied for their potential health benefits. Lanningham-Foster, et al (2007) compared standard sedentary computer games to exergames and found that movement and energy used was greatly increased for both adults and children in games that

promoted physical activity. This result was also supported by Maddison, et al (2007). Although, Graves, et al (2007) concluded that Wii Sport games did not match the energy expenditure of the real sports they represented, however, they did meet recommended daily exercise levels and were significantly higher than in sedentary video games.

The potential benefit of these systems for physical rehabilitation has also become a major focus of academic research. Burdea (2003) concluded that virtual reality (VR) systems have various benefits to patients with rehabilitation requirements, but cost was a major drawback of the systems. This has prompted the use of commercial video games consoles in rehabilitation studies. Morrow et al (2006) used the Xbox to provide a low cost alternative to expensive VR systems. Numerous recent studies has extolled the virtues of using the Wii console for rehabilitation (Dimoska, 2010 & Decker et al, 2009). Recognised benefits include the ability to easily store and track performance data; low cost, increased engagement compared to standard rehabilitation methods, and capacity to widen the availability of therapy. A recent pilot study by Chang, Chen, and Huang (2011) using the Xbox Kinect in rehabilitation of young adults with motor disabilities showed a significant increase in motivation and exercise performance. The use of full body motion capture systems has also been studied by Schonauer, Pintaric, and Kaufmann (2011) to assess the benefits to sufferers of chronic back and neck pain.

It is easy to spot potential benefits presented by the new forms of motion capture technology but for these systems to be effective they must also provide a positive experience to the person using them so they encourage repeated use. Slater, Usoh and Steed (1995) suggests that the for a system to be successful feedback must match with up a person's perception of their own body, and be consistent, predictable and complete to properly function, and any mismatch between these two factors could results in an unsatisfactory experience. Johnson, et al (2002) suggested people preferred movement based controllers but that the preference was also influenced by the amount of intuitiveness, control and realism experienced. Hoysniemi, Hämäläinen, Turkki (2004) suggest that using gestures to control games should be intuitive, easy to adopt and provide a pleasant experience by being responsive. The importance of precision provided in motion capture has also been considered; Nijhar (2010) found that the more accurate a system was the more realistic the gaming experience was and the better it fit people's expectations.

The focus of this study will be to consider how the different types of motion capture system now available in the form of worn sensors or controller free sensors provided by the Kinect affect the experience of exergaming and the influence they may have on the perceptions of the player. We will also consider if the precision of feedback provided could create a barrier to producing a positive player experience. This study will further advance theory which has considered the precision of motion capture devices and the perception of different motion capture modalities.

Next, the existing literature in the field will be discussed in more detail and then the research hypotheses will be considered. The research methodology and

experimental procedure will then be presented, followed by the main findings of this study. Finally, these findings will be discussed in relation to the literature reviewed, before the study is summarised in the conclusion.

CHAPTER 2.   LITERATURE REVIEW

This section will consider existing research into motion capture systems and the effects they have on the experience of the player. More specifically we will look at the influence on the type of controllers used, whether it is physical or controller free systems, and also the type of feedback received.

Controllers

The controller has always been an integral part of the gaming experience as it represents the connection between the player and the system. It provides the player with the means of controlling the game and provides a tangible and physical link to the system. Several studies have looked at the impact of controllers on the gaming experience and the range of effects different types of input can have.

The use of motion capture controllers as a direct input method was studied by Bianci-Berthouze, Kim, and Patel. (2007) who discussed the difference between a standard game controller and a motion sensor guitar style controller which encouraged physical movement. The results suggested that body movement as an input device increases engagement levels and also effects the way people become engaged. Johnson, et al (2002) found a preference for physical controllers that used body movement over standard controllers, but concluded that the preference was also moderated by the amount of intuitiveness, control and realism experienced.

Nijhar (2010) found that the accuracy of motion capture devices demonstrated in representing user movement effected levels of immersion and the more accurate a system was the more realistic the gaming experience was and the better it fit people's expectations. Research has also looked at how movement in game play affects the experience and has shown that engagement can increase with games involving body movement. Lindley, Couteur, and Berthouze (2008) compared a standard wireless video game controller with a non-standard bongo drum style controller and found that the use of a controller that encouraged physical movement increased engagement and social interaction.

The effects of controllers on game experience are not limited to movement. Rambusch's (2006) study looked at the effects of different input methods with one group using a game pad and another using a modified exercise bike as the input, but found no difference in performance, action frequency or gaming experience, but did find that the types of input used had an effect on the participants expectations about the type of interaction they would allow. The bike group blamed the bike input for poor performance whilst the game pad group blamed the game itself. Rambusch suggests that natural input devices like the bike can lead to greater expectations about game performance.

The previous studies discussed were more concerned with upper body movement, but full body motion capture has been studied by Hoysniemi, et al

(2004) who investigated the use of gestures as game controls and the relationship between player actions and their avatar. They suggest that using gestures to control game should be intuitive, easy to adopt and provide a pleasant experience by being responsive.

Li, et al (2006) investigated how to improve the experience of interactive games using motion capture and physical inputs. They argue that controlling a virtual character requires precise movements that can be difficult and ultimately frustrating, and suggest four reasons to disconnect the level of control the user has over their input into a game. Firstly, it is very difficult to design a game were the virtual interaction feels completely natural. Secondly, input precision should be variable. Thirdly, the user may not always be able to perform the same actions as a game avatar. Fourthly, performing precise moves with limbs and objects can be difficult. They suggest that immersion can be strengthened by improving control of virtual characters using novel inputs methods, and conclude that supporting the users intention could be more important than increasing the level of control, and that a 'sweet spot' can be found somewhere between artificially supporting user intentions and providing natural intuitive controls, especially when high speed movements are required.

Having seen the motion capture technology can influence the experience of exergaming it is also important to see if the different forms of motion capture device have an influence. Much of the previous research focuses on handheld or sensor free systems, however, due to the success of games like Wii Sports and Zumba fitness a proper study of this field must include worn motion sensors, sensors that are attached to parts of the body to monitor movement, which then feedback to the games console.

There has been a great deal of research in worn sensors but this has mainly focused on the use of this form of technology in the medical field to provide monitoring of clinical issues (Bonato, 2010), with the aim of studying the use of worn sensors as effective devices for relaying physiological information to medical practitioners. A study by Staiano and Calvert (2011) considers the use of exergame as tools to measure physical health. They question if they are reliable enough compared to gold standard medical devices and conclude that if they are proven to be reliable and valid in measuring factors such as heart rate and caloric expenditure then exergames may prove effective tools for measuring physical health. A recent study by Bergmann and McGregor (2011) highlighted the problem that there has been very little research regarding the experience and preferences of people who use worn body sensors, and that previous research was more concerned with technical aspects of these devices.

These studies have focused on medical use but the problem is the same with exergaming, there has been little or no research on the experience of worn sensors or controller free motion capture in this area, so little is known about how people perceive motion capture sensors, so research into this area is important to further the understanding of these devices.

Feedback

Another important feature of motion capture systems is the feedback they provide. Standard video games feedback is seemingly instantaneously after a controller button has been pressed. The nature of full body motion capture is more complex and provides many more challenges than standard games.

According to Slater et al (1995) when are our bodies are tracked and represented in a virtual world a fundamental requirement is consistency between proprioceptive information and sensory feedback, particularly between the mental body and the virtual body. This suggests that for a system to be successful feedback from the motion capture system must match with up a person's perception of their own body, and be consistent, predictable and complete to properly function, and any mismatch between these two factors could results in an unsatisfactory experience.

Pasch, et al (2009) studied movement based interfaces and identified four movement related issues that increased levels of immersion. Movement based interfaces can provides players with a higher feeling of control, through more direct and lifelike interaction. Player movement that is mimicked by the on screen avatar raises empathy for the avatar and adds to immersion. Proprioception is activated by movement and provides an extra level of feedback, and movement based games produce a physical challenge to player. The empathy for a virtual representation of the self has also been observed by Fox and Bailenson (2009) who found that people exercise more when a virtual representation of them is seen to gain weight.

Another form of feedback in exergames is the use of a virtual trainer to provide support for the user. Eyke, et al (2006) found that participants who exercised with the help of a virtual trainer reported higher levels of motivation and also exercised at an optimal level for a longer time. Ijsselsteijn et al (2006) also found virtual coaches aided in reducing tension and pressure when exercising as they were following instructions and goals set by the virtual trainer.

Using feedback to aid the player in other ways has also been suggested. Sinclair Hingston, and Masek (2007) suggest that feedback from the player could be used to adjust the game level to account for fatigue, boredom or exercise level. This could provide a feedback driven adaptive system that provides a loop from the game experience to the player and back to the game. They also suggest that exergame design focuses on two area, attractiveness and effectiveness. The basis for this theory is that people who play exergames do so on a repeated basis because they are fun. So for an exergame to be successful it must effectively meet the physical exercise requirements and must be fun and captivating enough to encourage people to use the game enough to perform exercise to the required level, so consequently attractive. The level of attractiveness is also linked to Csikszentmihalyi's (1975) theory of 'flow' which reflects a state of total engagement and focus on an activity.

The above studied show how types of feedback can be beneficial in movement based games, but there appears to be a lack of research focussing on what obstacles there may be, specifically regarding issues of precision and reliability. A more comprehensive understanding of feedback in motion capture exergaming is needed to determine how systems should best be designed.

Summary

As we have seen above, previous research has focused on how exergames can be used to improve physical health and as an effective tool in rehabilitation due to their ability to motivate and engage, but these studies have generally focused on systems like the Wii which have usually been restricted to activities that involve upper body movement. However, the recent release of the Xbox Kinect and games like EA Sports Active 2 now provides an opportunity to widen the scope of research into the area of full body motion capture. As of yet no study conducted has investigated how people perceive the experience of full body motion capture systems when using exergames, and we believe further investigating this area will provide useful insight into both the design of exergames for health and for rehabilitation by gaining the perspective of the end user, and by assessing what barriers there may be to the success of this type of technology.

CHAPTER 3.   RESEARCH HYPOTHESIS

How do people perceive the new motion capture technology in exergames? This question aims to examine the experience of different motion capture technology available with commercial video game consoles, specifically the free full body motion capture system available with the Xbox Kinect and the worn motion capture sensors available for the Nintendo Wii, and how these new types of technology can be used in exergames.

This new technology is now being used to create a new generation of computer games which allow for full body interaction and permits gestures and movements to be fully incorporated into the game experience. The game products available are also moving away from standard 'fun' gaming into more serious types of activity such as exercise. The question posed in this study will also consider how the new motion capture technology is being harnessed by games of this nature and will look at how they can best utilised.

Research hypothesis 1: Wearing motion capture sensors raises the awareness of being monitored.

Wearing motion capture monitors will increase the experience of being monitored due to the physical nature of the sensors, compared to the experience of sensors free motion capture which requires no physical devices. This will result in a stronger feeling of connection to the games system technology, a feeling that body movement is being monitored more closely, but also that movement may feel constrained whilst wearing sensors.

Research hypothesis 2: Poor feedback precision in motion capture video games will form a barrier to producing a positive player experience.

A disconnect between the movements performed and the movements represented on screen during game play will reduce the effectiveness of exergames and limit their ability to encourage healthy behaviour, due to delayed and inaccurate representation of movement and the negative affective states associated with these.

CHAPTER 4.   METHODS

This section will explain the choice of console and game used in this study, and will then discussed the participants selected, the design of the experiment, the procedure used, how the data was analysed and the pilot study conducted.

Choice of console and controllers

The Xbox Kinect was the computer console used in this study as it represents the best sensor free motion capture system available. The Xbox Kinect was also selected as it supports several exergames and allows for the representation of the user on screen in a highly interactive manner.

The sensors used (Figure 1) were taken from the EA Sports Active 2 exergame for the Nintendo Wii console, but the console was not used for this study. These sensors were used with the Xbox Kinect but did not actually communicate with the system, but were used to assess how participants would perceive the use of wearable motion capture sensors. The sensors were worn on both upper arms and the right thigh.

Figure 1 EA Sports Active 2 Worn Motion Capture Sensors

Only one form of games console and motion capture device was actually used to measure the participants movement, the Xbox Kinect, however, the worn sensors were used for half of the experimental conditions and participants were led to believe that these would be recording their movement when worn and in the other half of the conditions the Kinect system would be recording their movement.

There were two reasons for this design:

1. So feedback participants received from the game was exactly the same in all conditions, as using different consoles would have lead to variations in the feedback.

2. And so the motion capture technology was the same in all conditions. There may be differences in the ability of different systems with one type of system potentially performing better. Using one system ensures there

is no difference in the different conditions so motion capture system performance could not influence the results.

Choice of game and genre

The game used in this study was EA Sports Active 2 for the Kinect. This game was selected as it provided a large range of different exercise programmes that used full body activities. Only one game was used to provide consistency between the different conditions and minimize any confounding variables that might occur when using different games.

The individual exercises fell into two categories. Slow and Fast. The slow exercises were Alternating Side Lunges (ALS) and Lateral Shoulder Raises (LSR). These were selected as they represented a standard slow repetitive exercise. The fast exercises were Dodgeball and Goalkeeping. These were fast interactive games which would not be recognised as standard exercises and are based on a deeper level of interaction between the participant and the game and required a faster less predictable form of movement.

Participants

Sixteen participants were recruited (6 female and 10 male). They ranged between 22 and 37 years of age, with a Mean of 30.6 and Standard Deviation of 4.6. Participants were recruited from UCLIC MSc students and friends. Requirements for participation were that participants would like to do more exercise and they had no previous experience using the Xbox Kinect motion capture system, to ensure they would believe that the worn sensors were really recording their movement. It was also checked that participants had no existing medical conditions or injuries that might prevent them from taking part. Further recruitment emails were sent to Sona and other UCL departments but there were no respondents.

Design

A within subjects design was used were all participants experienced all the different conditions. One participant at a time took part. All conditions were performed using the Xbox Kinect sensor only and in the worn sensor conditions the participants were informed that the sensors would be measuring their body movement and not the Kinect. When the participants were informed that the wearable sensors were measuring their movement it was the Kinect system that was performing this job. Deception was used here to assess if there was any difference between the participants perception of the way the different motion capture systems monitored their movement. There were two types of independent variables used each with two levels, and there were 5 types of dependent variable used.

Independent Variables

The independent variables used in this study came in the form of different types of motion capture technology and different types of exercises. The first independent

variable was the type of motion capture system used; this had two conditions, the Xbox Kinect and the worn body sensors. The second independent variable was the type of exercise, this also had two conditions with two exercises in each condition, condition one slow repetitive exercises (ASL and LSR), and condition two fast reactive exercises (Dodgeball and Goalkeeping).

From the two independent variables used each with two levels there were eight different conditions used in total, as shown in table 1.

Table 1: Experimental Conditions

Kinect	Worn Sensor
Alternating Side Lunges	Alternating Side Lunges
Lateral Shoulder Raises	Lateral Shoulder Raises
Dodgeball	Dodgeball
Goalkeeping	Goalkeeping

Dependent Variables

There were five dependent variables used which were related to the experience of using the different motion capture technologies and the different exercises performed.

- Accuracy and speed of motion capture systems response to participant movement.

  To measure how participants perceived the performance of the two different motion capture methods, participants completed a questionnaire at the end of the each exercise, the questionnaire was produced for this study. Interviews were conducted after all the exercises were completed to further investigate this subject.

- Bodily awareness.

  To assess the effect of the motion capture sensors on the participants own bodily awareness, this was part of the questionnaire.

- Exercise difficult.

  Participants perception of the difficultly of the different exercises performed in the study was assessed as part of the questionnaire and interview.

- Emotional experience

The emotions associated with the different conditions were assessed with an open ended section on the questionnaire where participants listed any emotions experienced and the level of those emotions.

The dependent variables listed about where all part of a questionnaire used during the experimental procedure, at the end of each condition participants were given the questionnaire to complete which asked questions about their experience of the different exercises.

The questionnaire was designed as follows:

1) How accurately did the game represent your movement?

   Very poorly   1 2 3 4 5   Very well

2) How quickly did the game respond to your movement?

   Very poorly   1 2 3 4 5   Very well

3) How aware of your own body were you during the exercise?

   Very little   1 2 3 4 5   Very much

4) How difficult did you find the game?

   Not at all   1 2 3 4 5   Very

5) What emotions did you experience?

Procedure

The experiments conducted (lasting approximately 45 minutes each) followed the procedure listed below.

1. After arriving participants were asked to read an information sheet (appendix 1), a health and safety sheet (appendix 2) and read and sign a consent form (appendix 3). Participants were also informed of their rights to withdraw from the experiment at any time.

2. The experimenter would then load the game in preparation for the first condition. All games are set to low intensity to minimise fatigue over the course of the experiment and to ensure all participants would be capable of performing the activities.

3. Next, depending on the condition, participants were fitted with the motion sensors, with one attached to the upper right leg, and one attached to each upper arm.

4. The experimenter then informed the participants about the nature of the exercises they were about to perform and the different conditions there were to experience. In the wearable sensor condition participants were informed that it would only be the sensors that were measuring their body movement, and in the Kinect condition participants were informed that only the Kinect system would be measuring their movement.

5. The first exercise game would then be started, which would include a demonstration of the upcoming exercise and what the participant was required to do. Participants would then complete the whole exercise selected which would last one minute on average.

6. At the end of each exercise the participants would then be asked to take a seat and complete the questionnaire.

7. Each of the remaining exercise games would then be played in turn repeating steps 2-6, removing and replacing the worn motion capture sensors when necessary. All exercises are approximately one minute in duration.

8. After all exercises are completed a semi-structured interview was conducted.

Data Collection/Analysis

Semi-structured interviews: The interviews were conducted in a quiet room in an informal manner and were recorded using an electronic voice recorder. The interviews last between 10 to 18 minutes, and were conducted over the course of three weeks.

Script design: For the purpose of this study open ended interview questions were used to elicit as much of the participants experience as possible.

The questions were designed to elicit information about the experience of using the motion capture technology 'How was the experience of taking part in the motion capture exercise game?'

Participants were also asked to discuss if they perceived any difference in how the two different types of motion capture system used. 'Did you experience any difference in the way the two motion capture systems measured your movement?

Next participants were asked to discuss the emotions they experienced during the experiment. 'What emotions did you experience during the exercises?' The experimenter also went through the emotions listed by the participants in the questionnaire data as a reminder if required.

The focus of the questions then switched to the exergame with questions about the different types of exercise conducted 'How did you find the different types of

exercises you just performed?', and the experience of seeing their own avatar on screen 'How did you find the experience of seeing an avatar representation of yourself on screen?' and how they interacted with the virtual and voice coach 'How did you find the voice coach and the onscreen personal trainer, did they affect how you performed the exercises?'

Data Analysis

To analyse the data gathered and produce themes, grounded theory (Glaser and Strauss, 1967), Jordan's 'Four Pleasures' (2000) and McCarthy and Wright (2004) affective frameworks were used.

Grounded theory was selected as the main method for coding the interview data gathered and provided three processes for coding the data, open coding, axial coding and selective coding. Firstly, the interview transcriptions were read and open coding was performed; this process was the first step and identified important ideas and issues in the data. Secondly, axial coding was conducted to see if there are any relationships in the data. Lastly, selective coding considers the codes previously highlighted and how the data might focus on certain issues and how themes might be build around those issues.

Jordan's 'Four Pleasures' affective framework is a process of assessing the emotion impact of a design and focuses on the physiological, psychological, sociological and ideological aspects of an experience. The physiological aspect regards those emotions derived from the body and sensory organs. The psychological pleasures come from mental and emotional reactions. The sociological concerns the experiences that are related to interactions with others, and the ideological regards individual aspirations, values and tastes. The four 'pleasures' are used to code interview data to assess the negative and positive emotional impact of a piece of technology.

MacCarthy and Wright's 'Technology as Experience' is another affective framework that was used to code the interview data and focuses on the sensual, emotional, compositional and spatio-temporal experience of technology. The sensual regards how the technology design and atmosphere influence the experience. The emotional aspects focus on the emotional experience. The compositional regards how the overall experience creates a narrative, and the spatio-temporal considers the experience of space and time in the use of technology. Together with Jordan's 'Four Pleasures' these two frameworks were used to provide a broad base with which to code the interview data.

These methods were conducted one at a time. Firstly the grounded theory was conducted for each interview, then Jordan's Framework and lastly MacCarthy and Wright's framework. These methods were used one at a time so to not confuse the different elements of each method so the focus of each one was maintained.

Interview Coding

Firstly, the researcher familiarised themselves with the transcribed interviews by reading them through. Next the initial coding was conducted. This was done by manually identifying areas of interest in the interviews and highlighting the corresponding text. A spreadsheet was created to list all the relevant text and associated codes for each interview; figure 2 provides a sample of this.

Table 2 Initial grounded theory coding

PID	TEXT	ID	CODE
1	Not paying attention to when wearing sensors or not	1.01	Body awareness
1	kinect wasn't responding to the arms as well	1.02	Sensor preference
1	Arm movements were better picked up by the sensors	1.03	Sensor preference
1	With goalkeeping the sensors helped. Kinect slower at the arm raisers	1.04	Sensor preference
1	Not aware of wearing sensors in exercise	1.05	Body awareness
1	sensor made me feel like I couldn't cheat as much	1.06	Control and freedom
1	I did start to cheat	1.07	Cheating
1	The exercise games were quite boring	1.08	Engagement
1	I really like the dodgeball and the goalie one	1.09	Positive towards games
1	At first I thought I was the trainer as I was going so slow.	1.1	Confusion over avatar
1	I kept in pace with him the whole time, that was the aim	1.11	Trainer influence & Pacing
1	make you try a bit harder	1.12	Motivation

Once all the interviews had been coded in this manner they were compared and contrasted to each other to search for emerging themes. These themes were then visualised using post-it notes to aid in the emergence and construction of the main themes represented below in figure 2. These thematic maps helped to categorise the emergent themes which were later used to structure the analyses of the interview data covered in the results section. A copy of the transcribed and coded interviews can be found in appendix 4.

Figure 2 Visualisation of emergent grounded theory themes

Pilot Study

A pilot study was conducted before the main experiment in this study was conducted. This used the same experimental design but also used a full motion capture body suit. This was done to accurately measure the body movement of the participants to assess if the different exercises and motion capture systems affected the way participants moved.

The pilot was conducted with seven participants and their movement was recorded using the AnimaZoo motion capture suit and software. Whilst conducting the pilot it became apparent that the use of the motion capture suit was causing major problems for the validity of the experiment. The suit relies on material strips and Velcro to hold the motion sensor units in place and also involves the use of large battery pack and transmitter system. Due to the design and weight of the suit it would regularly slip during the exercises and would hinder the movement of the participants, especially in the fast exercises that required participants to move quickly. These problems with the suit influenced the final design of the experiment and led this piece of equipment being abandoned.

Ethics

This study was conducted in accordance with the departmental ethics committee. The study was given ethical approval for the experiment and the interviews to be conducted. Participants were given an information sheet (appendix 1) to explain the background of the study and a consent form (appendix 3) in accordance with the Data Protection Act 1998. All data information as anonymized by removing participants names from the data collected.

CHAPTER 5.   RESULTS

This section will be split into two main sections. The first will consider the findings of the questionnaire data and will highlight the different conditions used in the experiment. The second section will look at the results of the interviews data and will cover the motion capture and exergame experience.

Questionnaire results

This section will look at the results gathered from the questionnaire data. The questionnaire was split into five questions, four of which focussed on the quality of feedback received from the motion capture system, bodily awareness and game difficulty, the other question focused on the affective experience. The questionnaire results are as follows.

Body awareness

Here we will examine the effect the controller conditions had on body awareness in the different exercise conditions.

Goalkeeping condition: The results for the goalkeeping and controller conditions did not follow normal distribution so a non-parametric Related Samples Wilcoxon Signed Rank Test, One Tailed was conducted.

A significant effect was found in the Goalkeeping exercise between the Kinect condition (M= 3.4 and S.D=1.02) and Worn sensor condition (M=4 and S.D=0.73); W=12, p=0.0337. This suggests that participants were more aware of their body when wearing sensors than when not wearing sensors when participating in an exercise that involved high levels of arm and leg movement. There were no other significant effects of body awareness other than the goalkeeping condition as represented in the box-plot below (Figure 3).

Figure 3: Box-plot showing the levels of body awareness in all conditions
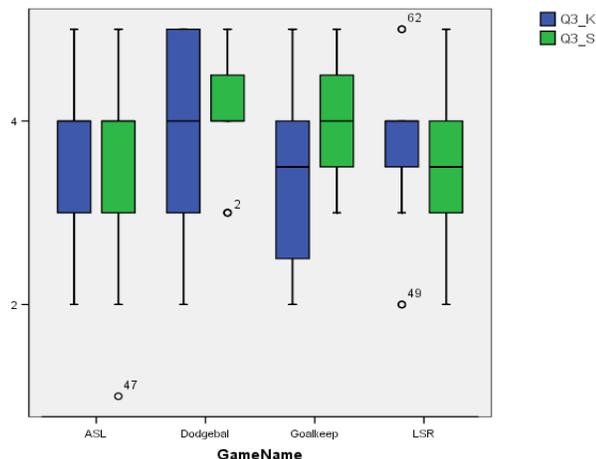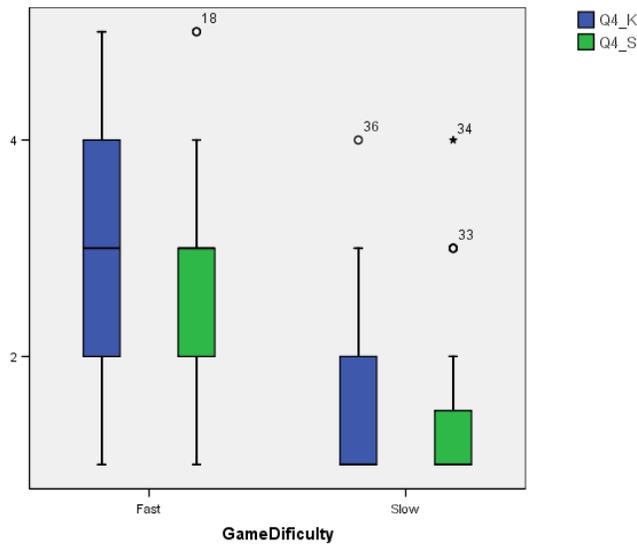
Difficulty

Here we will examine the effect the controller conditions had on the participants' perception of the difficulty of the different exercise conditions.

The mean for the fast games was higher than the slow games showing that participants found both slow games easier than the fast games. The sensor condition had no significant effect on the game difficulty experienced. This suggests that the choice of games for this experiment was reliable as participants did find the faster more challenging and the slower standard exercises easier. (Figure 4)

Figure 4: Box-plot showing the levels of difficulty perceived in fast and slow exercises.

Accuracy & Speed

Here we will examine the effect the controller conditions had on the participants' perception of the accuracy and speed of the different exercise conditions.

There were no significant results between the sensors conditions in any of the exercises in the perception of the accuracy or speed of the motion capture responses; this can be seen in the box-plots below. (Figures 5 and 6)

Figure 5 Box-plot representing the perceived accuracy of the motion capture in all conditions.
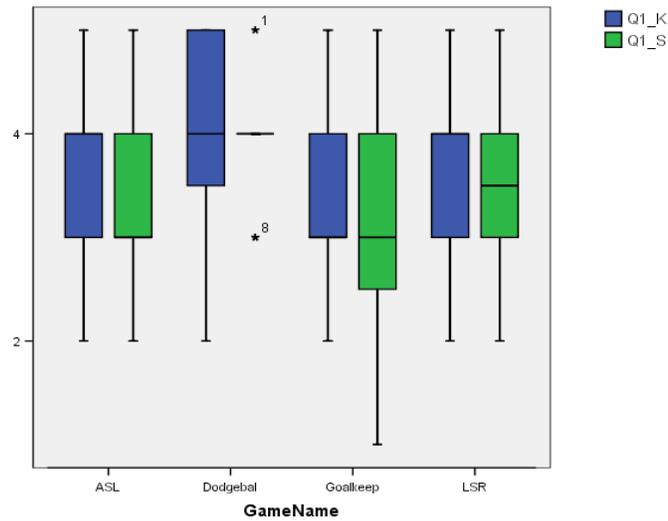

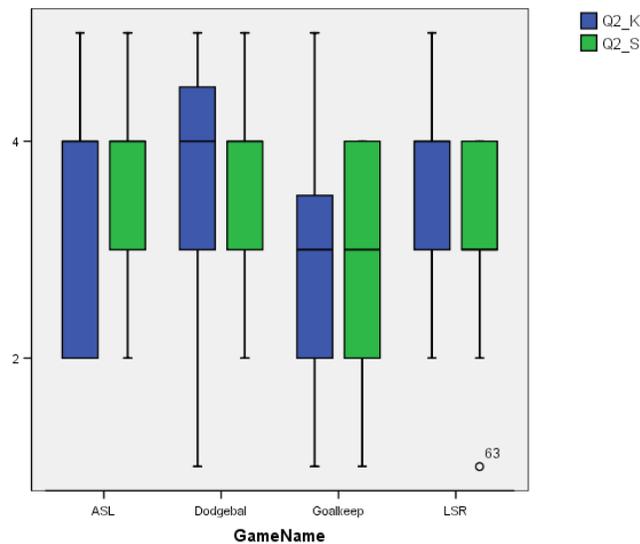**Figure 6: Box-plot showing levels of perceived speed of motion capture response.**

Affective Experience Q5

Question 5 of the questionnaire was an open-ended question regarding the emotions experienced during each exercise condition. This elicited a broad range of emotional responses, so in order to produce a workable report the affective responses were categorised using a combination of Barrett and Russell's (1998)

Activation-Evaluation Space model and Storm and Storm's (1987) Emotion Taxonomy. The affective responses were divided into High Arousal High Valance (HAHV), High Arousal Low Valance (HALV), Low Arousal High Valance (LAHV), Low Arousal Low Valance (LALV) and None, which indicates no emotion was listed for this condition.

Figure 7 shows the exercise results combined, irrespective of controller condition. The results show how Dodgeball produced experiences with high valance and high arousal, which covers emotions such as happy, excited and aroused. Overall Dodgeball appears to have been a positive emotional experience for many participants.

The other fast exercise, Goalkeeping, also produced many positive emotional responses but also several high arousal low valence responses, which represented emotions such as frustration and annoyance.

The two slow exercises, Alternating Side Lunges and Lateral Shoulder Raises, produced a greater range of affective experience, but lower arousal scores than either of the fast games and low valance scores. There were also several examples of no emotions being recorded at all.

Figure 7 Affective experiences of combined exercises irrespective of controller condition.
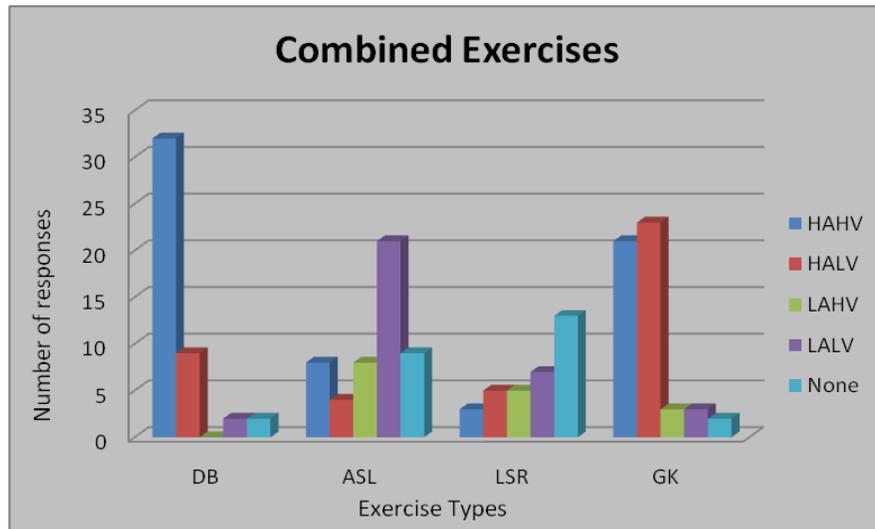
To see if the type of controller used produced any difference in the affective experiences the results were also split between controller conditions. Figure 8 below shows the individual emotional ratings.

Figure 8 Affective experiences of individual exercises and controller condition.
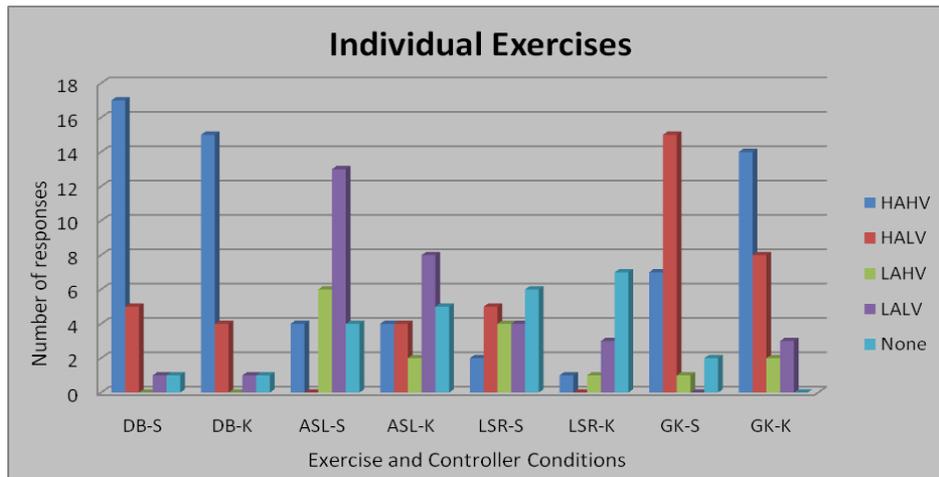
There are two prominent features here, one the Goalkeeping Kinect condition has a high HAHV score and is more associated with positive and arousing emotions, whereas the Goalkeeping Sensor condition is more associated with feeling of high arousal and negative affective experiences. This suggests more negative emotions associated with the worn sensors such as frustration and annoyance, and less positive experiences, whereas the Goalkeeping Kinect condition has more is linked to more positive emotional responses and less negative. The arousal is high in both conditions though, which reflects the fast and reactive nature of this exercise.

INTERVIEWS

The following section will discuss the findings from the semi-interviews conducted at the end of the experiment.

Delays

The initial positive experience soon gave way to frustration when participants became aware of the limitations of the system. This was mainly due to their movement not being measured quickly enough as many believed there was a noticeable delay between the movements they made and the movements of their avatar on screen.

"I was frustrated as it wasn't responding the way I thought it should." – P2. "It wasn't keeping up with me so I got a bit sad and frustrated" – P8. "The arms raises were poor with both (MoCap systems), it responded about a second later, which is ridiculous really. The reaction time was really poor." – P15.

The delay in recognising movement was most prominent in the faster exercises of Dodgeball and Goalkeeping but was also of concern in the slower exercises, ASL and LSR.

Accuracy

The accuracy of the moves captured was also a cause of frustration especially regarding arm movement. In the goalkeeping game participants often believed they had done enough to save the ball only for it ball to go by them.

"…in the goalkeeping, because it was high speed it didn't seem to track my limbs very well. I don't think it was very good at mapping my movement…It wasn't very accurate." – P4. "In my brain I've definitely dodged the balls and yet they're hitting me, getting annoyed." – P5. "In the goalkeeping there was a problem…I put my hands up and they would still go though, it wasn't accurate at all." – P16.

Here participants have an idea of how well they feel they have performed the exercise but the performance of their avatar on screen did not match this and their game performance was hindered, resulting in more frustration.

System differences (Kinect v Worn Sensors)

There were mixed views on whether participants experienced any difference in the way the different motion capture systems monitored their movement, but participants mainly thought there was little or no difference between the two systems. However, some participants perceived the worn sensors as better at measuring arm movement and the Kinect sensor better at measuring the main body area more effectively.

"When you are moving your arms only it's better because you are physically moving the technology (worn sensors), whereas the Kinect if you moved your whole body it moved quicker." – P11. "With the Kinect it looks at you as a whole." – P9.

There was also a preconception by some participants that the worn sensors would be better as they would be more connected to the game console and would better measure body movement.

"I honestly thought…the bands would be more responsive as there would be some sort of technology in there that would link it up." P9. "…I thought maybe it's going to be easier this time because they are going to see my moves (worn sensors)." – P13.

The worn sensors also represented a more understandable form of technology compared to the Kinect.

"Intrinsically I probably had more trust in the things that were on your body, because you can see them, see the technology working, compared to a disbelief (Kinect) that it could monitor what you are doing…It relates more to other technology that I understand like a mouse." – P15. "I feel like I need a physical presence connect to the computer. In the same way you would use a joystick, you are wearing the technology…" P11.

Here people compared the worn motion sensors to more familiar forms of physical technology that measure movement in certain ways. Moving the hand with a joystick or mouse is linked to the experience of wearing the sensors and that movement then registering on the computer system. There was little comment about the nature of the Kinect but some participants did ask how it worked during the experiment as they had no existing knowledge about how it functioned.

Freedom & cheating

There was a feeling shared by some participants that the Kinect was a more free form of motion capture than the sensors.

"In the goalkeeping with the sensors I felt like I was more likely to get the ball, with the Kinect it was freer and not as easy…" - P2. "I preferred not wearing the sensors as it was freer, less constrictive and less sweaty." – P5. "I think without the sensors I felt a bit freer, I don't know why. A subconscious feeling of being attached to something like a seatbelt you feel a bit restricted, even though you're not." – P9. "I found the Kinect to be much less restrictive and freer…" – P14.

These exerts seemed to express a feeling that the worn sensors were physically restrictive and may have hindered movement to some extent, or at least the perception of how much the participants could move, and that the Kinect system was not restrictive and induced feelings of freedom.

As well as seeing the Kinect as freer some also considered it would harder to cheat whilst wearing the sensors.

"Having the sensor made me feel like I couldn't cheat as much, but that might be psychological." – P1.

This could be linked to the above comments made about feeling more restricted whilst wearing the sensors as this participant appeared to feel their movement was being measure more accurately and consequently not feel like they could cheat.

Testing

Many participants were curious about how well the motion capture system performed and tested its capacity by moving differently to how the exercise required. This appeared to be for two reasons, one because they were bored in the slow exercises and had time to think, and the other because the system wasn't representing participants movement as well as they thought it should so they wanted to see just how accurate it was.

"When I realised it wasn't following me very well I started moving differently to see how it was measuring me." – P2. "I didn't really feel it was reflecting my movement the way it should have been…I was deliberately raising my hands above my head but it wasn't showing that." – P13 "I was a bit bored when I realised the

limitations of what it couldn't do…then I started to experiment with it…I wanted to see what it could do." – P5.

Testing the motion capture was more associated with the slow games as participants had time to think about what was happening a little more. In the faster games there was lots of frustration about how accurately their actions were represented but little in the way of testing as they were much more focused on the exercises and had no time to test in the same way.

Exergames

The different types of exercises performed in this study had an important effect on the experience of the participants.

The slow exercises, ASL and LSR, were overwhelming associated with boredom. Participants linked the slow standard exercise types to the types of exercises they associated with the gym.

"I didn't like the exercises ones, because that's just a bit boring, like going to the gym." - P8. "The exercise games were quite boring…I don't like gyms I find them quite boring, so I wouldn't do the exercise ones." – P1. "Bored of the slower games that weren't much of a challenge." – P4.

The faster more competitive exercises, dodgeball and goalkeeping, produced a wider range of experience, but were generally considered fun but also frustrating. It was the competitive nature of the faster exercises that increased motivation and demonstrated an increased desire to perform the activities again. The boredom experienced in the slow exercises appeared to limit how much participants wanted to do them again.

"With the football and dodgeball it doesn't really feel like an exercise routine, but it's more fun. The others are pure exercises with no fun involved. I wouldn't want to do them again." P2. "I enjoyed the faster games where I had a goal." – P6.

The faster exercises are more associated with having a purpose or focus and also seem to match what participants expected from a computer game. Participants appeared to expect computer games to be fun and competitive and did not associate the slower serious exercises with computer games, so boredom was prevalent when the exercise were not fun. However, the fact that the exercises were part of a computer game appears to have increased the desire to finish the activity the participants were engaged in.

Trainer

The influence of the trainer was also an important factor for some participants and appears to have effected on how they performed the exercises. Specifically the pace they exercised, the movements made, and changes made after receiving feedback.

"I kept in pace with him (trainer) the whole time, that was the aim." – P1.

Here the participant follows the timing the personal trainer keeps and considered this the correct thing to do, there was no consideration that they should keep their own timing, the game is indicating how the exercise should be conducted.

"The physical avatar, it was good to have someone to copy to see the movement." – P6. "I was trying to follow him (trainer) as best as I could. Do the same as him." – P10. "By seeing my avatar I could clarifying what I was doing right, I could match it to what the trainer was doing." – P7

As well as using the personal trainer for timing it was also used by participants to model the type of body movement required for the exercises, and to compare their avatar to the trainer to check their own performance. Several participants wanted to know they are performing the exercises correctly and found this system beneficial.

"…I guess it gives a feeling of companionship as people will be using this thing alone. So it makes it feel like you've got a personal trainer who's there to gee you up." – P14

This participant valued the presence of the trainer in helping motivate them but also as a form of company when performing exercises.

Physiotherapy

Four of the participants had undergone physiotherapy for back or knee problems they had experienced in the past. Some participants commented on how hard they found it to stay motivated enough to perform their physiotherapy.

"I find physio mind numbing and repetitive…My motivation plummets." – P5. "I didn't do the exercises I was supposed to; I wasn't very good at them." – P16.

However, participants thought the motion capture systems would be of benefit in helping them perform physio.

"If you had a series of exercises to do for physio and they could give you a game to do it on I think that would have inspired me to do it more often because it would be a chunk of your day…Plus it would all be in a list and you wouldn't be constantly referring to a piece of paper…it's all recorded so you can see your progress." – P15.

"When I went to the gym nobody is paying attention to what I'm doing…if he (person trainer in game) could teach me how to have a good posture and when I'm exercising if he could tell me how to do it properly, then I'd be motivated to do it because its improving my posture." – P16.

Here participants mentioned how a tailor made game to help with physio could help them prioritise a part of the day to perform exercises instead of just performing

them ad hoc when time aloud, and that having a computerised system to record performance and provide advice that was specific to how each individual was performing their exercises would help with convenience and motivation.

Summary

The findings discussed here provide an overview of the participant's perception of the motion capture systems experienced during the experiment and the more reflective experience provided by interviews conducted immediately after the experiment. The data highlights the two main themes which focus on the influence that worn motion sensors have on the experience of being monitored and the effect feedback has when engaging in exertion games.

The experiment demonstrated a significant effect between sensor conditions in body awareness during the Goalkeeping exercise. Here participants rated awareness of their bodies higher when the worn sensors were monitoring their body movement than when the Kinect was. The Goalkeeping game was also rated the hardest.

The emotional experience reported during the experiment suggests that participants had a more negative affective experience in the Goalkeeping sensor condition. The affective data also suggests that the fast games produced more arousal and more positive affective experience overall, and the slower games produced less arousal and a negative affective experience, they also resulted in no emotions for several participants.

Results taken from the interviews suggest support for the above findings with some participants describing a different experience when wearing sensors compared to the controller free Kinect condition. This was represented by a feeling of greater connection to the technology, a better understanding of how the technology performed, but most importantly there was much more reference made regarding arms and legs and how well the sensors monitored them, and a feeling that the Kinect was better at measure the core body movement. The interview data also reflected the feelings of excitement and fun experienced in the fast exercises and boredom and no emotion in the slow exercises.

The Interview data also suggests that the feedback provided by the system was a major concern. Many participants considered the accuracy and speed of responses produced by the motion capture systems to be unsatisfactory. At times the on screen representation of the player was just moving too slowly compared to real movement, and at other times the type of movement displayed was not accurate enough and did not represent the quality of real movement. These factors produced dissatisfaction and frustration for many participants.

In the next section we will consider the relationship between these results in greater depth and related it to previous research. We will also consider how these results can inform the design of future motion capture exergames.

CHAPTER 6.   GENERAL DISCUSSION

In the previous chapter we presented the findings of this study relating to the experience of motion capture systems and exergaming. We saw how worn sensors affected the perception of being monitored and how feedback limitations had a negative impact on the experience. In this chapter we will consider those findings in relation to existing literature.

The research hypotheses for this study were that wearing motion capture sensors would affect the feeling of being monitored and that the limitations of motion capture technology to measure and represent movement in interactive exergames would negatively impact their effectiveness. The results from this study provide support for these hypotheses by highlighting how participants perceived the use of motion capture technology and how in many cases it did not perform well enough to meet expectations, resulting in negative affective states which limited the desire to use the technology again, and how wearing sensors had an impact on the perception of how their movement was being monitored. Asides from providing support for the two hypotheses this study has also produced insight into the broader experience of motion capture exergaming. These issues will now be discussed in greater depth.

Controllers

Hypothesis 1 explored if wearing motion capture sensors would raises the awareness of   being monitored. The results of this study found evidence to support this from the questionnaire data conducted during the experimental procedure and from the interview data conducted at the end of the experiment. These results showed that participants were more aware of their body when wearing sensors during the Goalkeeping exergame than when performing the same exergame with the Kinect monitoring their movement and suggests increased levels of proprioception are experienced when wearing sensors.

The interviews results also demonstrated a perception that the worn sensors contributed to a raised awareness of being monitored which was reflected in several different ways. One was the notion that wearing motion sensors meant you were physically controlling the technology when moving your limbs, and that this type of control means you are more connected to the games console, that they provide a direct link to the actual system. These features could be explained by another issue that was raised, that worn physical sensors represent an understandable form of technology, ones that people can compared to other similar forms of technology. The Kinect, however, represents a completely novel form of technology which people have nothing to compare to and nothing to model their expectation on. The implication of feeling more monitored whilst wearing motion sensors also led to some participants to comment that they felt like they couldn't cheat as easily as they could when using the Kinect. This again suggests there was a greater feeling of

connection to the game console provided my worn sensors. The heightened feeling of being monitored by the worn sensors contrasted to a feeling of freedom experienced when using the Kinect. The notion of freedom was linked to a freer sense of movement recognition in the motion capture system, a sense of being physically unencumbered by the worn sensors, and a feeling of being less physically restricted in movement.

Here we have seen how the different types of input device used in motion capture gaming has affected the experience encountered. The results of this study show support for work by Rambusch (2006) which focused on the effects different controller types had on gaming experience. The study found that input devices that promoted natural movement compared to standard game controllers, lead participants to develop greater expectations about game performance. This current study has furthered this line of enquiry by focusing on the experience of using different motion capture devices, but also demonstrates that different input methods can alter player's perception of about the gaming experience.

Precision

Hypothesis 2 considered the precision of motion capture video games and how limitations in their feedback capabilities could form a barrier to the user experience.

The representation of participants' movement within the game was potentially the greatest problem encountered during this study. The key feature of this was how long it took from the point the participants moved to the time their avatar within the game moved. For many there was a perceivable delay between their movement and the movement of their in-game avatar.

The delayed movement was a major factor during the fast games (Dodgeball and Goalkeeping) that required participants to respond to balls moving towards their avatars. Participants would move but their avatars would move too slowly and would be hit or not save the ball. This represents a major problem for exergames that require fast reactions and movement as it would appear that participants did not believe the technology was sufficient to provide an adequate gaming experience. The consequence of the delays experienced was a great deal of frustration and a feeling amongst some that they were not getting as much out of the game as they were putting in, especially in the Goalkeeping exercise. Some thought maybe their own performance was lacking and they were not very good at the exercise, whereas others blamed the technology.

The accuracy of the system was also a problem, but mostly for the goalkeeping and the slower games. This was due to the perception that arms and legs were not recorded accurately enough to stop the balls and in the standard exercises the responses of the avatar were not fine enough. Several believed their arms movements were not recorded accurately enough and resulting in a poor performance. Again, they believed they had done enough to save the ball but the game did not reflect this.

Nijhar (2010) concluded that greater precision in a motion capture controller provides a more immersive experience and the more accurate a system was the more realistic the gaming experience and the better it fit people's expectations. Johnson et al (2002) found a preference for physical controllers that used body movement over standard controllers, but concluded that the preference was also moderated by the amount of intuitiveness, control and realism experienced, a conclusion also suggested by Hoysniemi et al (2004). Although, this present study did not compare different types of motion capture technology, only the perception, it has shown some support for Nijhar, Johnson et al and Hoysniemi et al, by highlighting how inaccuracies and an unrealistic experience with regards to the precision and realism of movement can harm the experience of motion capture gaming, and how these issues can create a barrier to providing a positive experience.

Following the advice from the studies above would lead us think that the more realistic a system is the better experience it would provide, but just how precise a motion capture system should be was questioned by Li et al (2006). They suggest controlling a virtual character requires precise movements that can be difficult and frustrating, and consequently suggest disconnecting the level of control the user has over their input into a game to produce a more satisfying experience. They conclude that the level of control a user has may be less important than supporting their intentions, and that finding a 'sweet spot' between artificially supporting user intentions and providing natural intuitive controls will provide a better experience. Here they suggest that precision is not the priority, but rather helping users achieve their goals. However, the results from this current study suggest that people expect to see their movement represented precisely when engaging in motion capture exergames, and that a disconnect between user intentions and the feedback displayed within the game were not welcome. This could be split into two areas though, in the fast games the element of competition was relevant and players were frustrated when they did not dodge or save balls, so some form of 'sweet spot' may have provided beneficial in this respect, but the slow games produced unsatisfactory experiences precisely because they did not represent movement accurately or quickly enough, and as there was no element of competition here it could be suggested that representing body movement as accurately as possible was the goal. So the suggests made by Li may hold for competitive games were the goal is to achieve specific outcomes, but in situations where the goals are less straightforward the same criteria does not necessarily hold.

In this respect the results found here are more in line with claims of Slater et al (1995) who suggest for a virtual world to be successful, motion capture feedback should match a person's perception of their own body, and must also be predictable, consistent and function properly, and mismatch between these factors could produce an unsatisfactory experience. A similar conclusion is made by Pasch et al (2009) that direct and lifelike interactions provided by movement based games increase levels of immersion and that proprioception provides extra feedback. The results of this study suggest that a mismatch between a person's perception of their body and that represented within the game did lead to dissatisfaction as participants reported a

negative experience due to the system not representing their movement with enough precision.

Other forms of feedback, other than the precision of the system, concern the use of virtual coaches in the exergame experience. The virtual coaches in the EA Sports Active 2 game used in this study included an audio coach and a virtual coach that appeared on screen. These coaches provided exercise instructions, encouragement and feedback on exercise performance. The on screen virtual coach appeared in the slow games as a personal trainer accompanies by an audio coach. In the fast games only the audio coach was used.

The results from this study regarding the use of virtual coaches suggests that they are very useful in helping players to understand the exercise instructions, provide a way to pace the activity, provide a form of companionship, and provided a means to check their own performance against that of the coach. The positive experience of exercising with a virtual trainer reflects the work of Eyke et al (2006) who found virtual trainers increased motivation and exercise quality, and those of Ijsselsteijn et al (2006) who showed that virtual trainers helped reduce tension and pressure whilst exercising.

Movement and exercises type

The types of exercises included in this study also had an impact on the experiences encountered. The types chosen fell into two categories, fast and slow. The fast exergames produced much higher arousal scores and were generally referred to more positively during the interviews. The slow exergames produced low valance and low arousal scores and even a total lack of affective responses in several participants. This was also matched by results from the interviews were many considered the slow activities boring and not engaging enough to want to try again. These results to some extent support the findings of Bianci-Berthouze et al (2007) and Lindley et al (2008) that games that encourage movement increases levels of engagement experienced as the fast exergames produced more positive associations and a desire to engage in the activity again, however, the results from the slower exercises did not produce the same results. The boredom and lack of affective experience in the slow games suggests that more than just body movement as an input device that is important, but the nature and design of the exercise activity that is key. Here the fast games were reactive and required whole body movement, whereas the slow exercises were standard exercises that required repetitive movement with little in the way of interaction or free forms of movement.

This could also be linked to the idea that people did not appear to associate video games with serious activities like the standard exercises used here, but associate them more with the fast exercises that were more specifically designed to be fun and interactive. This supports the theory on exergame design proposed by Sinclair et al (2007) that suggests they should be attractive and effective, and central to their attractiveness is that they are fun. It appears the fast games used in this study

provided that experience but the slow exercises did not, and consequently did not provide an attractive experience.

Advancement of theory

This study has advanced theory in motion capture gaming by extending the research conducted in this field by investigating the perception of worn and controller free motion capture systems. This specific area of research has not been conducted before so this investigation represents a novel approach. The results also suggest that wearing sensors can have a significant effect and increase the awareness of being monitored, an effect that has not been encountered before.

It has also been highlighting how limitations in the precision of systems can represent a barrier to them providing a positive experience. Previous studies into movement based games have suggested that increased movement is correlated to increased immersion and engagement. This study supports this theory to a certain extent but also found the type of movement and nature of the activity is just as important in creating a positive experience. Fast exercises which are designed more like games have been linked to high arousal and generally positive affective states, however slow standard exercises have been shown to produce a much more negative experience.

Future research in this area could revisit the pilot study conducted in this investigation to see if the different input modalities also have an effect on the type of movement produced. The worn sensors increased the awareness of being monitored in this study, so a quantitative measurement of body movement produced during the experiment would provide insight into whether different sensors would produce a bias in movement. Further study into the levels of precision required in motion capture gaming to provide the best possible experience could benefit the design of future games and provide potentially provide a benchmark for response times and how they affect the game experience. Other research could further study different types of movement based games to see what effects they might have on the exergame experience, as the two types used in this study produced very contrasting experiences.

Design Recommendations

Bases on the findings of this study there are several design recommendations that could be considered when creating exergames that employ motion capture systems. The precision of the feedback and interaction of any exergame is vital in providing a positive experience. Perceived delays and inaccuracies in the ability of the motion capture system to represent player movement on screen resulted in a negative experience. Players expected their movement to be represented accurately and instantaneously on screen. This was especially prominent in fast games were a quick reaction time was essential to the game play.

The type of exergame included in games should aim to provide some element of fun and engagement. Faster more competitive games that provide good exercise and fun are much more preferable than slow standard exercises that involve nothing more than repetitive movement. In this study the slow exercises produced a very negative experience and are likely to be used only be people who are interested in a proper work out. This could limit the appeal of exergames to a smaller user population interested in serious exercise. For exergames to be of most benefit in tackling issues such as obesity and rehabilitation they must include elements of fun and competition and aim to produce a positive affective experience.

The use and design of the virtual coach within exergames can be a powerful tool to helping people to exercise well and with the best technique. These could be better designed in conjunction with providing tailored feedback about exercise performance and issues such as posture. A system that could provide reactive one-to-one feedback about the finer details of physical performance, telling a person to keep their back straight during an exercise if their posture is poor, for example, would be a very positive step in the development of exergames. As would be designing an exergame that is responds to issues such as fatigue, boredom and exercise level (Sinclair et al, 2007). This level of interaction may not happen immediately but the potential is there using motion capture systems and powerful games consoles, and there could be many benefits to a system like this.

Methodological concerns

There are some methodological issues that may have arisen in the design of this study and may have affected the validity of the data. The game chosen could influence the results of this study as all games are design differently. Another exergame may well provide different results, as response times may be due more to the game design than the motion capture technology. The laboratory based setting of this study could bring into question the ecological validity. Also the participants used could have an impact on the results of this study. Issues such as age, health, weight, geographical location and profession could produce results that are not consistent across different demographics. The analysis of the qualitative data was conducted by one person and ideally at least two people would have been used to account for any potential researcher bias at this stage.

CHAPTER 7.   CONCLUSION

This study has demonstrated that different motion capture modalities can have an effect on the perception of being monitored and that poor feedback precision can lead to a negative player experience.

When players were wearing motion capture sensors and conducting exercises that required a large amount of limb movement there was more body awareness experienced than when conducted the same exercise type when not wearing sensors, and suggests that worn sensors could be linked to an increased sense of being monitored. The worn sensors also produced a strengthened feeling of being connected to the video game console due to the physical nature of the sensors and a feeling that they represented a form a technology that people understood, compared to the novel and slightly abstract nature of the Xbox Kinect. This extra sense of being monitored and connected was also linked to a feeling that it would be more difficult to cheat when wearing sensors. All these factors together suggest that people felt they were being monitored more when wearing sensors.

Poor quality of feedback when using the motion capture system resulted in a negative game experience which created a barrier to the uptake of motion capture exergames. Issues of precision in the quality of feedback provided by the system fell into two categories, speed and accuracy. Issues of speed related to delays that were perceived between a person's movements and how quickly that movement was displayed on screen. These issues were especially important in the fast games which relied on fast response times. When the game was unable to respond quickly enough the experience broke down and results in a negative experience and feelings of frustration. Issues of accuracy concerned the quality of movement displayed and how the system did not really portray player movement in the same details as they perceived it should. These two issues combined can produce inappropriate feedback that resulted in an unsatisfactory experience that offers less realism, creating a disconnection between the player and how they are represented within the game.

This study has also demonstrated that it is not just movement that helped to create a positive game experience in exergames but also the type of movement and the nature of the activity engaged in. Fast exercises that are more game like produced more positive experiences accompanied by the desire to repeat them, however, the slow standard exercises were more associated with negative experiences and little desire to repeat.

These results have academic relevance by furthering the study of motion capture systems and exergames, and could also provide useful commercial information about the future design of motion capture games and technology, by highlighting the affect worn sensors can produce, the need to produce precise motion capture, and the impact different exercise can have on the experience of motion capture exergames.

CHAPTER 8.   REFERENCES

N. Bianchi-Berthouze, W. W. Kim, and D. Patel. *Does body movement engage you more in digital gameplay? and why?* (2007) In Proceedings of the 2nd international Conference on Affective Computing and intelligent interaction.

Bergmann J. H. M. and McGregor A. H. (2011) *Body-Worn Sensor Design: What Do Patients and Clinicians Want?* Annals of Biomedical Engineering, Vol. 39, No. 9,

Chang, Y.-J., S.-F. Chen, and Huang, J.D. (2011) *A Kinect-based system for physical rehabilitation: A pilot study for young adults with motor disabilities.* Research in Developmental Disabilities.

M. Csikszentmihalyi. *Flow: The Psychology of Optimal Experience*. New York: Harper & Row, 1990.

Bonato, P. (2010). *Wearable Sensors and Systems*. Engineering in Medicine and Biology Magazine, IEEE 29(3): 25-36.

Decker, J. Li, H, Losowyj, D and Prakash, V. (2009) *Wiihabilitation: Rehabilitation of Wrist Flexion and Extension Using a Wiimote -Based Game System*. Governor's School of Engineering and Technology Research Journal,

Dimovska, D., P. Jarnfelt, Selvig, S and Yannakakis, G.N. (2010). *Towards procedural level generation for rehabilitation*. Proceedings of the 2010 Workshop on Procedural Content Generation in Games. Monterey, California, ACM: 1-4.

EA Games (2011), EA Sports Active 2, Access from:
http://www.ea.com/ea-sports-active-2
Last Access: 04 September 2011

Eyck, A. Geerlings, K. Karimova1. D. Meerbeek, B. Wang, L. IJsselsteijn, W. Kort, Y. Roersman, M and Westerink, J. (2006) *Effect of a Virtual Coach on Athletes' Motivation*. Persuasive Technology, Lecture Notes in Computer Science, Vol 3962/2006

Fox, J., and Bailenson, J.N. (2009) *Virtual Self-Modeling: The Effects of Vicarious Reinforcement and Identification on Exercise Behaviors*. Media Psychology, 12:1–25.

Glaser, B. G. and Strauss, A. (1967) *Discovery of Grounded Theory*. Aldine, London.

Graves, L. Stratton, G. Ridgers, N.D. and Cable, N.T. (2007) *Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: cross sectional study.* British Medical Journal 335 1282–1284.

Höysniemi, J., Hämäläinen, P., Turkki, L., (2004). *Wizard of Oz prototyping of computer vision based action games for children*. Proceeding of the 2004 conference on Interaction design and children: building a community.

Ijsselsteijn, W. A., de Kort, Y. A. W. Westerlink, J. Bonants, R. (2006). *Virtual Fitness: Stimulating Exercise Behavior through Media Technology*. Presence: Teleoperators and Virtual Environments 15(6): 688-698.

Johnson, D. M. Wiles, J. Sweetser, P. Hollingsworth, K. M. Gardner, J. A. (2002) *The Inherent Appeal of Physically Controlled Peripherals*. In Proceedings International Workshop on Entertainment Computing, pages pp. 371-378, Makuhari, Japan.

Jordan, P.W., (2000). *The four pleasures, a framework for pleasures in design*, In: Jordan, P.W. (Ed.), Proceedings of Conference on Pleasure Based Human Factors Design. Taylor & Francis, London.

Lanningham-Foster, L., Foster, R. C. McCrady, S, Jensen, T.B, Mitre, N and Levine, J.A. (2009). *Activity-Promoting Video Games and Increased Energy Expenditure.* The Journal of Pediatrics 154(6): 819-823.

Li, N., Moraveji, N., Kimura, H., Ofek, E., (2006). *Improving the Experience of Controlling Avatars in Camera-Based Games Using Physical Input*. Proceedings of the 14th annual ACM international conference on Multimedia

Lindley, S. E. Le Couteur, J. and Berthouze, N.L. (2008). *Stirring up experience through movement in game play: effects on engagement and social behaviour*. Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems. Florence, Italy, ACM: 511-514.

Maddison, Mhurchu, Jull, Jiang, and Rodgers. (2007) *Energy Expended Playing Video Console Games: An Opportunity to Increase Children's Physical Activity?* Pediatric Exercise Science, 2007, 19, 334-343

Majesco Entertainment (2011), Zumba Fitness, Accessed from:
http://zumbafitnessgame.com/
Last Access: 04 September 2011

McCarthy, J. and P. Wright (2004). *Technology as experience*. interactions 11(5): 42-43.

Morrow, K., C. Docan, Burdea, G. and Merians, A. (2006). *Low-cost Virtual Rehabilitation of the Hand for Patients Post-Stroke.* Virtual Rehabilitation, 2006 International Workshop on.

Mueller F., Agamanolis S., Picard R. (2003) *Exertion Interfaces: Sports over a Distance for Social Bonding and Fun*, Proc. Conference on Human Factors in Computing Systems, CHI '03, ACM Press.

Mueller, F. F., D. Edge, Vetere, F. Gibbs, M.R. Agamanolis, S. Bongers, B and Sheriden J. G. (2011). Designing *sports: a framework for exertion games.* Proceedings of the 2011 annual conference on Human factors in computing systems. Vancouver, BC, Canada, ACM: 2651-2660.

Nintendo (2011), Wii, Accessed from: http://www.nintendo.co.uk/NOE/en_GB/wii_54.html Last Access 04 September 2011.

Nintendo, (2011), Wii Fit, Accessed from: http://wiifit.com/ Last Access: 04 September 2011.

Nintendo (2011), Wii Remote, Accessed from: http://www.nintendo.co.uk/NOE/en_GB/systems/accessories_1243.html Last Access: 04 September 2011.

Playstation (2011), Playstation Move, Accessed from: http://uk.playstation.com/psmove/ Last Access: 04 September 2011.

Pasch,M., Bianchi-Berthouze,N., van Dijk,B., Nijholt,A. (2009). *Movement-based Sports Video Games: Investigating Motivation and Gaming Experience*. *Entertainment Computing* 9(2), 169-180

Rambusch, J. (2006). *The embodied and situated nature of computer game play*. Proceedings of the workshop on "Cognitive Science of Games and Gameplay", Cogsci 2006, Vancouver, July 2006.

Russell, J. A. and Barrett, L. F. (1999) *Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant*. Journal of Personality and Social Psychology, Vol 76(5), 805-819.

Schonauer, C. Pintaric, T and Kaufmann, H. (2011). *Full body interaction for serious games in motor rehabilitation.* Proceedings of the 2nd Augmented Human International Conference. Tokyo, Japan, ACM: 1-8.

Sinclair, J., P. Hingston, and Masek, M. (2007). *Considerations for the design of exergames*. Proceedings of the 5th international conference on Computer graphics and interactive techniques in Australia and Southeast Asia. Perth, Australia, ACM: 289-295.

Singh Nijhar, J. (2010) *Assessing the Impact of Movement Recognition Precision in Controllers on the Gaming Experience in Exertion Games*, UCL.

Slater, M. Usoh, M. and Steed, A. (1995). *Taking steps: the influence of a walking technique on presence in virtual reality*. ACM Trans. Comput.-Hum. Interact. 2(3): 201-219.

Staiano, A. E. and S. L. Calvert (2011). *The promise of exergames as tools to measure physical health*. Entertainment Computing 2(1): 17-21.

Storm C. and Storm T., (1987) *A taxonomic study of the vocabulary of emotions*, Journal of Personality and Social Psychology, Vol. 53, No. 4, pp. 805-816.

Wikipedia (2011), Kinect, Access from:
http://en.wikipedia.org/wiki/Kinect
Last Access: 04 September 2011

Xbox (2011), Xbox Kinect, Accessed from:
http://www.xbox.com/en-GB/kinect
Last Access: 04 September 2011.

CHAPTER 9.   APPENDICES

Appendix 1: Information Sheet

Information Sheet for Participants in Research Studies

You will be given a copy of this information sheet.

Title of Project: Understanding the effect of gestures and different motion capture modes on the gaming experience.

This study has been approved by the UCL Research Ethics Committee [Project ID Number]: MSc/1011/009

Name, Address and Contact Details of Investigators:

Nadia Berthouze, Shane Walsh, Alistair Wood - UCL Interaction Centre, MBEP 8th Floor, University College London, Gower Street, London WC1E 6BT, UK

We would like to invite you to participate in this research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or you would like more information.

Details of Study

This experiments requires participants to play whole-body interaction game (e.g., Nintend Wii, Kinect) while wearing a motion capture suit, during breaks in the game participants will be asked to complete various questionnaires relating to their experience of playing the games. During the experiment participants will be also be filmed. The expected duration of the experiment is one hour. Any participants who have any physical ailments should not partake in the experiment

It is up to you to decide whether or not to take part. If you choose not to participate it will involve no penalty or loss of benefits to which you are otherwise entitled. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason.

All data will be collected and stored in accordance with the Data Protection Act 1998.

APPENDIX 2: Xbox Kinect Health and Safety

Kinect health and safety guidelines

⚠ Photosensitive Seizures

A very small percentage of people may experience a seizure when exposed to certain visual images, including flashing lights or patterns that may appear in video games. Even people who have no history of seizures or epilepsy may have an undiagnosed condition that can cause these "photosensitive epileptic seizures" while watching video games. These seizures may have a variety of symptoms, including lightheadedness, altered vision, eye or face twitching, jerking or shaking of arms or legs, disorientation, confusion or momentary loss of awareness. Seizures may also cause loss of consciousness or convulsions that can lead to injury from falling down or striking nearby objects. Immediately stop playing and consult a doctor if you experience any of these symptoms. Parents should watch for or ask their children about the above symptoms, as children and teenagers are more likely than adults to experience these seizures. The risk of photosensitive epileptic seizures may be reduced by taking the following precautions:

- Sit farther from the screen

- Use a smaller screen

- Play in a well-lit room

- Do not play when you are drowsy or fatigued.

If you or any of your relatives have a history of seizures or epilepsy, consult a doctor before playing.

⚠ WARNING

4 Don't overexert yourself

Gameplay with the Kinect sensor may require varying amounts of physical activity.

Consult a doctor before using the sensor if you have any medical condition or issue that affects your ability to safely perform physical activities, or if:

- you are or may be pregnant,

- you have heart, respiratory, back, joint or other orthopedic conditions,

- you have high blood pressure,

- you have difficulty with physical exercise, or

- you have been instructed to restrict physical activity.

Consult your doctor before beginning any exercise routine or fitness regimen that includes using your sensor.

Do not play under the influence of drugs or alcohol, and make sure your balance and physical abilities are sufficient for any movements while gaming.

4 Take breaks periodically

- Stop and rest if your muscles, joints or eyes become tired or sore.

- If you experience excessive fatigue, nausea, shortness of breath, chest tightness, dizziness, discomfort or pain, STOP USING IMMEDIATELY and consult a doctor.

Appendix 3: Consent Form

Template Informed Consent Form for Participants in Research Studies

Title of Project: Understanding the effect of gestures and different motion capture modes on the gaming experience.

This study has been approved by the UCL Research Ethics Committee [Project ID Number]: MSc/1011/009

Participant's Statement

I ………………………………………………..…………………………………….

agree that I have

- read the information sheet and/or the project has been explained to me orally;
- had the opportunity to ask questions and discuss the study;
- received satisfactory answers to all my questions or have been advised of an individual to contact for answers to pertinent questions about the research and my rights as a participant and whom to contact in the event of a research-related injury.
- I understand that I must not take part if I have a physical ailment.

I understand that I am free to withdraw from the study without penalty if I so wish and I consent to the processing of my personal information for the purposes of this study only and that it will not be used for any other purpose. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.

Signed:

Date:

Investigator's Statement

I ……………………………………………………………………..

confirm that I have carefully explained the purpose of the study to the participant and outlined any reasonably foreseeable risks or benefits (where applicable).

Signed:

Date:

Appendix 4: Coded Transcripts

Interview coding

P101

Not paying attention to when wearing sensors or not. Anything with the arms both methods were quite similar. Games that used arms the kinect wasn't responding to the arms as well. Arm movements were better picked up by the sensors. With goalkeeping the sensors helped. But when it was your entire body like dodgeball they both worked quite well. Kinect slower at the arm raisers didn't work so well. Kinect would pick up the left leg as well when doing the lunges. Not aware of wearing sensors in exercise. Having the sensor made me feel like I couldn't cheat as much, but that might just be psychological. I did start to cheat, I noticed at if you only do a small movement is counts it as a lunge, so I did that and cheated. The exercise games were quite boring. I really like the dodgeball and the goalie one, I don't like gyms I find them kind of boring, so I wouldn't do the exercise ones again. At first I thought I was the trainer as I was going so slow. I don't know if he's really that necessary, it could motivate you if you are slowing down too much. I kept in pace with him the whole time, that was the aim. The audio feedback made me laugh in the dodgeball when it tells you you've been hit in the head, make you try a bit harder.

P102

I initially thought the kinect wasn't that sensitive, but later in the trial saw no difference between sensors and kinect. At first only concerned with playing game, but later was more aware of the game. My initial goal was to do the game properly, but later I was concentrating more on the movement, due to practice as I knew what was coming. Didn't have any emotion just concentrating on doing the game, apart from first lunges when my legs were on fire, but I didn't have any emotions of enjoying it or not. In the end I was frustrated as it wasn't responding the way I thought it should. And for the leg lunges I didn't think it was really reflecting the different type of lunges I was doing, it looked like avatar was just going through present motions at the same time I was rather than copying what I was doing. Disappointing that it didn't appear to do what I wanted it to do, with the lunges, but the last football I was getting very frustrated as it didn't really mimic what I was doing and the reaction was very slow. It didn't feel like a live experience as the delay between me moving and watching the avatar moving after was then difficult to get ready for the next ball as I was concentrating on me moving slowly and then reacting to the next one. I wouldn't buy one.

With the football and dodgeball it doesn't feel like an exercise routine, but it's more fun. It masks the exercise with enjoyment. The others are pure exercises with no fun involved. I wouldn't want to do them again. Slow one repetitive, the others had more going on, that helped motivation, I was looking at object and what was going on I didn't even notice how many there were to go. In the slow ones I was just counting down. I thought the trainer voice was quite patronizing, annoying. On the slow exercises I was focusing on what the trainer was doing, I didn't realize I

could move quicker. I didn't realize that if I moved quicker the trainer would follow me. I didn't notice I was wearing the sensors. When I realized it wasn't following me very well I started moving differently to see how it was measuring me.

P103

I noticed the avatar just doing limited movement. The kinect was better, the sensors were as good. I was seeing how closely it was copying my movements. The second dodgeball with the kinect wasn't as good. It was harder because it was freer. In the goalkeeping with the sensors it felt like I was more likely to get the ball, with the kinect it was freer and not as easy.

With the exercise games I felt there was more of a purpose. The arm raises you know what it is doing. With the faster ones it is more a byproduct of the game, more of a gimmick. Not quite as obvious why you are doing it.

The GK with the kinect was more frustrating because it felt a lot freer it wasn't picking it up properly. A bit more hit and miss and should have been registering you better. It's the machines fault that I missed. Maybe it was more accurate (kinect) but the sensors helped you out a bit. Long term you'd probably want the added challenge of the kinect.

Familiarity with the games changed my movement. In the competition games I just wanted to beat the machine as I knew what it was going to do.

The slow ones were very easy, you couldn't go wrong. It was more boring didn't feel like a game, but if you want to do the exercise I would do them. If you miss a ball, nothing happens anyway.

The trainer was quite useful to know what you're doing, as you wouldn't really know what to do if it just told you. I tried to copy the timing that was doing, as you assume that's what it wants you to do. A bit of trust.

P104

It was generally fine, I didn't think there was very good mapping of my movement and the experience of my avatar on screen. It wasn't very accurate. It was vague, slow for one thing, and the movements were a bit vague, so I did feel a bit hard done by at times. When they were kicking balls at me and I thought I was getting to them in time, I blame the technology for me missing those balls. It wasn't an accurate depiction of what I was doing, there wasn't as much subtlety of the avatar on screen. I thought that when it was measuring my whole body it was represented quite well, but when it measured my limbs it was limited. My initial reaction was that I didn't notice any difference between the two technologies. It seemed to be consistent. Once they game started I wasn't aware of the sensors. With the slower exercises there was a glitch on the lunges, again when the whole body is moving it picks it up better. In the lunges it picked it up very well, and with the dodgeball it was the same as I was throwing my whole body around. With the arm raises it was ok as it registered I did them but not accurately, in the goalkeeping

because it was high speed it didn't seem to track my limbs very well. The predominant emotion was probably fun, it was a good laugh. With the football I was frustrated with myself, but you never know if it's you or the technology, so it's shared between them. I tend to be more frustrated towards the game as I was putting a lot of effort in. bored of the slow games that weren't much of a challenge. I do like a challenge when I exercise. I like to push myself. When I go running I like to go faster than the last time. The lunges I found difficult, when lunging to my left didn't feel natural. It kept telling me to get lower and I just knew I couldn't. I tried to though. I'm not convinced the avatar had much effect (on motivation) but the voice coach did. It started out being quite encouraging, but it kept repeating the same thing, I got pissed off with it, it kept hectoring me. Hacked off when it was saying the same thing and I was trying. With the visual coach I thought I was supposed to do the action after him but when I was more used to it I tried to match him, but I didn't get much out of them. The dodgeball is great fun and probably the best work out. I try to think it's realistic so I try to put my body in the proper position. In the start of the dodgeball I was just moving side to side, but it was better when I was more of a challenge. In another similar game I wondered why I was going to all the effort when I don't need to, but I'm so into it and want it to reflect real life. Its not just about scoring points.

P105

I thought it was quite fun, I certainly quite liked it. In the first couple of games I was interested to see how accurate it was, what I could do, and just how that was represented on screen. And then as it progressed I was a bit bored when I realized the limitations of what it couldn't do, especially the speed at which it registered. That started to get a bit frustrating, but then I started to experiment with it a bit more and doing things you were meant to do. Its limited in terms of what you have to do (avatar) so I wanted to see what it could do. It was ok (what you could do). The legs were good and jumping. With the sensors it doesn't really register any movement above your elbows, it just guesses. it was better with the sensors, but I didn't register a massive difference. I was trying to move my arms in the lunges to see what it registered. In the slower games I had more time to think so I was exploring the game more. I exaggerated my movements more as the game went on and that's why I think I got a better score in the dodgeball and football. I was doing more than I felt I should (movement). I got quite frustrated in the middle games, I felt it's too slow, not fine enough. In my brain I'd definitely dodged the balls and yet they're hitting me, getting annoyed. The second time I was exaggerating the movements more it was kind of aware of the delay, time wise I was planning the jumping, still not quite on it. Not quite picked up (movement). I enjoyed the competitive ones where there was a challenge rather than the other ones. I'm currently doing physio, and I find it really horrendously, mind numbingly boring. it makes me quite angry. I've been doing a martial art that does the same stuff but I've found it much more calming and enjoyable. I find physio mind numbing and repetitive. There's no mental challenge, nothing to think about. When you're doing more complex sports/exercises your

mind it doing lots of calculating, but with stretches and squats, they're fine as a warm up. Those kind of exercises I don't find enjoyable I find really annoying. My motivation plummets, when I get these exercises I'll do them for a week or two, then my interest will rapidly fall off. I'll avoid doing them or forget to do them. It takes a sustained effort to keep them up. Typically after any new repetitive action you can learn to do them in a very short space of time and you can them do them, and there is not continued motivation to push. I feel they waste my time and aren't particularly useful, redundant. I don't really feel the benefits of doing them. (Competitive games) Yeah, I'd be more likely to do them again. I noticed the second time round, the first time you do the fast games you are figuring them out, the second time it becomes more competitive so you want to beat yourself. The voice coach I found annoying, inane American accent. Pretentious and irritating. Maybe if it was female I'd feel differently. Mostly ignored him and most of what he said was ineffective. But when he said you should push harder that was ok. I was watching my own avatar and the second time round I was experimenting with what my avatar could do. In the more competitive games I was more aware of the speed and time lag. Didn't really pay much attention to the trainer avatar, in the first time for the timing but not for the poise or posture, as I didn't feel it was accurate enough. I preferred not wearing the sensors as it was freer, less constrictive and less sweaty, I'd be more inclined to used at home if I could just press go. I like to be able to gauge my own improvement, if I'm getting faster or stronger. A sense of personal improvement is key. I keep a record of my performance and enjoy seeing myself

improving. When I was doing the most cycling and running I had quite accurate records of times and routes and things.

P106

I didn't notice much difference to be honest (two methods). In the faster ones I tried to duck and it didn't register. In the football one I was doing the arm raisers and it was difficult, I didn't know if it was me or the system doing something wrong, it was too fast to analyse. I wasn't sure if I was rubbish doing the arms wrong, my technique was rubbish or the machine was wrong. Mainly annoyance and frustration was at the coach which got quite annoying, that was point when it didn't pick me up very well. The side lunges kept telling me to keep my other legs straight, I had it straight and it kept telling me. I found it really annoying. Mainly with the kinect. With the sensors it was telling me my back wasn't straight. It was just annoying, irritating because I knew I was doing it right. It would reduce my willingness to do the exercise again, or I'd just turn the coach off. The frustration was like the football where I couldn't get the balls. I enjoyed the faster games where I had a goal, relatively easy to do but had a sense of achievement. The slower ones it was more about getting the right posture the right movement, getting the stretch right, but fast ones it was the score, dodging the balls. I was definitely aware of the score and the competitive element. The physical avatar it was good to have someone to copy to see the movement, the slower ones you were getting the timing, so when he moved, you moved. It was annoying in the slow movement because even when I

was doing it right he was disappointed. That got a bit annoying. In the faster one was good as it was more encouraging. (self avatar) it was good to see what the system was picking up because if I was doing it wrong I was good to see what I was doing. But it was annoying because it wasn't picking up what I was doing.

P107

It was interesting, the kinect was better in some ways but the sensor was also better. The dodgeball the sensors were useless, it couldn't tell where I was tilting. With the sensors I was ducking and it didn't know I was ducking. The kinect knew so I wasn't getting hit. The football, the kinect didn't detect my range of movement. the arm movement, it knew I was going one way. The slower games were fine, nothing strenuous, and I was on the spot so it made it easy for things to be picked up. The speed was fine, the accuracy was a problem. I would put my hands together and it wouldn't register. Both bad. The sensors were better to detect by the accuracy was a bit off. It was exciting because I've never used the kinect before, but that gave way to frustration with the sensors once it didn't pick up what I was doing. It was in the faster ones, but I preferred the dodgeball because you just moved your body and less accuracy in that respect. When you have to catch individual balls it's harder, just more irritating. You know you've blocked it, stupid thing wouldn't adjust. The slower games I was bored, the ones where I was just standing still. Maybe because I did the more exciting ones first. The faster games were exciting because it was novel, but frustrating because I wasn't picking me up. I didn't think about my

avatar, the coach was accurate at picking up, the voice when I went quicker than it, it was stop and adjust itself, if I followed. The avatar coach was good because you know what pace to go at, I would go straight away, it helps you follow as you don't know what you're doing. Quite useful. By seeing my avatar I could clarify what I was doing was right, I could match it to what the trainer was doing, otherwise I would be assuming. Seeing a represented you can match it. Better than not having a representation. The football one I was more active than I needed to be, doing proper goalkeeper saves, when I realized the it was picking things up then I thought I was just side stepping instead of being proper active, I was assume a side step, not as engaging as the instruction was. I didn't notice the scores, the dodgeball I was excited, it was more engaging to me, I could have kept playing it. More random shapes would have been cool. The football one, you could see the counter but as so many of the when thought I got frustrated, my drive dropped. In the others was looking at the calorie counters so see how many you burnt. The first time I was intruiged, just to do it, the second time the motivation was less.

P108

A bit boring, some of them were fun. No, no difference. Yes, I thought they were the same. I thought it was pretend, I wasn't sure if they worked. They didn't seem to do much. I found I was very good, with without them. In the first game I didn't know what I was doing, but by the third game I did. I didn't know what was

going on, that the person (on screen) was me. I didn't realize she was doing what I was doing. Q, what did that feel like then you realized it was your on screen?

Wonder. Therefore my scores in the first game (questionnaire) cos I didn't realize it was. By the 3rd game I was involved in the goalkeeping I realized. Because I was doing (stuff), but with the exercises I was just copying the man, it was just an image on screen. 3rd game I was playing and realized it was me. I was moving more just to see myself moving on screen, not necessarily to play the game better. How well it was doing, I was testing the equipment. Q, how was that. A. it was alright, it wasn't as fast as me. In the football one I was getting to the balls, but it was saying I wasn't. I knew I was. It was frustrating, very frustrating. I wouldn't want to play that again. I knew I was doing a good job. I didn't like the exercise ones, the ones that were clearly exercise, because that's just a bit boring, like going to the gym. I preferred the ones where you were interacting, doing something. (slow games) you could cheat and it didn't make any difference, you didn't have to put any effort in. as I did the second time round, I just did a little movement and it said 'well-done'. With the running around ones you could see yourself. (fast games) The fact that was one screen, that was me, and I was scoring, the game element. Q, what was it about the fast games?. A, it's the childish thing of seeing yourself on tv. I would exaggerate my moves, that were unnecessary to see them on screen, to test it was working, make it a little more dramatic, I like the game element of it. But I like team games, sport. I would play those again. I'd never go near them again. They were boring. I prefer running or rowing, not repetitive exercises. (Sad?) that was the first time I did it, and it wasn't keeping up with me so I got a bit sad and frustrated. I

found it fun, I enjoyed it, but I was frustrated and that made me sad. But the second time round I better at it and that didn't make me as frustrated but I was still a bit frustrated. (happy) because I was running round and having fun, it was new to me, maybe if I played it a bit I'd get bored, but it was new to me and I was looking at my body on screen. Finding it funny if the ball hit me in the head. In the football I would a way of just standing in front of the ball instead of kicking it. I was testing out my moves on screen, didn't monitor moves very well. It was getting my moves but giving me comments that were connected to what I was doing. I found the voice really annoying, the accent.

P109

I found it interesting, as I've never played any of those motion capture games. Sometimes it felt more responsive that others on certain games. It was fun. There were problems on the lunges, but nothing on the others. There was a lag on one of the football ones, which I accounted for when moving. I corrected on the 2nd time as I got more saves. When you are doing a new exercise you realize the movements, but I thought I should have bloody got that, but I wasn't getting it, I went down a bit quicker, it was about speeding up my movements. You feel a little bit dejected. Reminds you of being a kid when you miss the ball. Nothing to go home and cry about. I honestly thought the was with the bands would be more responsive as there would be some sort of technology in there that would link it up, but I thought the

kinect was a bit better, maybe it was just me getting used to the exercises. The goalkeeper and dodgeball I got a better score. I couldn't tell any difference (controllers). I crossed my hands in the lunges and it didn't represent that, it didn't noticed them crossed. I thought that if something is attached to you it would be a little more responsive, but you could be attached on one part of your arm and move another, and how would it know? it might know you've moved your arm high but not know what you've done with the other part. With the kinect it's looking at you as a whole, but I assumed that if you are attached to something it might be a bit more detailed. I think without the sensor I felt a bit freer, I don't know why. A subconscious feeling of being attached to something, like a seat belt you feel a bit restricted, even though you're not.

Lunges were ok, kind of frustrating, not massively. People lose their patients with technology, I was thinking 'its not doing it!' that was a bit annoying. I enjoyed the GK and DB a bit more, because you are moving around a bit more, I get a bit bored. The DB reminded me of boxing and I enjoy football. I've never been into gym stuff, if I didn't have to do them I probably wouldn't. there wasn't any pressure I was just kind of doing them, going through the motions (slower).

(faster) it was the competitive streak kicks back in, I really want to save it, I really want to dodge all the balls. I've always had ok hand-eye co-ordination so I just wanted to make sure I still had it.

The only emotion I felt in the lunges one was mild frustration because it wasn't registering properly. I didn't feel anything I was indifferent to the exercise bands,

but the DB and GK I was more focused on it, I didn't want to get a low score, I was competitive, but with no-one. It felt good. (laughs). The last DB and GK I got a bit score and didn't get hit, I got 100% scores, I thought 'yeah, that's ok'.

I don't need that sort of technology to that the slow games you can do them on your own, but it helps to monitor you doing them correctly, they're not that difficult to get wrong. With the DB and GK it adds competition and its not something you can do on your own.

(voice) It reeks a bit of aerobics infomercials. It was overly saccharin. It was useful when it suggested how to do the exercises (where to move your foot).

(avatar) after a while I just ended up looking at the limbs moving. In the 1st Gk game there were a few high balls I missed and the 2nd time I realized I need to get there a bit quicker, have a better reaction time. It might have been my own reaction time getting used to that programme.

P110

I felt the sensors reflected the movement more accurately. It wasn't lagging like the kinect, it was not as accurate. If I raised by arms it was a bit slower. I enjoyed using the sensors more. I wasn't sure whether there would be a difference. I didn't even notice I had them on. (movement) especially in DB and GK the sensors were

much more accurate, not lagging as much. A lot more accurate. Any jumping, the legs and arms, the whole thing, much more accurate. When it was less accurate it was a little confusing, I wasn't sure if it was picking up on my movement as accurately. It was exciting, I felt a little nervous in the GK game, there were all these balls, I was getting nervous and anxious that I wasn't going to catch it. It was really exciting, I felt happy, it was pretty engaging, a good emotion. It wasn't boring, it was exciting. Not across all the games, the GK and DB were. The exercises weren't so much. It was an engaging experience as I felt I had to keep up with the trainer, it felt kind of neutral, I didn't feel anything more. It was like 'wow this is cool'. I felt like I had to keep up with it. I was motivated to complete all the different, I felt during the shoulder exercises I found it hard to raise them as high as he was going, it was difficult but I felt like I still needed to keep up, I didn't give up. I felt like I had to finish and not give up, even though it was hard. (ASL) they were fine, not as difficult. I had to keep up. (faster) I wanted to get as much points as possible and dodge all the balls and get all the balls in the GK. Perform well, do as best as I could. Not come across as incompetent.

(range of movement) I feel like my movements were, I didn't have to focus as much on 'am I not moving right'. I could move more freely, I was conscious of the movements not being so accurate with the sensors, but with the kinect I wasn't thinking about it. I wasn't thinking about moving more or less.

(voice) I wasn't really paying attention, but at times when he said 'with control', most of the time I was looking at the guy on screen, but sometime I would put my

arms down slower. I didn't pay much attention to the voice. It just blended in with the music.

(avatar trainer) I was trying to follow him as best as I could. Do the same as him.

I'd find this useful, my heart was beating pretty fast. I would speed it up a bit. The lunges were a tad too slow.

I didn't feel like the sensors were on me, there was no constraints.

P111

Interesting. I didn't think it would be as connected as it was. Which was quite good. I felt connect to it, to the tv, but not in a surreal way, it mimicked everything I did. It was quite clever. Its quite interesting how your body connected to it. I think I preferred the sensors, because you could feel them on your body and you feel like you have to do something to make them work. With the non-connectors you could be lazy because you don't feel like connected to it or part of it. I feel like you need a physical presence connected to the computer. In the same way you would hold a joystick, you are wearing the technology rather than it being imbedded in who you are.

I don't believe I changed my movement. it was interesting that the avatar didn't mimick everything that I did, like rolling on the ankles, etc. that when you realized

it's a game, not you. I don't think the 2nd one was as quick a connection to the box, it felt like a delay in my motion (kinect). When I did the GK and DB that was better in the kinect. When you are moving your arms only it's better because you are physically moving the technology, where as the kinect if you moved your whole body it moved quicker.

The kinect coped better with the quicker games, but slower on the arms, it felt like I was doing then it was doing it on screen. The 1st was quicker (sensor). I can see why people would prefer the kinect as you are not connect to it, but that presents a slightly odd feeling because you're not connected to it.

It was new, never been connected to a computer, so it was a new way of playing games. It was quite novel in the feelings of excitement was quite good. I didn't even look how many reps I had to do or how long I had to work, it was just the fun of being in it. I could have thousands I would have kept going. Wanting to complete it, beat it. The competitiveness comes into it.

(disconnection ASL-RS) it was like a warm up, so it didn't feel challenging. The side lunges, I prefer the quicker reaction based stuff, they felt like a warm up you kind of switch off and just do it. If you get off the weights or bike, you feel a connection to it. That was partly down to it not mimicking my motions, it would wait and then doing. It wasn't following what I was doing.

(Fear) yeah, I put that as I didn't really know what was going on to start with. Didn't click that the football highlight where they're coming from. They're a sense of 'whats going on? Am I going to get hit' and the sensors didn't react quick enough

and there was a fear of being hit by the dodgeball. I properly wanted to do it. (GK) It was the same thing, panic, I was panicking, I was disappointed they weren't mimicking my moves, so panicking, I was trying to pre-empt the movement by moving before they were being kicked, which was an element of panic to try and beat it.

(happiness) the DB was brilliant. I loved that game, with the kinect. I felt that reacted to fast movements a lot quicker, body movements not just arm movements. The sensors were quicker with arm movements. For body movements the kinect was better.

(frustration) in the GK because I felt I was going to get a clean sheet, frustrated I let that two in.

(voice) I liked that. I did register that as well. I took it on board. Don't know if I change my exercises.

(trainer) that was good, he obviously set the pace and I was trying to stick to the tempo without watching and keep to a tempo of my own. But you have to watch him a few times to get the pace.

(motivation) The game, it was to complete it. Any type of computer game you feel like you must complete it. (slower) to get to the next one. Finish it and get to something more exciting.

P112

I didn't really see the difference. The second part for DB the movement was quicker. Maybe the 1st I didn't really understand how it works. Without the sensors I got hit by the ball but not in the 2nds part. Wearing the sensors didn't bother me, but I felt the leg one might slip off. For the slow games it was more accurate, the lunges I wasn't sure how much it measured so didn't dip that far and it still worked, so you can cheat quite a bit for that game. With the sensors the cheating didn't work.

(fast) You had to move really fast, it was slow in capturing my movement and I lost points. Especially the first DB without with sensors, and I lost points. 'I did it!' but I was too slow. But the slow exercises it had enough time to catch up. The GK was confusing as I didn't know how to use my hands to stop the ball. They were both (controllers) too slow to register.

(emotions) happy because the DB score, the 1st time i didn't know it too well, the 2nd I did and I was happy. Excited, the fast games were both more exciting. The side lunges were boring. I was curious how much I could cheat, how it works, does it still count my points if I don't do it properly, and I just didn't like that one. Content, I like it because this one didn't allow me to cheat, so I earned what I was doing. More accurate. Annoyed for the GK because it didn't work very well. Bored, afte the exiting games it was like, ok. For the LSR, nothing came up. It was ok, not

that exciting, but not that bad as the side lunges, I didn't have any emotions. It was accurate, so I was content.

(motivation) I DB I'd like to try again, it was engaging. The GK was annoying so I wouldn't try that again, not accurate. If I feel the system is more accurate, the content part, if I'm doing something wrong it doesn't give me points I feel more motivated, otherwise I just cheated. It's helpful if there is a score there, but only if its accurate. I want to know I'm doing the exercise right, not that I'm doing whatever and getting points. I wasn't aware how my body was, if I was doing the exercise right, I want to know. I want a mirror to see myself. I didn't trust my avatar that much. I have trust issues with seeing the avatar. When I was doing it I didn't think about it. I would also like to see what I'm doing, but because of the delay. With the ASL if I hardly did nothing my avatar did it perfectly, its not accurate. If I do that exercise and get more tired I think whatever (give up and cheat), I wouldn't be as motivated. If its more accurate and actually gives me points fairly I would actually be more motivated.

(faster) I also looked at the points. The 2nd DB I had really high points and I was 'OK!'. It's the points work, I think. I didn't remember the number in the first game but it was quite low.

(voice) I didn't really pay much attention. When I tried to cheat it told me to lift my arms, I noticed that.

(trainer) I was looking at it, seeing what I had to do but I was still not aware how my body was moving in terms of like arms, especially for the sensors.

(avatar) In the slow games I was concentrating on the trainer, and I was trying to see if I was doing the same things, I was trying to see if my body works. In the fast games I was concentrating on the balls coming towards me.

I'd like to try the GK again to see if I did something wrong. I like to compete with myself. The slow games were a bit boring. if I make a plan, then I would do them again.

P113

It was good, felt like a proper workout, but it was a bit annoying at times because it felt like the thing didn't respond to your movement properly. So I did feel slight irritation on occasion, and I was really concentrating. It might just be my poor hand-eye coordination, but it felt like I was making a move but it wasn't reflecting the move I was making. The second time around it was easier once you know what to expect. But no, it was good, if you want an indoor exercise game for working out, then thumbs up.

It was weird, when I put them on, maybe it was a placebo effect, but I thought maybe it's going to be easier this time because they are going to sense my moves. Maybe that was a confidence boost, weirdly. I think there was a confidence were I've got these on my arm now the machine is going to sense you, so when you are actually making moves. In the first lunging one it did reflect my movement a bit better, maybe that was shear fluke I don't know. But I didn't know if that was down

to the sensor thing. It might have been my imagination, but I thought it was better. The box is going to reflect you moves better, picking up what you're doing better so you don't get annoyed with it by going 'I didn't make that move, why's it done that?' More confidence from that point of view that's its an accurate reflection so you can actually see what you're doing, monitor what you're doing.

(kinect) it's a bit weird, I was assuming the two must connect, but when I was playing the game I wasn't really thinking about that at all, I was kind of oblivious to it, I was trying to look at the picture on the wall and dodge the balls, or kick the balls. It's kind of weird, you forget its there.

(Measurement) marginally better the second time round with the sensors.

(fast/slow) I don't have anything to compare it to, I don't really play those kinds of games, I know my hand-eye coordination is usually quite poor until I've warmed up a bit, but there were definitely times when I thought, I moved my arm or leg and it didn't copy. So that was mildly frustrating. It was more my limbs that didn't register. I might move earlier or later, it's knowing what to expect of the game, once you know it's a bit earlier or later you can adjust your move, if you're trying to get a really accurate reflect of what your body is doing its not doing that.

(emotion) You don't know what to expect of the game (nervous) I was self-conscious, also when you watch what the screen does and think about what your movements doing, you think am I doing the same thing, you're looking at the picture on the screen and thinking did that look ok, like what I'm supposed to be doing, reflecting the virtual instructor, or trying to get the exercise right. You want

the movements you're making to be reflected properly on screen and sometimes that wasn't, he (trainer) was giving advice but I wasn't sure if that was just saying to stuff like they do in games or responding to my movement. I don't know how realistic it was.

(embarrassed at DB) I'm not very good at taking in an instruction immediately. I was trying to get used to where the ball was coming from, they give you quite a bit of time to move out of the way, but it just wasn't connecting, but I'm not very good at doing things first up.

(no emotion slow) I was just going through the motions really, I wasn't really feeling anything.

(annoyance – LSR) I didn't think it was reflecting my movements the way it should have been. It didn't feel like I was watching myself. I was deliberately raising my hands above my head but it wasn't showing that. I lost faith in a bit, its not actually doing what its supposed to be doing, its not really a true reflection.

(concentration - DB) I knew what was coming so I concentrated a bit.

Competitive in the GK, yeah I think that one engaged me, made me want to do it, want to kick the balls away. So that was quite good. I like football. It was just the sense of, satisfying when you kicked them away.

(Voice) It sounded ok, stuff that an instructor would say. I didn't know if it was an added sound effect, I didn't know if was talking to me specifically, as my movement was represented quite right. I was half listening and not taking on board

everything it said, but trying to. I was trying to, but I didn't feel like the picture was changing like I was, so it was frustrating. I wanted to do it for me, but I was distracted by what I looked like on screen.

(trainer) I didn't know whether I was leading him or he was leading me. I was confused, but it was quite helpful. (following) to a certain extent yeah. I was keeping my own time as I felt like I was leading him.

(avatar) it's a good idea, it certainly helps when its accurate. You got used it, it was a bit weird at first. Its good, I don't look completely weird.

(motivation) I'd want to do it to the right level so I could get fit, quickly enough that I'd get fit. The whole point is for fitness so I wanted to feel like I'm using some muscles. As a fitness game I thought it was quite good. (faster) brought out a bit of competitiveness which is good because you want to beat your previous score. Less bothered with doing the slower ones again, but I would the faster ones to do it faster and better and building up coordination skills.

P114

It was mostly quite entertaining, I found compared to the Kinect boxing that there are tardier in their movements, they seemed to reacted slightly slower and didn't represent my body movement as quickly and as accurately as the Kinect does.

The motion sensors I found less responsive than the kinect. The exercises that required quicker movement struggled more than the lunges and the raises as I think there are less movements its easier for it to follow. The quicker ones weren't that quick. Without having used any of them before I might think that the worn sensors would pick my movement up more accurately. I don't know why I would think that, maybe I have an image of green screen stuff picking out various parts of body movement. With the DB if I moved my hands slightly it was much more magnified using the Kinect rather than the sensors.

(self on screen) It was quite entertaining. I know they have a use as a keep fit exercises, it might be quite interesting to see if you are immersed in a game environment. As a keep fit exercise it's good to do, it's novel. Something new. I didn't feel constrained by either of them. I did feel the sensor did pick up more natural how I was moving than the kinect, with my limbs. They seemed to represent my body fairly accurately. The lunges and raises it represented better because there are less movement, its more regular movement. It felt like it was doing at the same time. The GK was the most difficult to get you hand in the right spot, particularly the higher and lower balls your hands not getting down and you have to rely on your feet. Give a bit of practice on it you'll get a bit better, only playing a bit I struggled more on that.

DB is good fun, it comes from watching the fun. I quite enjoyed it. I was frustrated when I got hit, I thought damn I don't want to get hit again. I found the GK most difficult to get my hand in the right position. Whether it was my reactions being too slow or the games reactions not being quick enough, I was missing more

on the floor so I ended up kicking them. I don't really have any interest in games that are keep fit, I'd prefer to do something else. I didn't find any enjoyment in that I was just moving from side to side. That kind of thing is for entertainment, I didn't find any entertainment in that. I own a games console but I wouldn't buy one of these things for it.

(voice) Fine. The only time I remember in the lunge exercise it said keep going its you that benefit and bend your elbow, in the tutorials definitely.

(trainer) I found it slightly strange that you were standing off centre but I guess that's so you can see the trainer and you are training opposite someone, which I guess gives a feeling of companionship as people will be using this thing alone. So it makes it feel like you've got a personal trainer who's there to gee you up and keep you along and don't just do it once and go back to eating biscuits. I felt like I was waiting for the trainer, so I was pre-empting it quite a lot.

I found the kinect to be much less restrictive and freer and I found it more responsive.

P115

How was the experience of using the motion capture games?

It was really interesting. I found it fun and better than I'd anticipated. I'd even go as far to say it would make me buy one.

How did you find the different types of motion capture device?

Intrinsically I probably had more trust in the things that were on your body, because you can see them, see some technology working, compared to a disbelief (about the Kinect) that it could monitor would you are doing. I thought they were both the same regarding what the output was. I guess the Kinect is more free though if you are doing exercises. I definitely would have put more trust in the sensors because there's something there, it relates more to other technology that I understand like a mouse. Its something that I hold onto even if its not connected. Having something is better than having nothing, psychologically. (kinect) it's so beyond me realms of understanding that it boggles my mind. (sensor) I felt a bit more reassured that I was working, even though there was no difference. The feeling of wearing the sensors made me understand the technology better, I suppose the reality is that wearing no technology is better for the experience.

Were you aware of them?

No, not really. They were really cumbersome.

Did you see any difference between the way your movement was measured between the two systems?

No, I felt like it was pretty much the same. I felt there were certain games that neither system responded quick enough to. The arm raises was poor with both, it responded about a second later which is ridiculous really. I don't think it represented

the range of movement either. The reaction time was really poor. You'd put your arms up and then down, and it would still be up.

The faster games?

Yeah, that seemed to be reacting quickly but that might have been because I was thinking about my next move and what was going on, so maybe my perception was that it was moving faster but that was because I was thinking about different things. In the slow games, that's all you're doing, I probably paid more attention to the responses but in the fast games I was looking out for the next ball. I thought they were really fun, I was really engaged, I was thinking about getting out of the way of the dodgeballs or trying to reach the football. I didn't thing the FB was as good.

What about the emotions you experience?

DB – Yeah, I was excited throughout the whole thing and I thought fun, so happy, and I was quite nervous about getting hit by the ball. It felt like 'Oh, my face.' It felt realistic. (exciting) Just the whole thing, because it was the first thing, the first try, and I was really impressed by the technology. (confused and frustrated) Yeah, even though I'd watched the trial I was clear about how to hit the ball. I kept saving them with my feet but every time I put my hand out it was miles away. I don't know if the implication was that I had to jump high or I was sure what was going on, so I was quite frustrated.

(Boredom and no emotion at lunges and arm raises) Yeah, just bored, I hate those things in real life so I don't enjoy doing that in the gym, and I found them both

a little less receptive as well. Not as impressive. I guess I was a bit disappointed because the other high activity games had been quite impressive, and a great use of the technology, and the second the two slower games seemed to highlight the flaws of the technology when its not as reactive. So it was a bit disappointing, plus I found it a bit boring.

(Physio, kind of exercises did you do for your knee). I did a lot of work on wobble boards, to make you knee unstable. Then we did forward lunges, weights, where you push again your thighs. To open your knee up.

Could you see yourself doing those with this system?

Yeah, cos there were little things I could do at home which were easy, like standing on one leg. If I'd had a system like this it would definitely have inspired me to do it more because I found myself doing when I was washing the dishes or something. If I could set a chunk of time, as its quite fun. It's a game. If you had a series of exercises to do for physio and they could give you a game to do it on I think that would have inspired me to do it more often because it would be like a chunk of your day. Get home, do 15 minutes on the Xbox and you might inclined to do some more at the same time. Plus it would all be in a list and you wouldn't be constantly be referring to a piece of paper, and double checking and 'how many repetitions' and writing it down. I guess that's another thing about it, its all recorded so you can see your progression.

(Intrigue and mischievous) I guess that was again because I was bored by the activity I was starting seeing how far I could test it. If I put my foot backwards,

would it? And it didn't. The I was trying all different things, I was just messing about really.

How did you find the voice coach?

It's good for the explanation, but I don't like it for all that 'Good job!', but I guess it comes with all of them, the Wii and everything. I'd probably turn it off.

Did you change your movement when you heard the voice?

Hmm yeah, at one point I went left instead of right and it said go right. I wouldn't have noticed on screen as I was quite involved.

When it said go more slowly did you?

Oh yeah, I did. It must have been subconscious. I do remember that now.

How about the trainer?

Yeah, I thought that was quite good. I don't think did interact with that, but if it was an exercise I was unfamiliar with then you'd just copy it. Use it as a demonstration. I was keeping my own time, do it as fast as possible.

What was your motivation during the slower exercises?

I think because it was a bit boring I thought I'll just get this out of the way. When I was doing my physio I was doing them more conscientiously because there was as direct benefit to me.

How about the faster exercises?

That was fun though, they were engaging. I was happy to do that for as long as, except for the football which was a bit rubbish, although that was the amount of balls coming so there was no way to rush it.

P116

How was the experience of using the motion capture systems?

It was a good experience. In the first time I tried to focus on the personal trainer to see what he was doing rather than me. I tried to copy and follow. In the second time I noticed I was going too fast so I tried to follow the pace of the trainer.

Did you noticed any difference in the sensors and kinect?

Not I didn't notice that. I was trying to see what the trainer was doing, I tried to picture myself in a real situation. (In the lunges) when I went right I could see what I was doing, but when I went left I felt that it wasn't the most accurate, so I tried not to watch it. So I focused more on the exercise than the screen. In the football one I don't think I really looked at the avatar.

Before did you think there would be any difference in the sensors?

No, I didn't think about it. I wasn't aware of wearing them.

How about the slow games? The lunges and arm raises.

In the last two, the fast ones, the reaction to my movement weren't accurate and it was frustrating. In the 3rd one of the first round I noticed that it wasn't doing what I was doing. I was jumping and the balls still got me. I don't think the balls were at the same level as my avatar. In the GK there was a problem with the high balls and it wasn't accurate at all. I put my hands up and they would still go in, it wasn't accurate.

What was frustrating about it?

Well, that I was doing the exercise and I thought I was doing it perfectly and I wasn't according to the computer.

Do you think you were at fault or the computer was at fault?

I think the computer was at fault.

What did feel like when you were doing the slower games?

Probably something that I am doing because I have to do, I wasn't think about anything in particular. I don't normally do those types of exercises I prefer running and jumping or move, those kinds of things.

Faster games?

Much better, if I was doing them as part of a routine I would feel like I'm working out. As opposed to the first games which I wouldn't see myself doing. The last two were a fun situation. I was trying to put myself in a real situation and not let the balls touch me and save the balls.

Were you aware of the score?

No, I didn't even look at the scores. I looked at how many movements left I had (slow). The fast two I had no idea. The slower ones I wanted to finish them faster. (faster) My goal was for the ball to not touch me or save the ball rather than the score.

Were you aware of the voice coach?

Not at all in the first round. In the second round I noticed it when the guy was doing what I was supposed be. I thought maybe I should listen. Maybe if I did something wrong. Again, trying to put myself in a real situation that the guy is there and doing it and focusing what he was saying. It could be a language situation (not first language).

How about the personal trainer?

I think it could be correlated to the fact that English is not my primary language that I was easier to see what he was doing than to listen. I think it effected towards the end to it properly how he was doing. Even if I'm not enjoying it I wanted to do it properly.

How did you feel about seeing your own avatar on screen?

I think in a sense the balls were coming towards me not the avatar, I didn't really look at the avatar. I did in the last one when I was trying to find the best way to stop the ball as it wasn't really accurate. I was trying to see how accurate it was.

Did you do any physio when you had back problems?

I did yoga and it really helped. I went to see an osteopath and it helped but didn't get rid of my pain completely. Yoga was great, I was with a group and everyone was in the same situation (general yoga class). I was looking at the trainer on the game and thinking that would be great for the yoga class where the trainer wasn't really paying attention to what I was doing, if the avatar is accurate and doing what I'm supposed to be doing and the software is good enough to tell me I'm doing a good job, you're not moving how you're supposed to be moving, then that would be great. When I went to the gym nobody is really paying attention to what I'm doing or maybe only the first class and maybe that would fade. (Physio) I didn't do the exercise I was supposed to, I wasn't very good at them. I think it was the environment, if I was running I would do more stretches, but at home even though I knew it was good for me I don't do it. I have the association that home is the end after I've done exercise, that's where I finish.

How would you use this system to encourage you?

More about the posture. I remember it telling me I need to stand on my heels, and at that moment I stood on my heels, I thought wow maybe I wasn't doing it properly. Maybe if he could teach me to stand in general when I waiting for something. Here he said stand on my heels but he didn't know if I was, but if he could and teach me how to have a good posture and when I'm exercising if he could tell me how to do it properly. Then I'd be motivated to do it because its improving my posture.