DESIGNING GAMES FOR CHILDREN'S REHABILITATION

by

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Abstract

The upsurge of video games applied to various contexts such as health care and education has led to an increased interest in strategies on how to design games that generate real-life outcomes, knowledge or skills useful outside of the game itself. However, the current state of game design research that borrows extensively from game studies is at the risk of inheriting a predisposition for descriptive over prescriptive theories, to the detriment of potential applicability and industrial relevance. This MPhil project explores a design strategy that is focused on producing and predicting real-life behavioural outcomes by emphasizing mechanics and interactions over rules and content.

With the aim of scrutinizing this design strategy a multi-method case study was conducted during the concept phase of a video game that utilizes the Nintendo Wii's motion-control capabilities, for the rehabilitation of children within the age range of 8 – 16 with an acquired brain injury (ABI). The action research method was used to explore the design thinking underpinning the mechanics and interactions that bring about behavioural outcomes; those which satisfy specific therapeutic needs in the areas of motor, socio-emotional, and cognitive skills. Design decisions were subsequently evaluated through a series of playtests performed with the purpose of tracing real-life behavioural outcomes back to their roots in mechanics and interactions.

This study has led to a thorough understanding of the advantages and limitations of the applied game design strategy under scrutiny, and contributes to the field of game design studies by: 1) critically analysing some of the formal concepts that underpin our current understanding of applied game design; 2) promoting an applied game design strategy for therapeutic effect, that emphasizes mechanics and interactions over rules and content; 3) providing the basis for a playtest method for validating design decisions.

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Preface

This is a multidisciplinary project involving the following areas: game design, production planning, programming, research, sound design, music composition, 3D animation, visual art design, and interaction design. Although this work highlights only a small selection of these disciplines, it is important to understand that the game designer makes decisions that affect each of these areas.

For a long time theoretical knowledge on game design has been the domain of industry game designers, sharing their ideas mostly in the form of website articles and game production focused books. Definitions and models from these sources had the tendency to be inclusive and functional on one hand, but on the other hand also imprecise and overlapping. It wasn't until 2001 that the study of video game design was recognized as an emerging academic discipline (Aarseth 2001). But why would the study of video game design be of interest to scholars and researchers? For one thing, according to professor Espen Aarseth "design theory is quite underdeveloped compared to the other traditions [in game studies]", complementing his statement with the argument that "there is a clear danger that commercial success and sales numbers will dominate the discourse" (Aarseth 2005: 4-5). However, the tradition of game studies, the discipline which studies games in the broadest sense of the word, is a complicated one. Rather than presented as a unified field, it encompasses other disciplines and sciences that contribute to our understanding not just of games and their design, but also of related fields such as game culture, play theory, history, and literary studies. Subjects in game studies vary greatly in methodological and theoretical focus; it was aptly described by game researcher Ian Bogost (2009) as a mess, "a mess we don't need to keep trying to clean up, if it were even possible to do so".

As a reaction to the dissimilarity in definitions and models from these fields, and to differentiate the study of games from other media, game researcher Gonzola Frasca (1999) proposed the term *ludology*. Central to the ludological position is that games should be understood on their own terms and not through other disciplines or media.

This somewhat crude classification delineated ludology as a characteristically formalist position within game studies and garnered significant following amongst game researchers. Even though formalist game research is often considered *transmedial*[1] (July 2003), game researchers started to find that different game forms, e.g. video games, social games, and pervasive games, brought their own peculiarities (Myers 2009, Copier 2007, Nieuwdorp 2005) and as such certain models and definitions could not easily be generalized. Similarly, applied video games challenge our current understanding of video games and their design.

For reasons stated above, when reviewing game literature it is important to understand the position from which it was written. Even within the ludology field different perspectives are presented; this is called the *game and player problem* by game researcher Jesper Juul (2008). The designer or theorist typically looks at games through its content, while the player or analyst looks at games from an experiential viewpoint. In the same way, designer theories tend to be prescriptive in nature whereas analyst theories tend to be descriptive, often resulting in conflicting terminology, definitions, and models. The position of this exegesis however, is that a game designer is concerned with the area where the game perspective and player perspective overlap (Figure 1), essentially connecting the game's content to its experiential counterpart.

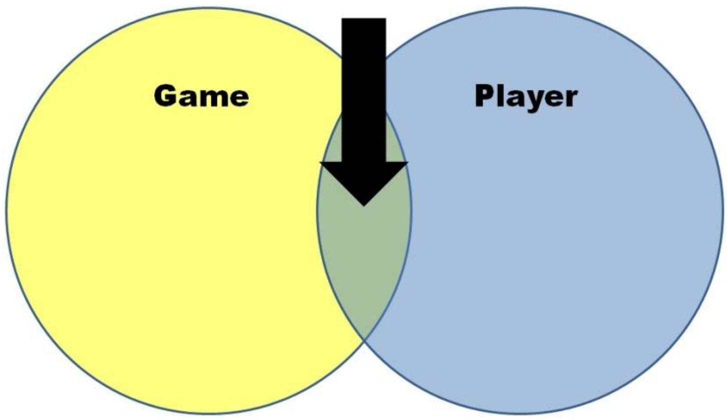

Figure 1: Game and player perspectives, the position of this MPhil research is where both overlap

[1] Many formalist theories make no essential distinction between various forms of games such as video games, board games, card games, and sports games.

Although this MPhil research project is predominantly an academic pursuit, its subject relates to the interest in devising practical design tools to guide the design and development process of an applied video game for therapeutic effect. As such, the intended audience for this exegesis is both academics and professional game designers.

Acknowledgments

Although the video game I am working on is still in development at the time of writing, all the work so far and writing this exegesis have been a very pleasurable experience. However, the part that excites me the most is recognizing the people who left an indelible mark on my research and practice. First and foremost I would like to thank Professor Jeroen van Mastrigt-Ide for entrusting me with the role of lead designer for the GATE Health pilot which made this research project possible. His visionary ideas about applied games that at first I could only intellectually comprehend have slowly been integrated into my own ideas and practice. I sincerely hope that he recognizes this work as an embodiment of our collective ideas put into practice. I would also like to thank my supervisory team consisting of Professor Stephen Deutsch and Dr. Stephen Bell from Bournemouth University for their invaluable guidance and criticism. Most notably the Skype video discussions have helped me sharpen my research practices and writing. Special thanks are extended toward Lies van Roessel who assisted me with all of the playtests and gave me valuable feedback on my argumentation, and Micah Hrehovcsik who assisted with project management when I had to finish this exegesis. Instrumental to the success of the work are my colleagues and students who have worked with me on the GATE Health pilot, the children who participated in the playtests, as well as all the members of our board of experts.

Management

Professor Jeroen van Mastrigt-Ide (Executive producer)

Willempje Vrins (Applied Game Design Programme Manager)

Production

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Hans Dunnik (Intern Game Design)

Ian van Kempen (Intern 2D graphics design)

Meindert Ekkelenkamp (Lead Artist)

Micah Hrehovcsik (Game Design)

Richard van Tol (Sound Design)

Roos Schultheiss (Concept Art)

Stan Koch (Music Composition & Arrangement)

Walter Beerens (Character Animation)

Yme de Jong (Sound Design)

Research

Lies van Roessel

Willemijn Prins

Board of Experts

Anka Michielsen (Rehabilitation Therapy Researcher, De Hoogstraat)

Doret Brandjes (Project Manager, iZovator)

Jaap Buurke (Physiotherapist & Researcher, Roessingh Research & Development)

Joep Janssen (Children's Rehabilitation Therapist & Researcher, De Hoogstraat)

Joost van de Kreeke (Children's Rehabilitation Therapist, Mytylschool)

José Ermers (Children's Rehabilitation Therapist, De Hoogstraat)

Marlies Stalenhoef (Health Care Insurance, Agis)

Marleen van de Wees (Child Psychologist, Rehabilitation Centre Blixembosch)

Richard Tanke (Director Technology Trial Centre Arnhem)

Willem-Jan Renger (Vice Chair Faculty of Arts, Media & Technology. HKU)

Author's declaration

Hereby I declare that the work in this exegesis has been written in compliance with the Bournemouth University Code of Practice for Research Degrees. The work is original except where indicated specifically by reference. During the course of the research there have been a number of occasions where findings from this study were presented.

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April 2012, Niels Keetels

Introduction

Beyond commercial entertainment, video games have been holding the promise to be effective for education and training for three reasons: 1) play is intrinsically motivating; 2) the responsiveness of the game environment provides immediate feedback to the user; 3) the content can have sufficient complexity to allow for ample learning opportunities (Ritterfeld et al. 2009: 5). These types of games are typically referred to as *serious games,* and have gained considerable market support (Van Mastrigt-Ide and Prins 2010) and scholarly attention. However, debates in recent years have demonstrated differences over the term *serious games* (Ritterfeld et al. 2009: 5). Does *serious* refer the content of the game, to the purpose for which the game was designed, or to the goal for which the user selects the game? According to Ben Sawyer of the *Serious Games Initiative* "all games are serious" (Sawyer and Smith 2008) because all games teach something, but it is not always readily apparent what exactly they teach (Koster 2005, Blow 2007). Still, the word 'teach' does not cover the full utility of *serious games,* as it mainly implies a didactic or instructive aim, whereas the application of *serious games* in other socially relevant contexts such as rehabilitation and *exergaming*[2] (Appendix A: Serious games taxonomy) reveals aims that depend crucially on the activity of gaming itself. For this reason it is useful to think in terms of *applied games* rather than *serious games,* to denote games that were deliberately designed to generate real-life outcomes that are useful in a specific socially relevant context. *Applied* refers to the "tactical use and usefulness of (the knowledge and skills acquired during) the game activity outside the domain of the game itself" (Van Roessel and Van Mastrigt-Ide 2010 cited Prins 2010).

Problem statement

Although there is significant academic and scientific support for applying video games to socially relevant contexts such as health care and education, the practical

[2] Exergaming is a term used for playing games that are also a form of exercise.

aspect that deals with the design of such games has not been investigated to a similar extent (Winn 2008). This study relates to the interest in how to design applied video games that lead to behavioural outcomes that are useful in such contexts. A common approach to achieving this goal is to simulate a real-world situation or environment, representative of the context to which the game is applied. Two distinct examples of simulation-driven design approaches are *procedural rhetoric* and *simulation experience design*.

Procedural Rhetoric (Bogost 2007) is a theory that proposes a form of persuasion through reflective interaction with *symbolic* content (simulation). The focus of this strategy is on the procedures that model that which the game is about, and the affordances that allow the player to affect variables that influence the runtime[3] behaviour of the simulation. An example of a video game using this design approach is *The Truth About Game Development* (Figure 2), a game that makes an argument about the business ethics of video game development. The goal of the game is to maximize profitability and workforce efficiency by keeping employee salaries as low as possible and firing those who go on strike or do not work hard enough. While the visuals of the game ostensibly depict inhumane working conditions, the satirical undercurrent is exposed predominantly through meticulously upsetting the game's dynamics and reflecting on the outcomes.

Figure 2: The Truth About Game Development (Kloonigames 2007)

[3] In computer science, runtime refers to the duration of when a computer application is running.

Simulation Experience Design (Raybourn 2008) proposes a form of developing competencies through interaction with *iconic* content (simulation). The focus of this strategy is also on the procedures that model the content but with emphasis on imitating the context realistically. A rather extreme example of an iconic simulation is a video game for the treatment of acrophobic[4] patients on the V-Gait training system (Figure 3) by Motek Medical B.V. The game, in which the player needs to cross unstable rope bridges, is played in front of a large projection screen by walking on an instrumented treadmill. The movement of the treadmill platform in combination with the projections of high altitudes is designed to produce sensations of height.

Figure 3: V-Gait (Motek Medical B.V. 2011)

The primary feature that differentiates the theory presented in this exegesis from *procedural rhetoric* (symbolic content) and *simulation experience design* (iconic content) is that simulation is not considered a prerequisite for designing applied video games, rather, the mechanics and interactions for playing the game are promoted over the content. Hence, behavioural outcomes derive not from what the game is about but from the activity of gaming itself. Jeroen van Mastrigt-Ide (2009) calls this principle “what you see is not what you get”. For example, although the video game *Guitar Hero* (Figure 4) is played using an input device that resembles a

[4] Acrophobia is the fear of heights.

guitar, it does not teach many relevant competencies for playing a real guitar. Still, it does train finger strength, independent hand movement, music memorization, and rhythm skills that may be valuable for other purposes. On a similar note, *Sim City 2000* (Figure 5) is a video game about city-planning, but it does not teach relevant city-planning competencies. It does train the player to balance a complex and dynamic system of numbers, taking into account that a sudden mutation in its variables may present itself at any time in the form of a natural disaster. From a functional point of view it does not matter whether the player is planning a fictional city, zoo, or even a beaver dam; the player is balancing a system using mechanics that allow him to manipulate the system's variables. This balancing activity is what *Sim City* is really teaching, not actual city-planning.

Figure 4: Guitar Hero (Harmonix 2005)

Figure 5: Sim City 2000 (Maxis 1993)

Research question and objectives

This exegesis holds the position that it is possible for a game designer to anticipate the change in behaviour of the user if one looks at video games in terms of game mechanics and interactions. The aim of this research project is to argue the value of this view by iteratively designing an applied video game with emphasis on mechanics and interactions over content, and testing whether the intended behavioural outcomes are produced. Thus, the primary research question is:

What are the advantages and disadvantages of using a design strategy that emphasizes mechanics and interactions over content?

From this research question the following objectives emerge:

- Establish a working definition for the term *game mechanic;*
- Outline the design decisions for selecting appropriate mechanics and interactions that produce intended behavioural outcomes;
- Propose a playtest strategy for validating design decisions;
- Evaluate the design strategy by linking outcomes back to mechanics and interactions.

Method

The nature of the research problem suggests a research method that is appropriate for exploratory analysis. For the purposes of this study and to address this research problem, a multi-method case study has been chosen, allowing for an in-depth examination of the practical implications of using a particular design strategy containing all the contextual conditions congruent with a real applied game development scenario (Yin 2003: 14). The case, concerning the design thinking underpinning the mechanics and interactions for an applied game intended for children's rehabilitation, serves as a "typical instance" (Denscombe 2007: 40) of applied video game development, therefore findings from this study can potentially be generalized to an entire class of applied video games designed to achieve therapeutic aims.

Although a case study approach is useful to explain the nature and scope of the research project, it does not prescribe guidelines for the collection, analysis, and interpretation of data. Since the research project focuses on two distinct phases[5], the

[5] Although design phase and testing phase are mentioned, the design process is typically cyclic in nature, which entails that design decisions are iteratively *tested, evaluated,* and *revised* (Fullerton et al. 2004). In this case the design process was iterative but the research process was sequential.

designing and testing of mechanics and interactions, appropriate research methods have been chosen for each phase:

Design-phase

This phase consists of the processes for the selection and implementation of appropriate game mechanics and interactions with regard to a given set of desired behavioural outcomes. The design phase's inherently collaborative (Adams 2003: 148) as well as its iterative nature, combined with the active role of the researcher as the lead designer, provides justification for using action research in which "the two processes of research and action are integrated" (Somekh 1995 cited Denscombe 2007: 124). The action research strategy is crucial for achieving research objective number 2:

Outline the design decisions for selecting appropriate mechanics and interactions that produce intended behavioural outcomes.

Testing phase

For this phase a modified version of the playtest method was used for the collection of data with regard to behavioural outcomes, combined with the semi-structured interview method for obtaining qualitative data about the clarity of the video game prototypes. The combination of these two methods was chosen in fulfillment of the last research objective:

Evaluate the design strategy by linking outcomes back to mechanics and interactions.

The case study approach encourages the use of multiple methods in order to capture the complex reality under scrutiny (Denscombe 2007: 45) and therefore presents itself as the best option for the purposes of this study.

Research scope and limitations

Since the complete development cycle of an applied video game exceeds the time frame for this MPhil project, the research concentrates on the design process from the initial concept to a fully functional digital prototype of an applied video game for the rehabilitation of children with an acquired brain injury (ABI) within the age group of 8 – 16. This exegesis examines the design decisions that were made during this process in the light of the theory for designing applied video games that is provided in this work, with the aim of evaluating the practical implications of using a design strategy that emphasizes mechanics and interactions over content.

Another constraint on this study is that it is only focused on the role of the game designer. This entails that the research is carried out with the purpose of determining whether behavioural outcomes can be produced and predicted using the design strategy that is proposed in this exegesis. Inquiry into the therapeutic value of these outcomes is not within scope of this research project as that is considered to be the responsibility of content experts rather than game designers.

A third constraint is the time frame in which this research project is conducted. The practical element of this study was carried out over a period of 8 months, which restricted the number of design iterations that could be performed, as well as the frequency and depth of playtests.

Significance of the research

Game design theory as an academic discipline is quite underdeveloped in video game studies, and “there’s a clear danger that commercial success and sales numbers will dominate the discourse“ (Aarseth 2005: 4-5). This research project supports the position that it is possible for a game designer to anticipate the change in behaviour of the user, and argues the value of a design strategy that looks at video games in terms of mechanics and interactions for achieving this goal.

“The ability to theorize design enables the designer to move from an endless succession of unique cases to broad explanatory principles that can help to solve many kinds of problems“ (Friedman 2003: 515). Described in this exegesis is an exploratory investigation into a design strategy that can potentially be developed into a method for designing applied video games. For this MPhil research project the theory is applied specifically to the design of an applied video game for children’s rehabilitation, but it could be extended to include other socially relevant uses.

Exegesis structure

Introduction: Introduces the research problem, a specification of the research question and objectives, an overview of the methods used as well as their justification, and the scope of the research project.

Chapter 1: Designing for Behavioural Outcomes: A literature review for establishing working definitions and theoretical underpinnings of the design strategy that is to be tested.

Chapter 2: Applied Video Games in Health Care: Provides an overview of the state-of-the-art in using (video game) design and technology in the health care sector, as well as scientific and academic support for applied video games.

Chapter 3: *WiiHabilitation* pilot: Introduces the game *Project Dream* (code name), and elaborates on its design parameters and game mechanics.

Chapter 4: Case Study Design and Implementation: Provides justification for the case study and methods used for data collection, in addition to the design and implementation of these methods.

Chapter 5: Case Study Analysis and Interpretation: Outlines how the research data was analysed, and how findings relating to the research objectives were interpreted.

Chapter 6: Conclusions and Implications: Presents the conclusions drawn from research findings, the effectivity of the research methods that were used in this study, practical implications of the design strategy that is proposed in this work, a review of the limitations of the study, highlighted areas for further research, and a discussion about applied game design responsibility.

Chapter 1: Designing for behavioural outcomes

This chapter presents the theoretical foundation on which the practical research is based. The literature review is focused on practical models and definitions for designing applied video games. There currently exists a substantial body of literature pertaining to game design models and definitions; however, for this review only academic literature that presents state-of-the-art knowledge with regard to (applied) video game design is used. This criterion significantly narrows the collected works under consideration, but also offers ideas that are well supported with relevant research findings. It is worth noting that game theory literature is excluded from the review. Game theory is a branch of applied mathematics that deals with analysing decision-making strategies within rule-based systems, and is frequently referenced in game studies. The reason for excluding game theory is that it does not factor in (asymmetric) player competencies, rather it presupposes idealized players with unlimited cognitive capacities. It is furthermore exclusively focused on rules in complete disregard of the game's experiential counterpart in play. In the light of designing an applied video game for therapeutic application, as is the case with this MPhil project, preference is given to theories that account for the human factor in play.

As the research problem deals with the design of applied video games, a conceptual model for integrating input from *content*, *context*, and *concept* experts is developed through literature synthesis, as well as a proper working definition for the term *mechanics*. It is important to keep in mind that care needs to be taken with the interpretation of definitions and models from *serious games* literature as such games have become associated with positively connoted features such as seriousness[6], education, and learning (Ratan and Ritterfeld 2009: 11). The theory discussed throughout this exegesis is not so much concerned with learning opportunities as it is with training competencies. In the light of the recent uprise of sensor-enhanced gaming technology such as the Nintendo Wii Remote and Balance Board, Microsoft

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[6] Seriousness refers to the social value of a game's outcomes (Rodriguez 2006).

Kinect, and Sony Move, allowing for the continuous reading of human activities, the training of player competencies presents itself as an arguably more relevant topic for discussion than learning opportunities. This supposition is supported by current trends in the applied video game industry. Figure 6 demonstrates that games that train competencies to improve health account for a quarter of applied video games developed in The Netherlands[7]. On a global scale the applied game market is expected to grow from 1.5 billion Euros in revenue in 2010 to 10 billion Euros in 2015, with an average annual growth rate of 47% (IDATE 2010).

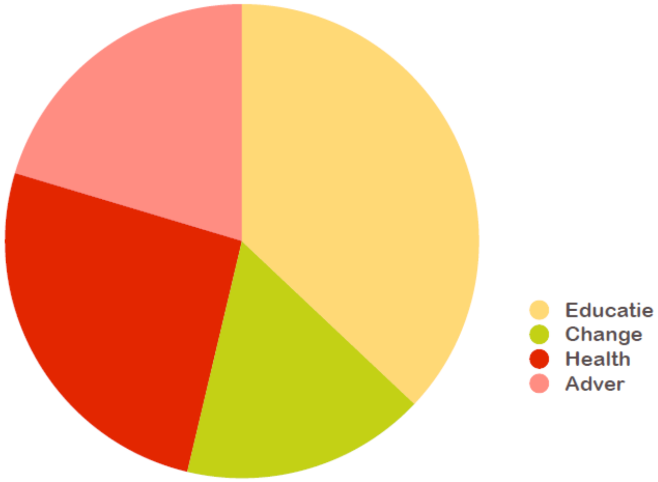

Figure 6: Distribution of applications of video games in The Netherlands (Van Mastrigt-Ide and Prins 2010)

[7] Ratan and Ritterfeld (2009) conceived a *Classification of Serious Games* which included 600 educational video games but excluded the applications with which this exegesis is concerned.

Introduction

This exegesis does not aim to argue the value of applied video games, instead its focus is strictly on designing video games for behavioural outcomes that are useful in a socially relevant context outside the game itself. This is motivated by the idea that all video games train player competencies, and applied video games are designed to train a specific set of desired competencies. To illustrate the point that all video games train player competencies (although it is not always readily apparent which), it is worth examining which competencies an exemplary non-applied video game such as *Super Mario Bros.* (Figure 7) trains.

Figure 7: Super Mario Bros. (Nintendo EAD 1985) [CDROM Videos/Chapter 2 – Mechanics]

From the point of view that is argued in this exegesis the game is not about an Italian plumber trying to rescue Princess Toadstool from the clutches of King Bowser in the Mushroom Kingdom. It is also not about collecting coins, defeating enemies, or reaching the end of a level without dying. These are arbitrary surface features that have no essential connection to the playing activity itself. *Super Mario Bros* is all about the jumping mechanic and requires the player time jumps correctly, change linear into vertical momentum, and estimate distances on a moment-to-moment basis. The game can only be played successfully by mastering the jump mechanic; every obstacle is meticulously designed to challenge the player's jumping skills in different ways. However, learning to control Mario's physics through the jumping mechanic has little value outside the domain of the game itself; it does not teach any competencies that can be used in a real-life socially relevant context. By this case *Super Mario Bros.* cannot be considered an applied video game. Although the game was not designed for strategic application, it does train competencies in the areas of spatial imagination, concentration, and memory that potentially could be applied. From this theorem it follows that there is no essential distinction between applied and non-applied games, other than its intended purpose.

Integrating content, context, and concept parameters

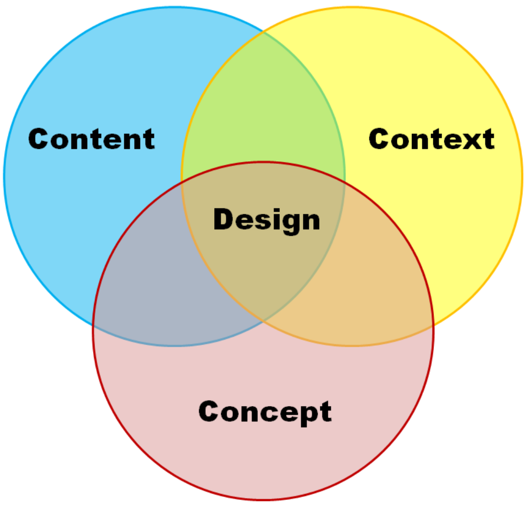

Figure 8: Content, context and concept model

"Making a good game is hard. Making a good serious game is even harder" (Winn 2008). The applied video game development process shares many similarities with commercial entertainment game development, but in the area of game design the differences are particularly pronounced. A good applied video game must produce and regulate behavioural outcomes and also fulfill the entertainment aspect that is expected from video games because they "compete with many other leisure-time activities, so they must be highly entertaining or personally useful to the target user group" (Lieberman 2009: 126). For producing a serious game with an educational aim, Brain Winn and Carrie Heeter (2006) designed a framework based on the *technological pedagogical content knowledge*[8] (TPCK) model, which distinguishes between three essential disciplines: game designers, pedagogy experts, and content experts. This model has been adapted and revised by Willem-Jan Renger[9] (2007). Renger's position is that tensions between these disciplines are necessary because each perspective emphasizes different values that are critical to the game's success. For example, an applied video game for education may never find its intended audience without a context expert (e.g. pedagogist) advocating *how* the game can be embedded in the classroom. Without a content expert (e.g. teacher) advocating *what* the game is designed to teach, the game's outcomes may be ineffectual, and without a concept expert (game designer) the seriousness of the game may come at the cost of its entertainment value. A potential pitfall in the development of an applied game is that the positions of content, context and concept expert not necessarily embodied by different parties, often resulting in lopsided design goals. The *content, context, and concept model* (Figure 8) presented in this exegesis is a modified version of Renger's model, with the intention of making it applicable to the design of applied video games with aims other than education. The categories of *content, context,* and *concept* are further outlined below:

Content: defines what the game is about, or what it is meant to accomplish. Content experts specify the game's outcomes and are responsible for the quality of these outcomes.

Context: deals with the aspects of why, how and where the game is played, and by whom (target audience). Context experts know the conditions under which the game is to be played and are responsible for ensuring that the game's outcomes are appropriate for the context to which they are applied.

Concept: is concerned with sustaining player motivation. Game designers select appropriate game elements for producing and regulating desired player behaviour.

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[8] The TPCK model is a framework for addressing the knowledge required by a teacher for the integration of technology into their teaching.

[9] Willem-Jan Renger leads the *Creative Design for Motivation and Transfer* and *Applied Game Design* research programmes at the Utrecht School of the Arts.

Together these three positions contribute to the design parameters of an applied video game. Explicating these parameters is very useful as they can be used in the design process to reinforce or verify design decisions.

Game mechanics

In 1976 a Japanese hardware manufacturer named APF Electronic Inc. marketed a video game console called the *APF TV Fun.* The console featured four built-in variations on Atari Inc.'s immensely successful video game *Pong* (Atari 1972) by the names of Tennis, Hockey, Squash, and Practice (Figure 9). What is interesting about these games is that the affordances through which players could affect their runtime behaviour[10] were identical for all four games; using a dial input device the players could move a paddle along the vertical axis of a two-dimensional plane, and whenever something collided with it, it would be reflected from that paddle's surface. The only differences between Tennis, Hockey, Squash and Practice were the placement of these paddles on the screen and the circumstances under which points could be accumulated. One could argue that irrespective of the connotations brought forward by the names of these four games they were essentially mostly identical in how they were operated.

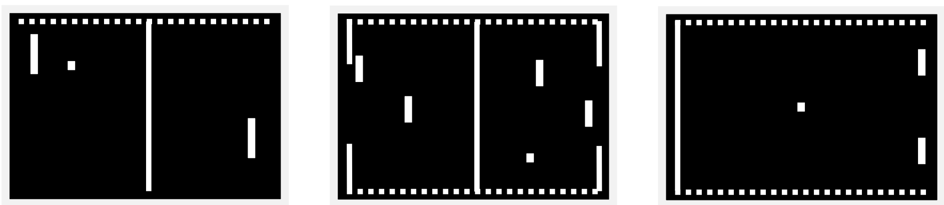

Figure 9: APF FUN TV games: Tennis, Hockey, and Squash respectively

What makes *Pong* recognizable in all of the *APF TV Fun* variations above all is the similarity of the *mechanics*, the affordances that allow the player to manipulate the

[10] The runtime behaviour of a game refers to the automated continuous operation of the game.

game-objects in effect to increase the perceived value of the game's outcomes. The similarity of mechanics in all of the *APF TV Fun* games is an approachable example that illustrates how mechanics can be considered the key identifiers of a game. As Jesse Schell (2008: 130) affirms, "game mechanics are the core of what a game truly is. They are the interactions and relationships that remain when all of the aesthetics, technology, and story are stripped away". Following this logic there is no essential distinction between *Disney Monopoly*, *Pokémon Monopoly*, or *Star Wars Monopoly*; it does not matter whether you are buying streets, Disney locations, or planets from the Star Wars universe, below the game's surface features reside the exact same mechanics as in the original *Monopoly*[11] (Figure 10) that was published by Parker Brothers in 1935 (Elizabeth, J., Magie Philips 1935). Furthermore, all versions of the game train the same set of player competencies.

Figure 10: Monopoly and Disney & Pixar Monopoly

Across the same video game genre, games share the same set of core mechanics[12] (Costikyan 2005), although many games can be seen as belonging to several genres at once (Apperley 2006: 19). In that sense the notion of a video game genre is different from that of fiction or film, it is not based on theme but on how the game

[11] The *Monopoly* example is often used by Professor Jeroen van Mastrigt-Ide to demonstrate that a game's fiction has no essential connection to its mechanics; when switched out for something else it will still be the same game.

[12] "the core mechanic is the essential moment-to-moment activity players enact. A core mechanic is repeated over and over in the course of a game to create larger patterns of experience" (Salen and Zimmerman 2003: 327).

plays (Costikyan 2005, Järvinen 2008). It is therefore that game researcher Espen Aarseth (2004: 6) argues that studying games without playing them is a tricky proposition, "unless the game genre is so familiar to the analyst that no substantial learning is necessary".

The practical end of this project underscores the need to establish a working definition of the term *mechanic* for practical purposes. However, a brief examination of definitions of this term used in the academic field reveals semantic confusion among game researchers and game design researchers (Järvinen 2008: 250). This may be attributed to what game researcher Jesper Juul (2008) called the *game and player problem*. The designer or theorist typically looks at games through its content; the player or analyst on the other hand looks at games from an experiential viewpoint. Theories, models, and definitions from these viewpoints tend to be prescriptive and descriptive respectively, and sometimes contradictory. In the following sections the term *mechanic* will be investigated from both viewpoints, and a practical working definition will be provided.

Mechanics as methods of agency

Figure 11: Scan from the manual of Klonoa (Paon 2009) explaining the running and jumping mechanic.

Game researcher Aki Järvinen (2008: 39) describes mechanics as formal elements that "connect behavioural elements – players and context – to the systemic ones".

They are the actions that the player can do in the game world (Rouse 2005: 310 cited Sicart 2008). Seen this way, the best way of understanding mechanics is to formalize them as verbs (Järvinen 2008, Sicart 2008), named after the actions they represent in the game world. Hence, video game manuals (Figure 11) typically use verbs such as ‘run’, ‘shoot’, and ‘jump’ to denote methods for player agency. Referring back to *Super Mario Bros.*, the whole game revolves around the jumping mechanic. Jumping is used to reach platforms, leap over gaps, defeat enemies, and collect coins. The obstacles in the game are meticulously designed to exploit this mechanic, in increasingly complex and demanding patterns. In *Super Mario Bros.*, early sections in the game require the player to leap over small gaps and defeat or avoid enemies with very predictable behavioural patterns, whereas later in the game he has to jump on moving or falling platforms, avoid fireballs, and deal with larger numbers of enemies with less predictable behavioural patterns.

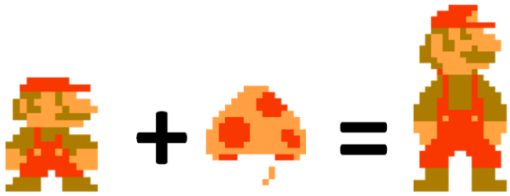

Figure 12: Power-up mechanic, if Mario touches the mushroom he transforms into Super Mario.

Sometimes however, a mechanic describes a causality that was not a direct result of a player action. Unfortunately this insight is not reflected in most definitions of a mechanic, but as will become apparent in the next section (Mechanics as state transformations) it clearly belongs to the same category. The ‘power-up’ is an example of such a game mechanic (Figure 12); Mario has the ability to grab items such as mushrooms, and as a result of that he transforms into Super Mario who has more abilities than normal Mario.

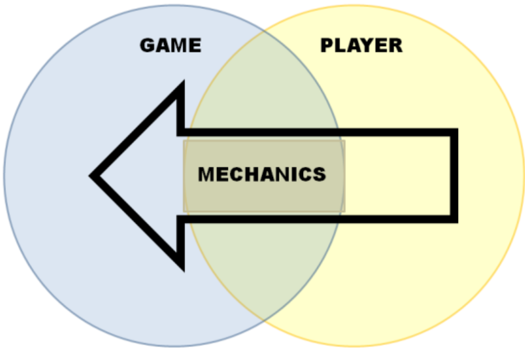

Figure 13: Viewpoint of mechanics as methods of agency

Mechanics described as methods of agency is a perspective on games from the user who plays it (Figure 13). Central to this perspective is player decision-making, they allow for what Salen and Zimmerman (2003: 34) call 'meaningful play': "it is the process by which a player takes action within the designed system of a game and the system responds to the action. The meaning of an action in a game resides in the relationship between action and outcome".

Mechanics as state transformations

Other academic definitions of the term *mechanic* omit the necessity of player agency; in many video games human and computer players have symmetric abilities and limitations resulting in the same type of outcomes. Miguel Sicart (2008) defines mechanics using concepts from object-oriented programming and game theory as "methods invoked by agents, designed for interaction with the game state", where an agent can either be human or computer. Sicart's definition alludes to the concept of affecting state variables, as described by game theorist Rufus Isaacs (1956: 190): "players act in the game by manipulating the values of control variables, such as changing the angle of a joystick or the pressing of a key. In turn, these inputs affect the various state variables, which describe, by their values, the current state of the game". In this sense, mechanics can be understood as affordances or procedures which allow the player to reconfigure an underlying system of state variables.

Represented in the game state are game-world objects such as players, enemies, collectable items, player lives, obstacles, projectiles, and doors.

The concept of a game state deserves further explanation, as it is crucial for understanding mechanics from a technical point of view. An example often used in game studies and design literature is that of a game of Chess (Juul 2003, Salen and Zimmerman 2003: 218). In Chess, the game state is represented predominantly by the arrangement of the pieces on the board. It contains information about the location of each of these pieces (as a 2-dimensional coordinate), the type (pawn, knight, bishop, rook, queen, king), the colour (black, white), and whose turn it is at any given moment. In a video game the game state is represented by values in memory. When saving the game, part of the game state is written to storage-space, which can be loaded back into memory when returning to the game. From a technical viewpoint, game mechanics are procedures that allow players to change game state variables on a moment to moment basis. In Chess, it is changing the position of a piece, which can have large consequences for winning chances. In *Super Mario Bros.*, it can be changing the state of Mario from standing to jumping. In this jumping-state Mario's relation to enemies is changed, because enemies can be defeated by being jumped on. Defining the word mechanic on technical terms affords a unique opportunity for observing player behaviour.

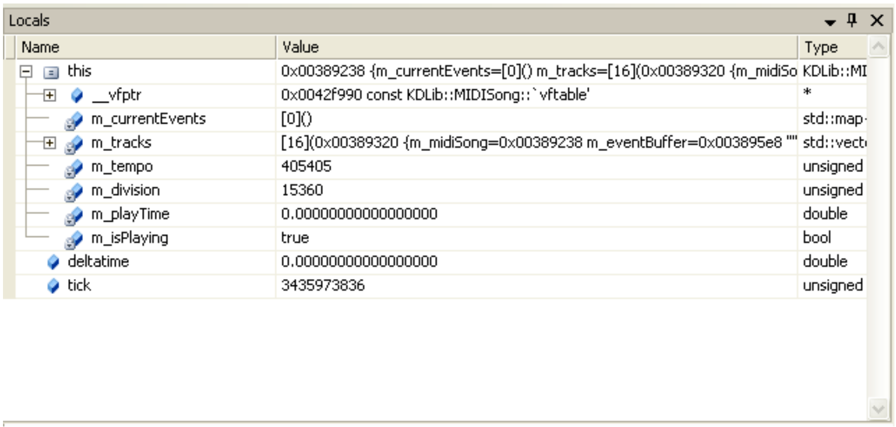

Figure 14: Microsoft Visual Studio Debugger

Using debugging software (Figure 14) mutations of state variables in computer memory can be detected and induced. Referring back to the power-up mechanic example of the previous section (Mechanics as methods of agency), when Mario transforms into Super Mario, some of his state variables (object attributes) mutate as an indirect result of collision between the Mario object and a mushroom object. Circumventions that allow the player to change the game state without using game mechanics are typically referred to as hacks or cheats.

The game-central perspective (Figure 15) on mechanics that is outlined in this section focuses on the properties of game-objects and the procedures that expose these properties to the player (and other game-objects). For designers and theorists these procedures are discrete units (Sicart 2008). They do not encompass the actual algorithms that reconfigure the game state, rather they initiate a chain of events given a set of input parameters. In computer-science terms they can be considered the callers of subroutines. Referring back to the example of the jump mechanic in *Super Mario Bros.* the mechanic does not calculate the distance or height of the jump, rather it tells the system that Mario has entered a state of jumping, leaving the rest to specialized algorithms.

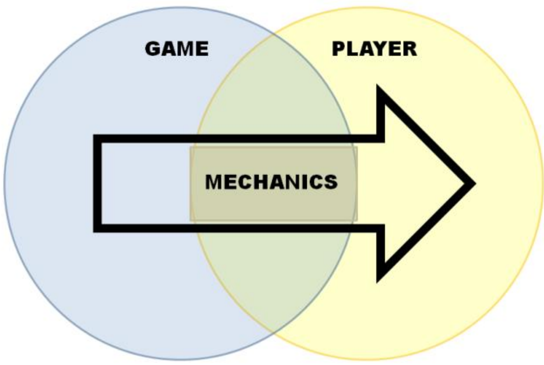

Figure 15: Viewpoint of mechanics as state transformations

Mechanics as determinants of behaviour

The viewpoints on mechanics that were explored in the previous two sections position themselves in the extreme ends of Juul's (2008) *game and player problem*. They are useful for analytical purposes, but from an applied game design perspective it is more useful to describe how game-content and behavioural outcomes are related. In other words, the game design problem deals with the area where the game domain and player domain overlap (Figure 16).

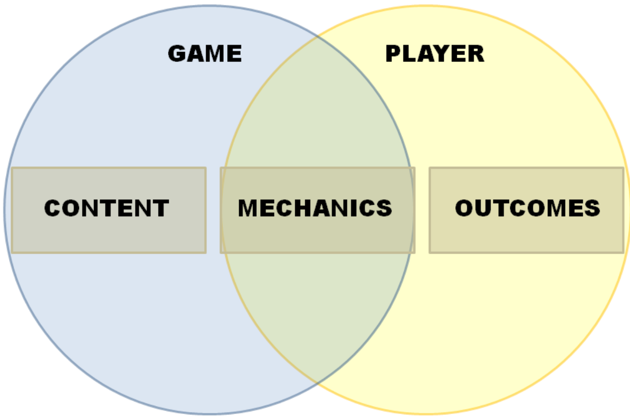

Figure 16: Content, mechanics, and outcomes model

By designing mechanics game designers select modes of interaction with the game state. The challenges of the game, which are considered part of the game content in Figure 16, present opportunities for players for using these mechanics. This allows designers to guide the player into particular behaviour by "constraining the space of possible plans to attain goals" (Järvinen 2008: 254). Thus, to a certain degree the combination of challenges and the selectivity in mechanics allow designers predict courses of interaction, "but not to determine how the game will always be played, or what the outcome of that experience will be" (Sicart 2008). Even games that do not focus on challenge but rather on freeform play embody someone's idea of how they should be used or played. Seen this way, mechanics are bidirectional constructs. They are procedures that allow players to perform actions in the game-world by changing state variables, and at the same time they regulate player behaviour through the configuration of the game's challenges.

The viewpoint explored in this section demonstrates that behavioural outcomes can be predicted through a design. It follows that the relationship between mechanic and outcome can be tested, providing opportunities for tracing back behavioural outcomes to their root in mechanics and game content. For a game designer these tests are useful for making informed design decisions. As the practical end of this MPhil research project involves evaluating design decisions by testing whether mechanics bring about the intended behavioural outcomes, a working definition for the term mechanic should be determined. For the purposes of this study, and with consideration for the viewpoints that have been discussed, the term mechanic is henceforth used to refer to a design construct that describes a procedure for reconfiguring the game state, initiated by an agent, by means of a behavioural pattern.

The hardware control interface

One last important factor to investigate is the relationship between mechanics and hardware control interfaces such as a keypad, touch-screen, steering wheel, or motion-sensor. The hardware control interface is the medium that maps player behavioural patterns to game mechanics (Sicart 2008, Järvinen 2008: 256), when direct access to the game state (such as in board games) is not possible. In some cases they also produce output, e.g. the Wii Remote has a rumble-device and speaker, and a touch-screen produces visual feedback. The key strength of a hardware control interface is that it consolidates multiple actions into one point of control. The choice of the interface also significantly influences how video games are going to be played (Järvinen 2008: 329). For example, the central feature in the history of video game hardware interfaces has been the button (Griffin 2005: 1). For the player this button functions as a metaphor for performing in-game actions (Järvinen 2008: 307), for example pressing button ‘A’ stands for jumping. However, a simple pushbutton can only register two states: pressed and released. Therefore, the button is not suitable for mechanics that require very fine axial adjustments. Sometimes computer interface features are added or changed to accommodate certain types or genres of video games, a well-known example being the design of the Apple II computer: “a lot of features of the Apple II went in because I [Steve Wozniak[13]] had designed Breakout for Atari” (Steve Wozniak cited Connick 1986: 24). Also sound and a colour display were added “so that games could be programmed”.

[13] Steve Wozniak is a co-founder of Apple and functioned as a computer engineer for the Apple I and Apple II computers.

Since the rise of motion-control and biofeedback interfaces in video game hardware and smartphones new modes of interaction with the game state have been discovered. The Wii Balance Board lets players control video games using their center-of-mass; Microsoft Kinect allows for full-body motion capturing; and the announced Wii Vitality Sensor reportedly detects the player's heart pulse. These developments do not just change the way video games are played, but also inspire whole new sets of mechanics and game genres (Järvinen 2008: 329).

Designing game mechanics

In this chapter a model for determining design parameters was explained. Then, a practical working definition of the term mechanic was established, and the relationship between mechanics and hardware control interfaces was investigated. This section transforms the knowledge obtained from the literature review into a strategy for designing applied video games.

In the introduction of this chapter the argument was advanced that video games train player competencies though the configuration of their challenges, and the affordances that allow the player to manipulate the game-state. Subsequently, the role of the hardware control interface in relation to mechanics was demonstrated. Accordingly, to extend the theory of how applied games train player competencies, the role of game-content and the hardware control interface need to be integrated with the understanding of game mechanics as determinants of player behaviour. The relationship between game mechanics and game-content is pointed out by game designer Raph Koster (2005: 56), who says that "most games repeatedly throw evolving spaces at you so that you can explore the recurrence of symbols within them". In terms of nomenclature used in this work, the player is essentially repeating the same actions throughout the game, sometimes tactically and sometimes strategically, to overcome evolving variations on a central challenge. The player's behavioural patterns (mostly in the form of motor control activity) are symbolically mediated through a hardware control interface, resulting into in-game actions with the purpose of resolving artificial conflicts. From an applied game designer's point of view the reverse of this proposition is more interesting: the challenges in the game produce, through selective affordances that require an activity to be operated, predictable player behaviour.

A notation standard for game mechanics

Although analytically game mechanics can be isolated from each other as well as from game-content and the hardware control interface, in practice they are inextricably intertwined. For example, a 'shooting' action consists of multiple procedures and motor control inputs: the player aims [motor activity] at an enemy [content] using the control stick [hardware control interface], then presses [motor activity] the 'A' button [hardware control interface]. The contextual reference to the enemy in this example is needed because other actions such as the selection of a menu item share similar player behavioural patterns and hardware interfaces, but they are not the same mechanic. For documenting the practical end of this research project a flexible notation standard for game mechanics is necessary. Henceforth, transcripts of mechanics shall include; 1) an in-game action described as a verb (e.g. 'shoot'); 2) a reference to the in-game content or class of content on which the mechanic operates (e.g. 'an enemy'); 3) a reference to the control interface (e.g. 'button') if the mechanic is operated by a human player; 4) a behaviour that needs to be performed to execute the in-game action (e.g. 'point').

Transforming content parameters into game mechanics

As explained in the section 'Integrating content, context, and concept parameters' of this chapter, it is necessary to consolidate the interests of content, context and game design experts, in order to arrive at a design that addresses a need, actually works, and is satisfying to use. According to Renger (2007), designs often fall short of their intended goals when any of these disciplines are underrepresented. From the position advanced in this writing it is crucial that content parameters are properly transformed into game mechanics, rather than translated into declarative content such as cut scenes and character dialogues. The approach to this transformation process is to distinguish the key concept that needs to be understood or the competency that needs to be trained from the form in which it is generally expressed in practice.

Figure 17: Customized Wii controllers as laparoscopic instruments (source: IMDS)

Figure 18: Screenshot of Grendel Games' laparoscopic surgery game.

An example of an applied video game that was designed with a similar approach is a forthcoming laparoscopic[14] surgery game (Figure 18) developed by Grendel Games (Laning and Goris 2010). A study from 2007 found that certain video game skills correlate with surgical skills (Rosser et al. 2007), stating that "surgeons who played the most video games in the past demonstrated better speed and accuracy [while performing laparoscopic surgery]". The game by Grendel Games addresses a lack of training in hand-eye coordination required from surgeons for laparoscopy, and is operated using customized Wii controllers that handle similar to laparoscopic instruments (Figure 17). Content design parameters for this game included the motor skill training of the active and passive hand, improving depth perception, and working under dimly lit conditions. Context parameters included appeal to both male and female audiences, and that it should be engaging enough to play after work time. Concept parameters included making the gameplay entertaining and making it competitive (Rosser et al. 2007). Instead of translating the content parameters to game-content, which would likely result in a realistic looking surgery simulator, the

[14] Laparoscopy is a surgical technique performed through very small incisions.

game designers transformed the underlying concepts and competencies into mechanics and game-content. Operated using two Wii MotionPlus[15] controllers the game mechanics require the player to use both his active and passive hand to grab and move game-objects around with a level of precision that is comparable to that of performing laparoscopic surgery. While it looks like a commercial puzzle game for entertainment (Figure 18), it trains competencies that are relevant to real laparoscopic surgery without the player knowing it. In accordance with the 'what you see is not what you get' principle, the game takes place in an underwater world instead of a surgery room, yet its lighting conditions are similar to those experienced in practice.

To summarize the analysis of this example, transforming design parameters into game mechanics and content involves identifying key concepts, skills and competencies that underlie their expressed form in practice. Then, modes of interaction that bring about these behavioural patterns are explored, as well as hardware control interfaces necessary for facilitating these interactions. After that, concepts can be created that aim to meet as many design requirements from the *content, context and concept* model as possible. And for assessing the suitability of the game, some of these concepts need to be prototyped, developed and tested iteratively. The case study presented in this work demonstrates this process, and argues the value of the design strategy that is outlined in this section.

[15] The Wii MotionPlus controller allows for more accurately capturing complex motions through its gyroscope which can determine rotational motions.

Chapter 2: Applied video games in health care

There is a substantial body of literature underscoring beneficial effects of playing video games. In fact, research dated back to the early 1980s has consistently shown that playing computer games produces increases in reaction times, improved hand-eye coordination, and raises players' self-esteem (Griffiths 2005). "Video game therapy" has been used successfully in rehabilitation for stroke patients, people with traumatic brain injuries, burn victims, wheelchair users, Erb's palsy sufferers, children undergoing chemotherapy, children with muscular dystrophy, and autistic children (Griffiths 2005: 161). The application of video games has found acceptance in the health care domain with a wide variety of uses (Appendix A: Games for health taxonomy) such as: pain distraction (*SnowWorld)*, public information (*The Great Flu*), and physical exercise and body awareness (*Wii Fit*). According to Dr. Pamela M. Kato, the most often cited reason for using video games for therapeutic effect (as opposed to other persuasive means) is that they provide motivation for action. "Engaging a patient's motivation is frequently necessary in health care because patients are often required to undergo procedures or engage in behaviours that are painful and aversive on the one hand (e.g., undergoing chemotherapy) or boring and mundane on the other (e.g., taking pills, exercising on a regular basis)" (Kato 2010: 113). She also notes that not only applied games are used for training and educational purposes, but also "commercially available off-the-shelf games that are repurposed to meet certain behavioural goals in health care" (Kato 2010: 133, Lieberman 2006, Lange et al. 2009, Herbelin et al. 2011). Using off-the-shelf video games and hardware is not just eligible from a financial standpoint, but also because it reportedly provides a high level of enjoyment from interaction and exercise with family members (Lange et al. 2009). This also means that applied video games are in the unfortunate position of having to compete against mass-market entertainment software, and "the hope that players would select those [applied] games and deliberately play them is often not fulfilled" (Moore and Rosenberg and Coleman 2005 cited Shen et al. 2009: 48).

Commercial off-the-shelf video games for rehabilitation

Rehabilitation Center De Hoogstraat in Utrecht is a forerunner in The Netherlands in using commercial off-the-shelf (COTS) video games and gaming hardware as part of their children's rehabilitation programs (Figure 19). In 2007 they introduced the GameLab and developed a matrix which enables therapists to select appropriate video games for specific therapeutic aims and player competencies (Ermers 2009: 4). The children's therapists at the GameLab use video games for both individual rehabilitation and group sessions; other rehabilitation clinics in The Netherlands have followed since then. Together with the Special Lectorship Rehabilitation at The Hague University, therapists and researchers from De Hoogstraat have developed TherapWii[16], an online resource website for supporting therapists in using COTS Nintendo Wii games effectively for the treatment of children with an acquired brain injury. According to some researchers, the confrontation of therapists with game technology and design holds potential for inspiring new ideas for therapeutic training (Herbelin et al. 2011: 4).

Figure 19: Guitar Hero for Nintendo Wii being repurposed for revalidation therapy (De Hoogstraat)

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16 TherapWii: http://www.therapwii.nl/index.php/

Notwithstanding the perceived advantages of using COTS video games for therapy, there are also a number of shortcomings such as the lack of adaptability to each specific user, and the evaluation of use (Herbelin et al. 2011: 1). As different patients have different therapeutic needs, adaptability to each specific user is crucial. There have been research projects focused on improving adaptability by augmenting the hardware control interface of existing games with more physically involving sensor-based interfaces, or consolidating different controllers into one so that people with diverse physical disabilities can play the same video game together. Other research projects focus on modification of (open-source) game content (Herbelin et al. 2011). However, making hardware and software adjustments requires significant technical expertise, the level required of a programmer is equivalent to a Bachelor student in computer science (Herbelin et al. 2011: 3).

The effectiveness of using applied games for physical training

There is also a sizeable body of scientific research that supports the health care sector's enthusiasm for applied video games. Professor Shin-ichiro Takasugi from Kyushu University Hospital conducted research into the efficiency of balance and agility training for the elderly using a repurposed arcade (game) machine and found that in the areas of functional reach[17] and reaction time[18] the game produced better long time results than controlled tests did (Takasugi 2010). According to professor Takasugi these effects can be attributed to heightened motivation and continued activity, which can be achieved by making the exercise pleasurable. Similar positive results were found in the areas of executive functioning[19] (Staiano et al. 2010), pain reduction (Hoffman and Patterson 2005) and self-efficacy in relation to cancer treatment (Lieberman 2008). Various commercial off-the-shelf products also produce favorable results; researchers at St. John's Rehab Hospital in Ontario,

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[17] Functional reach controlled test used a forward hand stretching test.

[18] Reaction time controlled test measured reaction time by having the subject press a button as fast as possible after a sound has played.

[19] Executive functioning is the ability to organize thoughts and activities.

Canada, found Nintendo's *Wii Fit* useful for measuring weight distribution and postural control (Fung et al. 2011). Additionally, the *Wii Balance Board* peripheral presents itself as an affordable alternative to the professional force plate for certain tasks such as assessing postural balance (Clark et al. 2009), offering sufficient precision when measuring moderately slow shifts of weight.

It is noteworthy that many studies on the therapeutic effect of video games is done in the medical field as opposed to game research and computer science fields (Whitehead et al. 2010), though very few studies actually report numbers. A possible explanation for this is that for applied video games in health care, such as games for physical exercise (exergames), it is not always clear what the most relevant measures are; e.g. energy expenditure (calories burned), oxygen uptake, heart rate during game play are often measured and compared with results from controlled tests, but the motivational aspect of video games is frequently overlooked.

Considerations for designing motion mechanics for physical training

Because the design of good motion-controlled video games is considered a "radically different new paradigm" (Isbister 2010), the Applied Game Design research programme at the Utrecht School of the Arts conducted field research with the purpose of discovering the qualities of motion-controlled games that produce pleasurable physical behaviour. The research involved playing a number of COTS games that promote physical movement as a core ingredient of the gaming experience. The video games that were selected included the following Nintendo Wii games: *Samba de Amigo* (Gearbox 2008), *Red Steel 2* (Ubisoft Paris 2010), *Michael Jackson: The Experience* (Ubisoft Montpellier 2010), *Wii Sports* (Nintendo EAD 2006), and *Rayman Raving Rabbids TV Party* (Ubisoft Paris 2008). Using a three camera setup, one recording the game, one recording the players from the front, and one recording the players from above, the movements of players while playing these games were captured on video. When analysing the video materials distinction was made between fine motor skills (small specific movements), gross motor skills (full body movement), frequency, and intensity of movement. Contrary to expectations, *Wii Sports Tennis* (Figure 20) produced relatively low levels of gross motor skills and intensity. Another game that fell short of expectations (albeit for different reasons) was *Samba de Amigo* (Figure 22). While this musical rhythm game produced relatively high levels of frequency and intensity of movement, the game's technical problems with registering fine motor activities forced players into unnatural behavioural patterns to the detriment of their enjoyment. Two notable examples of good motion-controlled games are *Wii Sports Boxing* (Figure 21) and *Michael Jackson: The Experience* (Figure 23). Both games produced high levels of fine and gross motor skills and were reportedly highly enjoyable to play.

Figure 20: *Wii Sports* (Tennis) [CDROM Videos/Chapter 2 – Wii Sports Tennis]

Figure 21: *Wii Sports* (Boxing) [CDROM Videos/Chapter 2 – Wii Sports Boxing]

Figure 22: *Samba de Amigo* [CDROM Videos/Chapter 2 – Samba de Amigo]

Figure 23: *Michael Jackson: The Experience* [CDROM Videos/Chapter 2 – Michael Jackson]

Katherine Isbister (2010), who studies movement play, found a positive correlation between physical movement and enjoyment while playing video games. According to Isbister, the most successful examples of motion-controlled games are those that promote full body movement and also have a social component. This is in line with the findings from the field research by the Applied Game Design programme; multiplayer games with full body movement (Figure 21 and Figure 23) invariably produced smiles on the faces of the players and gained much attention from bystanders. The dual-flow (Figure 24 and Figure 25) model (based on Csikszentmihalyi's concept of the flow-state[20]) demonstrates that good motion-controlled video games need to be designed to be both psychologically and physiologically engaging.

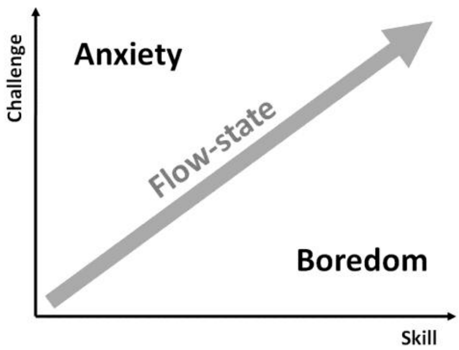

Figure 24: Psychological flow-state (Whitehead et al. 2010)

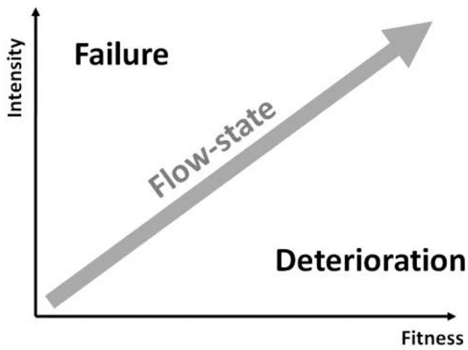

Figure 25: Physiological flow-state (Whitehead et al. 2010)

Taking into account the strengths and deficits of existing applied video games for health care, this MPhil research project aims to design an applied video game for the rehabilitation of children with an acquired brain injury (ABI) that; 1) looks and plays like a COTS video game for entertainment; 2) trains relevant competencies with regard to ABI; 3) offers adaptability to specific abilities or therapeutic needs; 4) offers monitoring functionality for the evaluation of the player's progress.

[20] The flow-state is a mental state in which a person is fully immersed in an activity.

Chapter 3: *WiiHabilitation* pilot

The practical end of this research project concerns the design of a video game for children's rehabilitation. The project started out as an innovation pilot with the working title *WiiHabilitation* for GATE, a Dutch government funded research project that aims develop a state-of-the-art knowledge base with respect to game design and technology. The purpose of this innovation pilot is to create awareness about the potential of gaming and simulation in the health care sector. The budget for carrying out the design and development of the *WiiHabilitation* project is €625,000 Euros and it has an estimated development period of two years. When the project initiated in 2009, an exploratory research phase was initiated with the aim of establishing the application and context of the video game. The criteria that were upheld for selecting an appropriate application and context were: 1) the target audience needs to represent a large segment of the Dutch population, which is necessary to be able to test the game effectively throughout the design and development process; 2) the context and application of the game should be recognizable as exemplary cases of the usefulness of applied game design, so that design principles can potentially be generalized to the whole class of applied video games; 3) the game should make use of commercial off-the-shelf hardware, thus placing the focus on game design rather than the hardware it runs on; 4) the game should be designed for mass-market appeal, as one of the overarching goals of the project (beyond this MPhil project) is to investigate whether a business case can be made for the development of commercial applied video games for health care.

Because of the rise of sensor-enhanced[21] hardware (such as the Nintendo Wii and Apple iPhone) in recent years, allowing for the continuously reading of body movement, it had been decided that the main focus of the game would be to make players move physically. Thus, the focus of the context research phase was placed on the physiotherapy domain. For a start, the state-of-the-art of applied games for health

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[21] Consumer electronics increasingly make use of technologies such as accelerometers, gyroscopes, GPS and image tracking for recording motor activity of the user.

care was investigated. An in-depth look at existing video games and simulations applied to physiotherapeutic practice revealed a strong tendency toward developing expensive proprietary hardware that could only be used under professional supervision and within the clinical environment. Additionally, a number of content and context experts were interviewed to obtain their views on using (video game) technology in physiotherapeutic practice. One important issue that was identified through context expert interviews is that the Dutch health care system is faced with rising costs and a growing demand for therapy, which the current workforce is unable to meet. Therefore, experts from the health care sector are actively looking for ways to make patients more self-sufficient. Although patients are partially responsible for their own recovery, after they are discharged from therapy they need to keep exercising otherwise the patient might fall back into his previous condition. To address this problem a potential solution was suggested: an applied video game designed for clinical and domestic use that allows therapists to customize mechanics to fulfill the therapeutic needs of patients. From the outcomes of the research an initial set of design parameters had been collected (Figure 26), and a design proposal was conceived with the purpose of assembling an advisory board of experts.

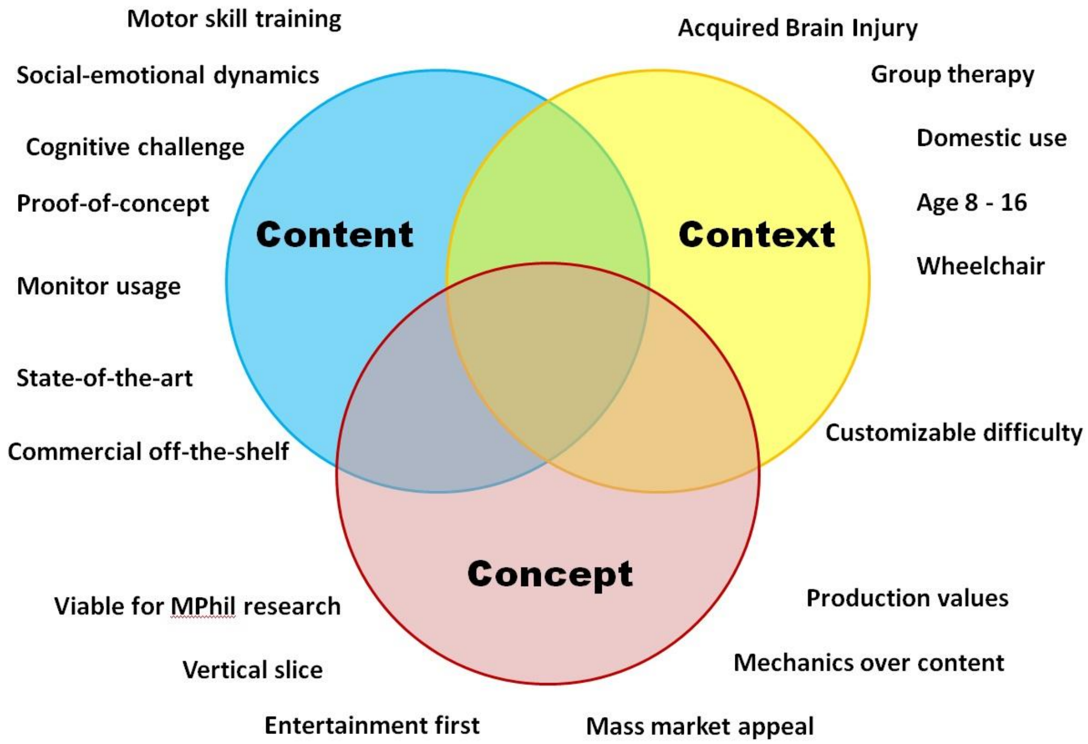

Figure 26: The initial set of design parameters for *Project Dream*

Design parameters

For the advisory board a number of experts were invited, not just content experts (therapists, researchers), but also context (health care insurance, health care innovation platform) and concept (game designers) experts. The purpose of the advisory board meetings that occurred twice per year was, in addition to determining the scope of the project, to make sure that the project's development kept heading in a direction that would satisfy all stakeholders[22]. The board consisted of the following members:

Context experts: who deal with the aspects of why, how and where the game is played, and by whom (target audience). Context experts know the conditions under which the game is to be played and are responsible for ensuring that the game's outcomes are appropriate for the context to which they are applied.

- Therapists from De Hoogstraat, Roessingh Research & Development, Mytylschool in Utrecht, Blixembosch in Eindhoven, had worked with children with an acquired brain injury and had ideas of how they would use the game in their practice. They also provided opportunities for playtesting with the target audience.
- People from Technology Trial Centre Arnhem and iZovator innovation platform provided their network to make the project known and watched over the marketability of the project.
- Agis Health Insurance was involved to find out whether applied video games could be imbursed by insurance companies, as video game therapy could prove to be an inexpensive solution to certain health care related problems.

Content experts: define what the game is about, or what it is meant to accomplish. Content experts specify the game's outcomes and are responsible for the quality of these outcomes.

[22] It is important to note that the *WiiHabilitation* project (or *Project Dream*) was not designed by committee, all design decisions were made solely by the game design team.

- The GATE committee determined that the innovation pilot would be applied to the health care domain, and that it should serve as an exemplary case of applied game design.
- Researchers and therapists from De Hoogstraat, Roessingh Research & Development, Mytylschool in Utrecht, and Blixembosch in Eindhoven, determined that the areas of motor, socio-emotional, and cognition skill training were crucial for the revalidation of children with an acquired brain injury.

Concept experts: are concerned with sustaining player motivation. Game designers select appropriate game elements for producing and regulating player behaviour.

- People from the Utrecht School of the Arts and the Applied Game Design programme were involved to make sure that the project's design and production team would pursue state-of-the-art game design, and to obtain knowledge with regard to applied game design for therapeutic effect.

Figure 27: Advisory board of experts meeting

Context parameters

Context experts from rehabilitation center De Hoogstraat in Utrecht, The Netherlands, suggested that the target audience for the pilot should be children within the age group of 8-16 with acquired brain injuries (or similar therapeutic needs such as children with autism and Asperger's syndrome). Children with acquired brain injuries represent a substantial population in The Netherlands, and working closely with therapists from De Hoogstraat allows for rapid playtesting of the game. Another important context parameter is that the game should be playable both in a clinical environment and at home, so that the therapist can introduce patients to the game (in group therapy) after which the patients can play it at home together with their friends and family, or by themselves.

Acquired brain injury

Acquired brain injury (ABI) is a term that describes causes of injuries to the central nervous system occurring during development. Such injuries can be the result of incidents, infections, diseases, alcohol or drug abuse, poisoning, near drowning, or hemorrhage, but the most common cause is trauma[23]. (Hagberg-Van 't Hooft 2005: 9). The brain is very fragile even though it is protected by a strong bony skull and fluid. Therefore, small causes can have large consequences. These consequences can be manifested in a variety of impairments in cognitive, communicative, physical, sensory, social, emotional, and behavioural domains. In general, these impairments are categorized into *motor*, *socio-emotional*, and *cognitive* disabilities (Palm 2005: 2; Anon 2011). Some of the key skills and competencies across these domains are further outlined below. The trouble with sustaining an ABI at a young age is that there is the risk of acquiring a developmental disability (Palm 2005: 3). Furthermore, some deficits may remain hidden until later childhood or adolescence (Tonks et al. 2008: 13). In The Netherlands, around 12,000 children under the age of 20 sustain an ABI, of which 85% sustain moderate injuries and 15% sustain severe injuries (Ritzen et al. 2011). A preliminary study also found that playfulness among children with an ABI is significantly less than their age-matched peers (Mortenson 2003: 100), this may be partially due to other skill deficits following ABI. Because the treatment of an ABI is complex, subsuming disciplines such as physiotherapy, occupational therapy, speech language therapy, and clinical psychology, it is useful to refer to the

[23] In the case of a brain injury caused by a traumatic force to the head the term "traumatic brain injury" (TBI) is commonly used.

term *rehabilitation therapy* to include the whole class of therapeutic professions.

Cognitive skills

Attention: rather than referring to a single entity, the word attention is a name given to a set of separate but interrelated brain processes. Cognitive skills associated with attention include; 1) the ability to sustain attention over time; 2) the ability to attend to stimuli selectively; 3) the ability to alternate or switch attention to stimuli or tasks, and; 4) the ability to divide attention to maintain more than one ongoing process (Hagberg-Van ‘t Hooft 2005: 17).

Memory: “memory is the capacity to retain information about oneself and one’s environment” (Hagberg-Van ‘t Hooft 2005: 19), and is generally divided into *short-term memory*, associated with retention over seconds to minutes; *long-term memory*, retention over days to years; and *working memory*, a temporary storing of information used to guide future actions (Gazzaniga 2002 cited Hagberg-Van ‘t Hooft 2005: 19).

Executive functions are often described as functions for self-regulation, and can be generalized to include three components; 1) *attention control*: selective and sustained attention; 2) *cognitive flexibility*: working memory, attentional shift, self-monitoring, and conceptual transfer; 3) *goal setting:* initiating, planning, problem solving and strategic behaviour (Hagberg-Van ‘t Hooft 2005: 23).

Socio-emotional skills

Emotion recognition refers to empathic skills for ascertaining intentions and motivations of others. Social interactions require the ability to recognize and understand emotions. Three easily identifiable emotion recognition skills involve; 1) reading emotions from eyes; 2) vocal analysis; and 3) facial expression analysis (Tonks et al. 2008: 9).

“Faux pas” recognition concerns the ability to detect violations of socially accepted norms (Tonks et al. 2008: 12).

Motor skills

Strength: hand strength is a fine motor function of the muscles. The two most common functional strength measurements are grip and pinch strength (Aaron 2006: 373).

Postural balance: “balance is the ability to assume any body position against the force of gravity” (Capon 1994: 9). Balance has a static and a dynamic quality. Static balance is concerned with maintaining or obtaining equilibrium in posture (Rinne et al. 2010: 24), dynamic balance concerns movements and center of gravity over base of support (ibid.).

Motor coordination: “the ability of the body to integrate the action of the muscles of the body to accomplish a specific movement or a series of skilled movements in the most efficient manner” (Capon 1994: 10). Gross motor coordination is concerned with full body movement, whereas fine motor coordination concerns specific small movements.

Content parameters

The content parameters concern what the game is meant to accomplish, namely training competencies that are relevant for the treatment of an ABI. As outlined in the previous section, these competencies are in the areas of cognitive, socio-emotional, and motor skills. A distinctive content parameter is using only low-cost COTS hardware to make the game. Not only does this place emphasis on game design over hardware design, it also makes the game commercially viable and potentially interesting for health insurance companies to fund. Other content parameters include features that allow the therapist to customize player abilities and monitor use.

Concept parameters

Another commitment is to design and develop a vertical-slice of the game; the focus is on a small subset of the game that demonstrates near-final quality across all of its components (e.g. in the areas of graphics, audio, game mechanics), so the playing experience of the subset provides an impression of what the actual final product will be like. The result can be compared with a demo-version of a video game in which only selected content is made available to try out. To make the game attractive to video game publishers it is designed with mass-market appeal in mind and demonstrates production values comparable to many Nintendo Wii games. Finally, as the design process of the game serves as a case study for this research project, the design strategy that is outlined in this exegesis is consistently used throughout the game's development.

Design philosophy

Game designers create designs for games. While this statement may seem like a platitude it really is not from a design research point of view--the purpose of any design activity is to create a design, a representation for an activity or artifact that is meticulously conceived to meet certain specific requirements. The word 'representation' emphasizes the challenge of the game designer to predict how the game is going to function. In the case of applied game design a designer creates a design through which (socially relevant) behavioural outcomes can be predicted. As Nelson and Stolterman (2003: 10) put it, "design is the ability to imagine that which does not yet exist, to make it appear in concrete form as a new; purposeful addition to the real world". Game designer Jesse Schell (2008: xxiv) provides a similar definition in context of game design, stating that designing is "the act of deciding what a game should be". The role of the game designer can be fulfilled by an individual or a group. In fact, game design is by nature a highly collaborative discipline. In the current video game development landscape "a designer seldom has ultimate authority over his game, even if he is the lead designer" (Adams 2003: 148). Chris Bateman and Richard Boon (2006: 105) add that "game designers rarely decide what the game will be about, what genre it will be, who the central characters will be, or any of the other factors which frame the creation of a game". Design requirements for a game may come from any number of different stakeholders, both from inside and outside the company that designs and develops it. However, this does not mean that game design is a paint-by-numbers affair. Every designer has his own qualifiers for what makes a good game design, a design philosophy. In the case of the *WiiHabilitation* project the lead game designer (who is also the author of this MPhil exegesis) was aiming for a cooperative multiplayer experience that would make players feel shared sensations such as excitement and pride, but also frustration and relief. One could say that this design approach has a lot in common with Walt Disney's famous quote that reads "I would rather entertain and hope that people learned something than educate people and hope they were entertained". In other words, while the therapeutic value of the game is considered very important it should not come at the cost of its entertainment value. The game would be designed to appeal to all children within the age range of 8 – 16, regardless of whether they have therapeutic needs or not. It is desirable that children with an ABI play the game with their friends at home, therefore the game's appearance does not explicate its intended utility as a tool for revalidation therapy.

The game design process

With the design parameters being established, a design philosophy upheld, and criteria for the quality of movement mechanics in mind (Chapter 2: Considerations for designing motion mechanics for physical training), potential game concepts could be explored. The design approach used for the *WiiHabilitation* project consists of a set of best practices that were collected from commonly used game design approaches. Bateman and Boon (2006: 5) distinguish between seven commonly used video game design approaches, namely:

1. *First principles:* during the concept-phase of the design process a number of goals are explicated and the game design is created to achieve those goals.
2. *Clone and tweak:* the design is based on an existing game, through modifications

and transformations a new design is created.

3. Meta-rules: rules are defined to guide the game design process.

4. Expressing technology: a game is designed around available game technologies such as hardware interfaces, graphics rendering technologies, and physics simulations.

5. Frankenstein approach: starts with existing materials and attempts to design a game around them.

6. Story-driven design: the game design evolves around a storyline.

7. Iterative design (by committee): the game design is evaluated, revised, and tested repeatedly.

In the case of the *WiiHabilitation* project both the *first principles* approach and the *iterative design* approach were adopted. The game is designed to satisfy the requirements that were forwarded by content, context, and design experts, and this was done in an iterative fashion (Figure 28) with the purpose of verifying whether design decisions produced the intended outcomes.

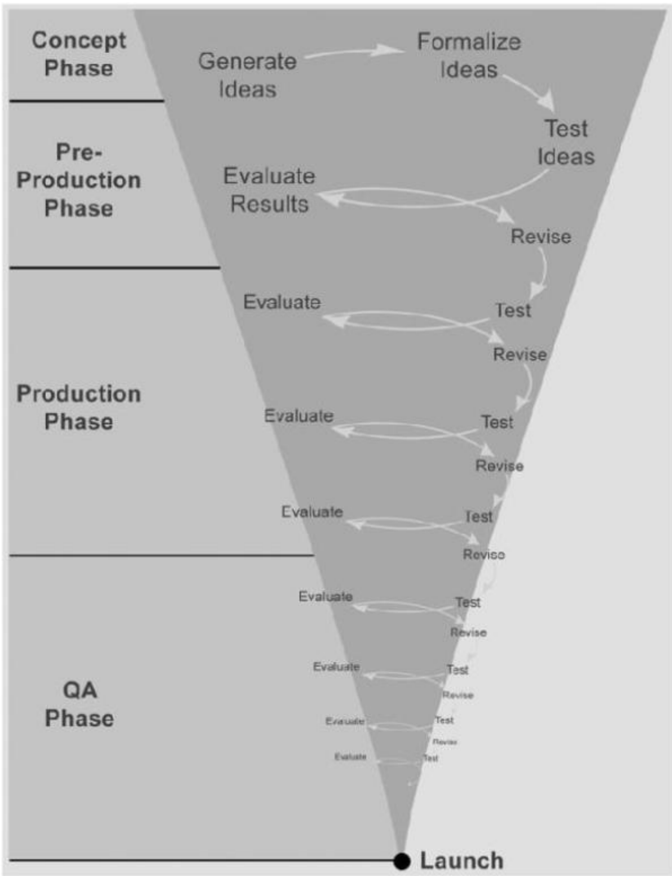

Figure 28: The iterative design process (Fullerton et al. 2004)

For coming up with appropriate game mechanics, many behavioural patterns in the areas of cognitive, socio-emotional, and motor skills were accumulated. These included:

Motor skills: standing up, walking around, shifting weight, pointing at the screen, throwing/hitting/slashing/etc. gestures with one or two arms, maintaining a pose, timing actions, shaking the controller, rotating the controller.

Socio-emotional skills: create dependencies between players (e.g. in the distribution of abilities or resources), offer meaningful choices that the group needs to agree on (e.g. which player will receive a power-up), give players 'secret' assignments, betting games, team-based play.

Cognitive skills: planning a course of action, puzzle-solving, building a construction (e.g. a stable bridge or a beaver dam), memorize patterns (e.g. enemy attack patterns), timed events which players have to react quickly to, dual-tasks (e.g. dividing attention between shooting objects and healing other players).

Many of these behavioural patterns carry genre associations with them, making it easier to envision how the game's mechanics will work. For example, rotating the controller is used to tilt the in-game world in typical marble-rolling games (e.g. *Super Monkey Ball: Banana Blitz* (Sega 2006), *Marble Saga: Kororinpa* (Hudson Soft 2009), *Mercury Meltdown Revolution* (Ignition Banbury 2009)). The transformation of content parameters to a game concept involves three steps: 1) compiling player behavioural patterns associated with the competencies that the game needs to train, or the concept that the game needs to teach; 2) associating these patterns with game mechanics of genres that produce these patterns; 3) finding content, or mixing genre conventions, in which all these mechanics make sense. This process resulted into a number of game concepts that satisfied the content parameters, some with more emphasis on a particular parameter than others. Described below are the working titles of three of the better concepts with a basic description of how they work and which parameters they emphasize:

BeaverGame: this game has players cooperate to build a beaver dam that is stable and high enough to withstand the threat of a constantly raising water level. Each player can command beavers with different tasks (some beavers can only carry materials, others can place ladders, hammer nails, or guide other beavers) by pointing and dragging them towards their destination. However, players are forced to cooperate in order to build something; someone has to command one beaver to get wood and someone else needs to bring a beaver wielding a hammer. When the beavers that are needed to build something are in the right place the players need to perform the appropriate gestures with the Wii remote, e.g. the player with the beaver wielding the hammer needs to perform hammering gestures. The winning condition of the game depends on the predetermined height of the structure, but the players fail when the dam collapses or when the rising water level exceeds the height of the dam. The *BeaverGame* focuses on interpersonal interactions (socio-emotional), dual-tasks and planning (cognition).

MysteryGame: this game is inspired by detective and crime scene investigation stories. By successfully completing a mini-game[24] the winning player receives clues about a particular conflict. During each round 4 mini-games are played, involving cognitive and motor challenges, and after every round players get to vote who they think committed the crime. One of the players is offered means to sabotage the performance of other players, the players who find out who committed the sabotages within 5 rounds win the game. *MysteryGame* focuses on interpersonal interactions (socio-emotional) and fine motor activities (motor skills).

AdventureGame: this game has the players cooperate to defeat enemies that attack players using a range of predictable attacking patterns. The game affords context-sensitive actions depending on the physical position of the player (relative to the television screen), for example, a player can attack an enemy only when he is close to the television screen, and can dodge enemy attacks by physically moving out of

[24] Mini-games are small games that only take seconds to minutes to complete.

the way. Furthermore, players can choose between different roles that embody different therapeutic needs; the fighting-class puts emphasis on training gross motor skills while the ranged-class predominantly trains fine motor skills. Additionally, the game challenges the players' cognitive abilities by attacking in predictable patterns, allowing the players to learn and improve their performance. *AdvenureGame* puts emphasis on dynamic balance, fine motor skills, and memorization of enemy patterns.

Prototyping ideas

The three concepts that were outlined in the previous section looked promising on paper, as each of them satisfied most of the design parameters adequately, but prototyping and testing was necessary to determine if they actually produced the intended behavioural patterns, and more importantly, if they were enjoyable to play. The prototypes were created by the lead game designer (author of this exegesis) himself using the Microsoft XNA framework[25] (for *BeaverGame* and *MysteryGame*), and Unity3D[26] (for *AdventureGame*). GlovePie[27] was used for the interpretation of accelerometer and infra-red data from the Wii remote[28]. The three prototypes had to be built within a timeframe of two weeks. Although some were not implemented completely, they still provided a sense of what the game would play like. Then a team of concept experts was assembled to play the prototypes and assess which ones were the most enjoyable and which ones worked best with regard to the content, context and concept parameters.

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[25] Microsoft XNA framework consists of a set of tools provided by Microsoft for developing games for Microsoft Windows, Windows Mobile, and Xbox 360.

[26] Unity3D is a game engine that is very useful for rapid prototyping.

[27] GlovePie is an application that allows hobbyist developers to use a variety of hardware peripherals with Microsoft Windows applications.

[28] The Wii Remote is the standard motion-sensing controller that comes with Nintendo's Wii game console.

Figure 29: Testing the prototype of a cooperative beaver dam building game.

Figure 30: First prototype of what would become *Project Dream,* demonstrating desirable outcomes. [CDROM Videos/Chapter 3 – Prototype]

The results of the playtests were surprising. Although all three games theoretically fulfilled the basic requirements, in practice some of them did not sustain the intended behavioural outcomes as well as predicted. The *BeaverGame* (Figure 29) produced very little physical activity other than pointing and occasionally (about once in every minute) simple gestures. Due to the chaotic nature of the game, players were hardly planning courses of action ahead of time. *MysteryGame* had technical difficulties resulting in frequent crashes, and without an actual scenario or storyline it did not meet its experience goals. *AventureGame* (Figure 30) however (which would later become known as *Project Dream*), produced a lot of physical activity both in the areas of gross and fine motor skills. Moreover, the game was found thoroughly enjoyable and unique. The concept experts unanimously chose *AdventureGame* to be developed into a full video game.

At the next advisory board of experts meeting the concepts of the prototypes and the results of the playtest were presented. *AdventureGame* was very well received by the content and context experts, and the first appointment for playtesting with the target audience was made (and carried out on the 6th of June 2010).

Project Dream

Figure 31: Poster design for *Project Dream* by Meindert Ekkelenkamp.

This section introduces *Project Dream* (Figure 31), the working-title of the game that originally started as a prototype called *AdventureGame*. The game takes players on an adventure in a dream-world in which they cooperatively overcome obstacles. For this adventure they can choose between three different character classes that embody different sets of therapeutic needs:

Figure 32: The sword-fighter, ranged-fighter, and melee-fighter class embody different sets of therapeutic needs.

Sword fighter class: emphasizes activities in the areas of gross and fine motor skills. Sword fighters use the Wii controller to attack enemies when standing close to the television screen, and can defend themselves from enemy attacks and other threats by walking away from the screen. Sword fighters can deal the most damage, but they are also the most vulnerable class to enemy attacks. This class is recommended to players who are able to stand and walk.

Ranged fighter class: this class is more suitable for stationary players (e.g. sitting in a wheelchair) who need to train fine motor skills. They do not need to walk, so they are typically positioned in the back of the (physical) playing field, and can protect themselves from enemy projectiles by holding the Wii remote and (optional) extension controller in front of them as if they were holding a shield. Ranged fighters deal less damage than sword fighters but they have the ability to help the other classes in unique ways, for example by shooting enemies in the eyes which stuns them temporarily. Most in-game activities for ranged fighters revolve around pointing the Wii controller at enemies and objects on the screen.

Melee fighter class: the melee fighter class combines the physical workout of the sword fighter class with the stationary element of the ranged class, and is therefore a suitable class for players who want or need the best of both sides. Contrary to the sword fighter class, a melee fighter uses both hands to fight. Melee fighters can protect themselves just like ranged fighters by holding the controllers in front of them. Players who play this class are typically positioned close to the television.

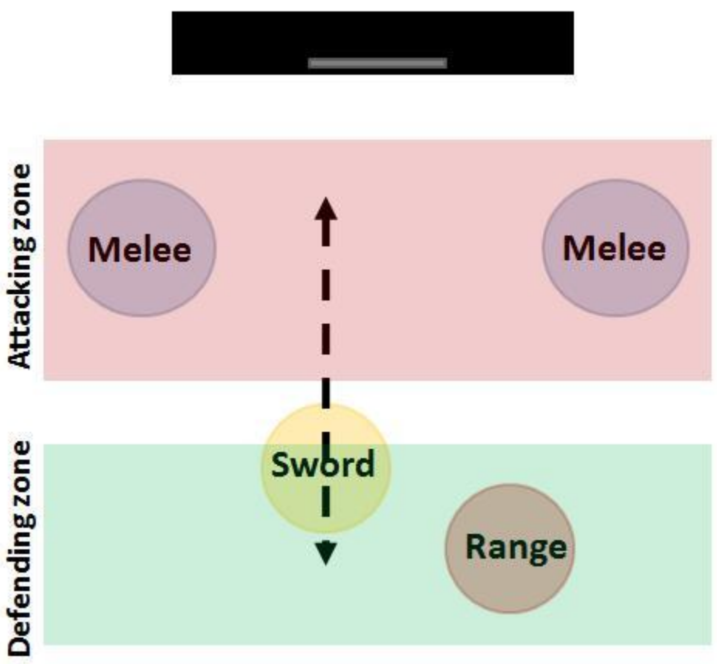

Figure 33: Schema explaining the physical positioning system of *Project Dream*.

The schema in Figure 33 demonstrates how the physical positioning system of *Project Dream* works. By having the IR-sensitive cameras in the Wii controllers measure the distance and angles between four LED lights just below the television, the game is aware of the positions of the players relative to the television screen. This position is compared with a virtual 'grid' that can be calibrated in-game to fit the dimensions of the room in which the game is played. Locations on this grid which are close to the television screen are marked as 'attacking zones' and those that are far away are marked as 'defending zones'. Depending on the physical position of the player different game mechanics are made available, e.g. when standing close to the screen a sword fighter can attack an enemy, but he is also very vulnerable against enemy attacks there. When a sword fighter stands in a 'defending zone' he can avoid the enemy's close-range attacks, but he cannot strike back at the enemy either.

Core mechanics

This section provides an overview of the core playing mechanics of *Project Dream*. These are described in compliance with the standard that was outlined in chapter 2: 1) an in-game action is described as a verb; 2) a reference is given to the context (in-game object) in which the mechanic is used; 3) a reference is given to the control interface; 4) a behaviour is described that needs to be performed to execute the in-game action. The following three core mechanics can be used to resolve most conflicts in *Project Dream*:

<u>Attacking</u>: when the player is standing or moving into the attacking zone he may attack enemies by swinging the Wii controller (fighter class), making a punch gesture with either the Wii controller or the extension controller (melee class), or by aiming the Wii controller at vulnerable parts of the enemy and pressing the 'A' button (ranged class). Contrary to both the fighter and melee class, the ranged class can also execute the attacking mechanic from the defending zone. The success-rate of an attack depends on how well it is timed. The game promotes hitting only when

it really counts (coordinating the frequency of fine motor activities), therefore a time-based attacking system is in place to reward players for not continuously attacking. After every attack a particular player makes a three second timer (called action-timer) is started. Waiting until the action-timer has expired gives the player a much higher damage rate (Figure 34).

Figure 34: The graphical user interface showing the amount of life energy (red bar), status (shield), and action-timer.

Defending: when the player is standing or moving into the 'defending zone' he automatically avoids close-range enemy attacks and can avoid long-range enemy attacks by holding the Wii remote up in front of himself (or both controllers for classes that require two controllers).

Healing: This mechanic restores some life energy of the player it is used on. It can be used by all classes, however, the ranged-fighter class has higher healing-rates than others, providing that player with the cognitive dual-task of keeping track of other players' health-meters while also defending. Healing cannot be used by a player on himself, meaning that players have to look out for each other or ask for help. The action is performed by pointing the Wii controller at the on-screen graphical user interface (displaying the life energy bar and action-timer for every player) at which point the player's cursor will change into an icon depicting adhesive bandage, and subsequently pressing the 'A' button. Just like the attacking mechanic, healing will cause the action-timer to be started, giving players the meaningful choice of either dealing damage to the enemy or restoring life energy of a player while temporarily putting their own defense at risk.

Figure 35: A video demonstrating the first playable prototype (22 November 2010) of *Project Dream*.
[CDROM Videos/Chapter 3 – PD Internal Test]

Figure 36: A video demonstrating a later design iteration (April 2011) of *Project Dream.*
[CDROM Videos/Chapter 3 – PD Internal Test]

Technology

The key distinctive feature of *Project Dream* is that it essentially projects a part of the game-world on the physical surroundings of the players. The game ‘knows’ where the players are and affords meaningful actions accordingly. No hardware other than what ships with a COTS Wii console has been used to achieve this[29]. Every Wii remote has an infrared-sensitive camera built in, which is normally used for enabling pointer controls. When the IR camera sees the Wii sensor bar, which is typically placed under or on top of the television screen, the Wii software measures the distance between two IR lights from the sensor bar. When the distance between these lights decreases the software assumes that the player is moving away from the television screen, when the distance increases it assumes that the player is moving toward the television. An extra sensor bar can be added to make the IR sensitive camera see four lights, so that when pointing at both sensor bars from an angle it sees these lights in perspective, making it possible to calculate the angle from which the sensor bars are seen (Figure 37).

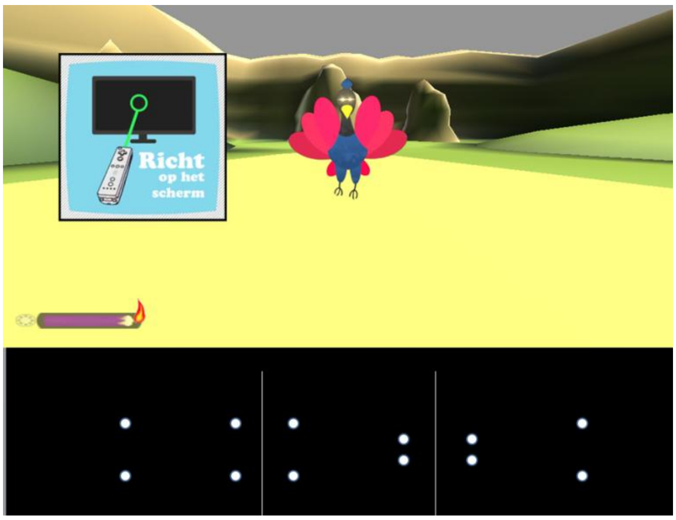

Figure 37: The IR-sensitive camera in the Wii remote is used to determine the player's physical position (front facing, left-side, and right-side).

[29] When this research project started Microsoft’s Kinect peripheral, which is arguably a more suitable technology for determining player positions, was not released yet.

Even when using only one sensor bar it should be possible to estimate absolute positions (using the DOTSIZE attribute of the IR-data that the Wii remote reads), but the open-source Wii remote library that is used for *Project Dream* does not provide the attributes needed for that. The motion gestures used in *Project Dream* are fairly simple to detect and do not require complex technical solutions. Every gesture can be decomposed into accelerations and directions and then compared with predetermined thresholds, which works well enough for the purposes of this game. There are three instances in which this technique is used in the game. The attacking mechanic of the sword-fighter and melee-fighter class is activated by testing whether the registered jerk[30] from the Wii controller exceeds a predetermined threshold (this threshold can be adjusted by a therapist). For activating the blocking/defending mechanic the gravity-vector of the Wii controller's accelerometer is tested, and acceleration over time is tested to detect constant waving of the controller, which is used during one of the boss-battles in the game to wipe bubbles off the screen.

Design challenges

Although the first prototype was well received by the advisory board of experts as well as the target audience, some aspects of the design remained unclear during the concept phase of *Project Dream*. One reason for this is that the core mechanics of the game, which revolve around the physical position of the players relative to the television screen, were biased toward the fighter class. As a result new abilities needed to be invented for the other classes to make the game equally interesting for players who cannot walk. One such decision was giving the ranged fighter opportunities to help other players by, for example, shooting both of the enemy's eyes which leaves it temporarily defenseless. All obstacles in the game need to be designed in such a way that every player-class has its own advantage against it, but never completely overpowers it. The design also needs to cope with the possibility that the game will be played by four players who all want to play with the same character-class, and still offer fair winning chances. Another particularly interesting

[30] Jerk is a scientific term for the change in acceleration over time.

challenge is developing good socio-emotional patterns. The reason for this is that the link between game mechanics and socio-emotional behavioural outcomes is not as clear as with motor skills. For example, when giving four players the choice to award one player with a special ability, one cannot predict accurately how the decision will be made. It is possible that the players give it to someone who earned it, or to someone who really needs it. The decision could also be made by voting. In other words, the interesting behavioural outcomes are quite unpredictable. Finally, one of the biggest challenges is making the difficulty of the game scalable to individual users. For some players fine motor skills such as pointing are a therapeutic need, but maybe fine motor skill disorders prevents them from aiming accurately. Therefore, some kind of aiming-assist option would be helpful. Some players, who have slow reaction times, might not be able to cope with the speed of enemy attacking patterns, while other players in the same playing session can cope with them easily. In the case of *Project Dream* this is solved by notifying those with slower reaction times earlier about enemy attacks.

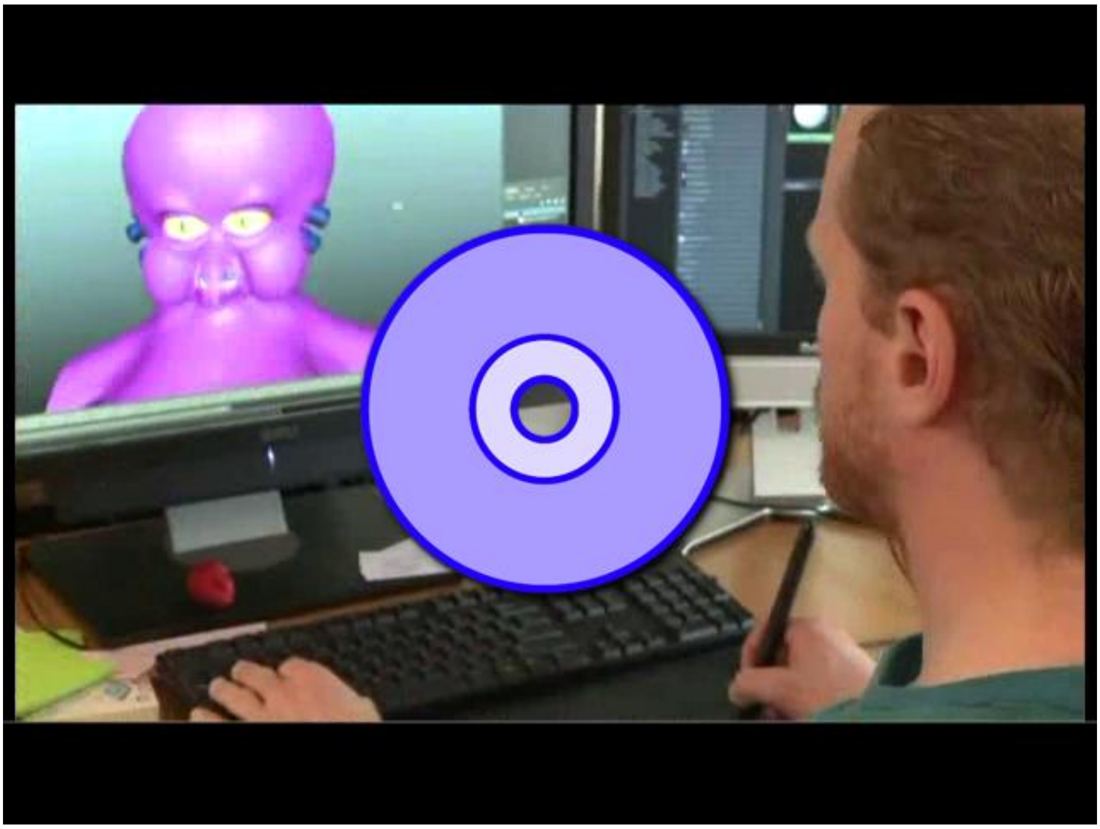

Figure 38: Video clip from *Game Play* (AGD 2011), *Project Dream* in development. [CDROM Videos/Chapter 3 – Development]

Chapter 4: Case study design and implementation

Research method

In the introduction of this exegesis the research problem that deals with the examination of a design strategy for predicting and producing behavioural outcomes was introduced. This led to the formulation of the following research question:

What are the advantages and disadvantages of using a design strategy that emphasizes mechanics and interactions over content?

From this research question the following objectives emerged:

- Establish a working definition for the term *game mechanic*;
- Outline the design decisions for selecting appropriate mechanics and interactions that produce intended behavioural outcomes;
- Propose a playtest strategy for validating design decisions;
- Evaluate the design strategy by linking outcomes back to mechanics and interactions.

The nature of this design problem suggests a research strategy that is appropriate for exploratory analysis. For the purposes of this study and to address this research problem, a multi-method case study has been chosen, framed around the early design phase of *Project Dream*, an applied video game for the rehabilitation of children with an acquired brain injury.

Justification

According to Denscombe (2007) case studies have become very widespread in social research. The design process of *Project Dream* makes for suitable candidate for a *single-case study* on the basis of the case study strategy's distinctive features (Denscombe 2007, 35):

- Spotlight on one instance: the practical component of this MPhil research project benefits from particular and practical insights rather than general ones. An in-depth exploration of an applied game design strategy for therapeutic effect requires a thorough understanding of the specific requirements that the design must meet;

- In-depth study: designing an applied video game is a complex activity. As with many design practices "there is no direct path between the designer's intention and the outcome" (Benneth 1996: 175). It involves recurrent shifts of focus between the detailed and the whole, the concrete and the abstract (ed. Kuittinen and Holopainen 2009: 2, Löwgren and Stolterman 2004: 17). Therefore, the research benefits from in-depth analysis;

- Focus on relationships and processes: in practice game design is a highly collaborative activity (Adams 2003: 148); sometimes design decisions have to change in order to accommodate the development process (Fullerton et al. 2004: 384). This study benefits from a detailed examination of the processes by which mechanics and interactions are selected, and also modified, in relation to a given set of therapeutic outcomes;

- Natural setting: this study attempts to argue the value of a design strategy in practical terms, with the aim of generating operational knowledge that can potentially be applied to (other) applied game development processes. However, applied game design does not lend itself well for controlled experimentation, because the contextual conditions of a real applied game development scenario (e.g. technical problems, missing milestones) are considered to be instrumental;

- Multiple sources and multiple methods: the applied game design activities under scrutiny require different research methods for inquiry. The case study method encourages (Denscombe 2007: 45) the use of multiple methods and data sources, as well as combining quantitative and qualitative methods. For this MPhil project, action research principles are combined with the playtest method.

The practical work of the research project, an applied video game for the rehabilitation of children with an acquired brain injury, serves as a "typical instance" (Denscombe 2007: 40) of applied game design as it is a very apprehensible example of a video game that produces socially relevant behavioural outcomes. Although it is specifically aimed at the treatment of ABIs, the competencies that the game trains are also relevant for other developmental disorders such as autism and Asperger.

Case study design

This section outlines the strategies used to address the validity and reliability of the research design in compliance with Yin's (2003: 34) design quality tests.

Validity

Construct validity: entails "establishing correct operational measures for the concept being studied" (Yin 2003: 35). In the case of the design of an applied video game there is the design thinking processes under scrutiny for which the action design method has been chosen. For the testing of the design the playtest method is used with the purpose of gathering quantitative data insofar the behavioural outcomes that the game brings about are observable, in conjunction with the semi-structured interview method for gathering qualitative data for those outcomes that are not susceptible to observation. The unit of analysis for the playtests is the frequency of occurrences of behavioural outcomes within a single game session.

External validity: means to "establish the domain to which a study's findings can be generalized" (Yin 2003: 35). The context in which this research project is embedded is a therapeutic one, serving as an exemplary case. Therefore, findings from this study can potentially be generalized to the whole class of applied video games for therapeutic aims. As such, this case study aims for analytical generalization rather than statistical generalization.

Reliability

According to Yin (2003:35) a good case study should demonstrate that "the operations of a study—such as the data collection produces—can be repeated, with the same results". The general way of addressing the reliability problem is to document the steps and procedures by which observations are made in detail. To meet this criterion a case study protocol (Appendix C section Case study protocol) was written which contains extensive instructions as well as observation and interview guidelines. This research protocol was shared with colleague researcher Lies van Roessel (who did not take part in the design process of *Project Dream*) who assisted with the playtest observations and conducted several interviews with playtest participants.

Implementation

Although the case study strategy is useful to explain the nature and scope of the research project, it does not prescribe guidelines for the collection, analysis, and interpretation of data. The research project consists of two distinct phases[31] that benefit from different research methods:

<u>Design phase</u>

This phase consists of the processes for the selection and implementation of appropriate game mechanics and interactions with regard to a given set of behavioural outcomes. Its inherently collaborative (Adams 2003: 148) as well as iterative nature, combined with the active role of the researcher as the lead designer, provide justification for using "action research" in which "the two processes of

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[31] Although design phase and testing phase are mentioned the design process is typically cyclic in nature, which entails that design decisions are iteratively *tested*, *evaluated*, and *revised* (Fullerton et al. 2004). In this case the design process was iterative but the research process was sequential.

research and action are integrated." (Somekh 1995 cited Denscombe 2007: 124). The action research strategy is crucial for achieving research objective number 2:

> *Outline the design decisions for selecting appropriate mechanics and interactions that produce intended behavioural outcomes.*

Testing phase

For this phase a modified version of the playtest[32] method was used for the collection of data with regard to behavioural outcomes, combined with the semi-structured interview method for obtaining qualitative data about the clarity of the video game prototype. The combination of these two methods was chosen in fulfillment of the last research objective:

> *Evaluate the design strategy by linking outcomes back to mechanics and interactions.*

Action research

Action research is a preferred method when the study involves practical issues. It is unique in the sense that application of research findings and practice itself become part of the research cycle. The action research method is appropriate for scrutinizing the design thinking process of *Project Dream* because of the method's following distinctive features (Denscombe 2007: 123).

Practical: action research works well with real-world problems and issues. The design decisions made for *Project Dream* have serious implications as the game has therapeutic aims. The game is developed by a professional team of developers and tested within a clinical environment with the actual target audience. It is the practice of designing applied video games which is the subject of study.

Change: the activity of designing iteratively produces constant change, which is regarded as an integral part of action research.

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[32] Rather than testing whether the game achieves the intended player experience goals (Fullerton et al. 2004: 248) we are more interested in whether the intended behavioural outcomes are achieved.

Cyclical process: game design by nature is a cyclical process in which design decisions are conceived, implemented, tested, and evaluated (see Chapter 3 section The game design process). As such, it shows congruency to the action research cycle (Figure 39).

Participation: the researcher and author of this exegesis is both project lead and game designer of *Project Dream*. Active participation allows for a focus on the processes and relationships that lead to changes in design.

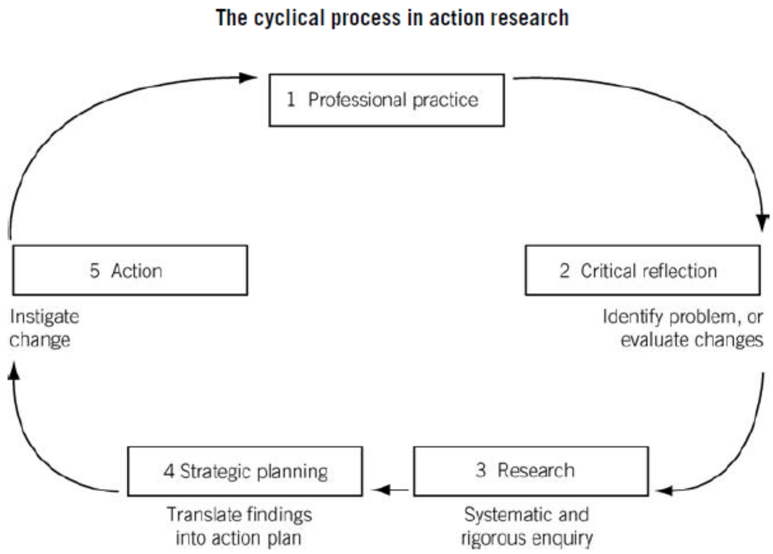

Figure 39: The cyclical process of Action Research (Denscombe 2007: 126)

Data is collected by meticulously documenting the design activities that were made over the course of the study. The cyclical process in which design decisions are conceived, implemented, tested, and evaluated finds its realization predominantly in the production-related reviews and meetings with those who are actualizing the design. In many cases game content needs to be created even though the exact design specifications for it (e.g. the speed and duration of a 3D character animation in relation to the pacing of the game) are not determined in advance. In other words, design decisions are often made in conjunction with content specialists such as 3D animators, sound designers and graphics artists.

Playtests

"Playtesting is the single most important activity a designer engages in, and ironically, it is often the one designers understand the least about" (Fullerton et al. 2004: 196). It is also a design activity that should be performed throughout the entire design process (ibid.). The purpose of playtesting is often confused with that of quality assurance and accessibility testing, but in *Game Design Workshop* (Fullerton et al.: 196) playtesting is defined as "something the designer performs throughout the entire design process to gain an insight into how players experience the game". The player experience goals are of great concern, but for the purposes of this study the playtest method is customized to collect quantitative data in order to determine whether a video game's intended behavioural outcomes are achieved. The unit of analysis is the frequency of occurrences of behavioural outcomes (e.g. the amount of button presses during one play session). The procedures for observation are included in the case study protocol (section Guidelines for playtest observation). The playtest data is captured by means of video recording.

Semi-Structured Interviews

For capturing behavioural outcomes that are less susceptible to observation (such as player decision-making and interpersonal dynamics) the semi-structured interview method is used. Semi-structured interviews generate qualitative data and the unit of analysis is words.

> "With semi-structured interviews, the interviewer still has a clear list of issues to be addressed and questions to be answered. However, with the semi-structured interview the interviewer is prepared to be flexible in terms of the order in which the topics are considered, and, perhaps more significantly, to let the interviewee develop ideas and speak more widely on the issues raised by the researcher. The answers are open-ended, and there is more emphasis on the interviewee elaborating points of interest" (Denscombe 2007: 171).

The interview data is captured by means of audio recording.

Research ethics

Because the playtests and interviews involve children in rehabilitation therapy, special care needed to be taken with regard to consent. Participation in the research was voluntary but the children's parents were asked to agree with an informed consent for collaboration, of which the implementation was handled by the rehabilitation center. The therapists were informed beforehand about what was going to be tested and what the predicted behavioural outcomes were. The selection of participants was based on diversity in therapeutic needs (Figure 40), which resulted into a group of 23 children within the age group of 8 – 16 with acquired brain injuries. For the pilot playtest (conducted on 21-06-2010) permission was obtained from all participants to use pictures and video material for presentational purposes. However, for the playtest that was carried out the 22nd of November permission was obtained for using video and audio recordings only for research; not for publication.

Figure 40: Participants of the pilot playtest [21 June 2010, De Hoogstraat] (used with permission)

Chapter 5: Case study analysis and interpretation

This chapter outlines how the data collected from the case study was analysed and interpreted with regard to the research objectives. For this, the following activities were undertaken: preparation of the data (audio and video transcriptions), initial exploration of the data (relevant information with regard to the research information was highlighted), analysis of the data (relevant information was grouped, represented in charts), representation and display of the data (appropriate expressive forms have been selected for visualizing the data), validation of the data (the results are compared with the theory described in Chapter 2: Applied video games in health care) (Descombe 2007: 252).

Playtest data

Figure 41: Video clip from *Game Play* (AGD 2011), playtesting *Project Dream* at De Hoogstraat. [CDROM Videos/Chapter 4 – Playtest]

During the time period on which this research project is focused, four playtests were conducted at different rehabilitation centers (of which one was a pilot playtest that is excluded from this data analysis). The purpose of these playtests was to validate whether particular game mechanics produced the intended behavioural outcomes. After subsequent prototype revisions, each addressing different issues that were highlighted by other playtests, new tests were conducted to determine whether the new design decisions had effect.

The playtests were recorded on camera from a perspective in which all players as well as the television screen were clearly visible. Although the intention was to bring three cameras, one camera filming from a high angle was found to be sufficient. The transcription of the video material was carried out by counting occurrences of specific behavioural patterns on an observation sheet (Appendix C section Playtest observation sheet). Figure 42 shows a sample of a filled in observation sheet.

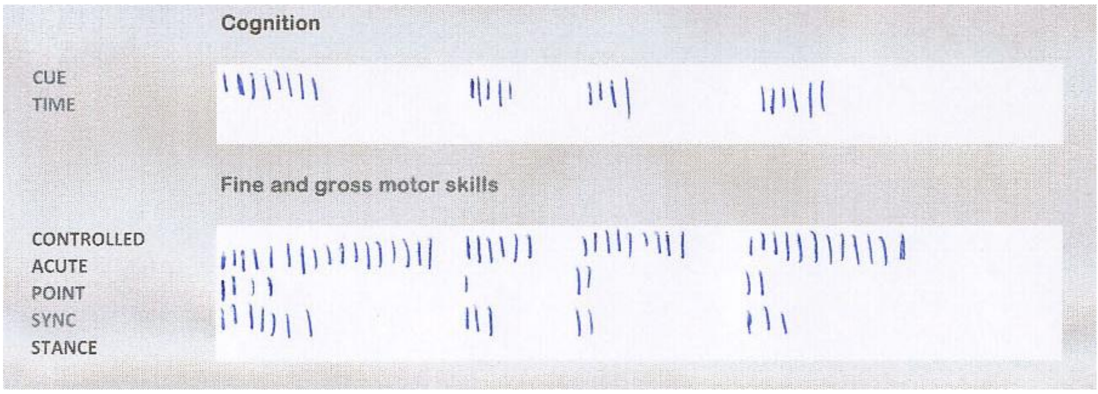

Figure 42: Playtest Observation Data Sample

As explained in the Case Study Protocol (Appendix C section Case study protocol), the keywords on the left refer to behavioural patterns that can be observed and counted. Both videos of the players and game are necessary to see in which context the player used a mechanic. When represented in a line-chart, the measurements from the playtest reveal interesting trends. For these charts following keywords are used:

ACUTE the player performs an acute fine motor activity with the controller;
CUE the player performs an activity after an explicit visual or audio cue;
POINT the player uses the controller to aim at the Wii sensor bar;
SYNC the player uses the controller (and extension controller) to block;
TO BACK the player moves away from the television screen;
TO FRONT the player moves toward the television screen;

The horizontal axis of the charts represent the battle sequences (repeated play sessions) that have been completed. The vertical axis represents the frequency of occurrence of the activity that is specified by the keyword.

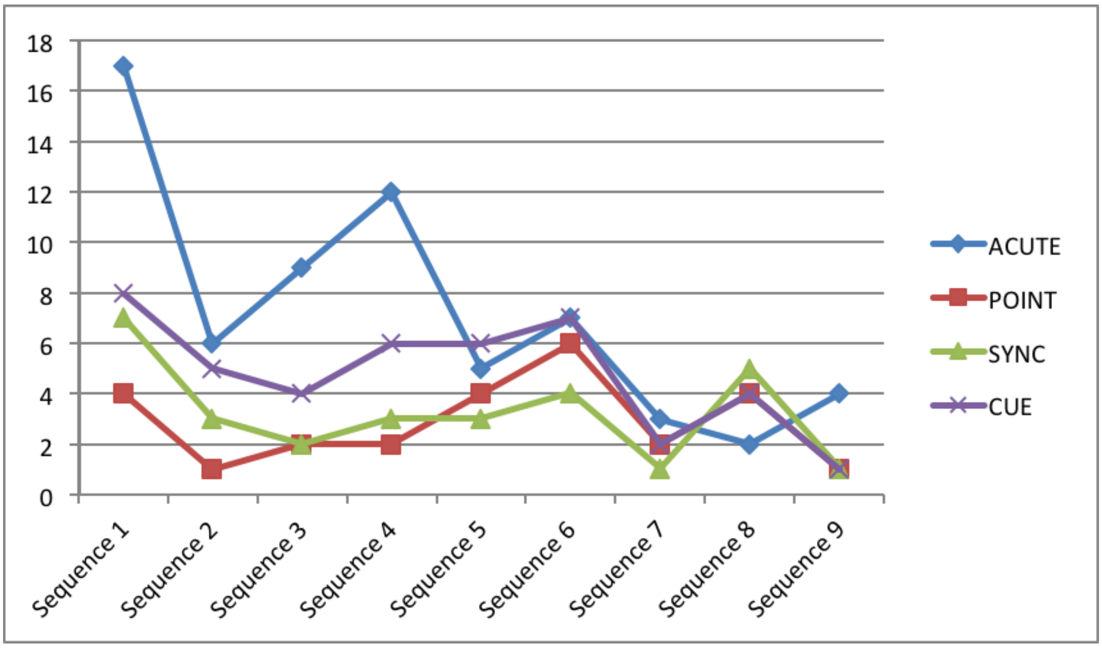

Figure 43: Diagram showing occurrences of behavioural outcomes for a standing / walking person.

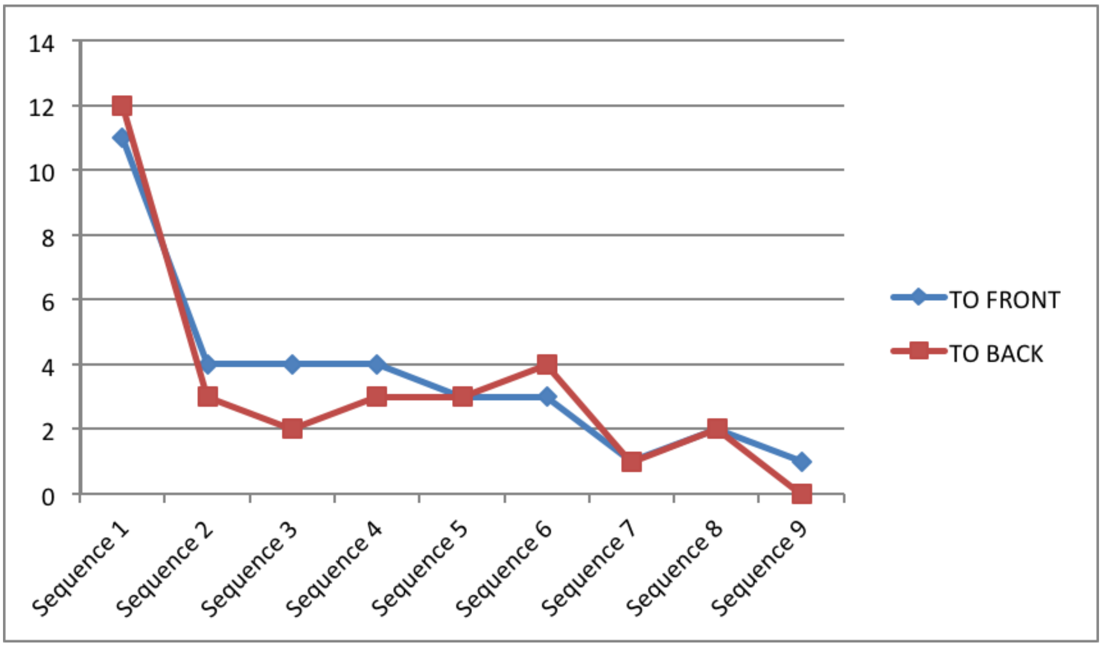

Figure 44: Diagram showing changes in distance in relation to the Wii sensor bar for a standing / walking person.

The horizontal axes in the two diagrams (Figure 43 and Figure 44) represent the battle sequences that the players engaged with. A battle sequence starts when an enemy appears on screen and ends when the enemy disappears. In the current example 9 battles were fought against the same enemy. Although not all measurements are very useful (e.g. walking to the front and walking to the back could be combined), they do reveal that in general activity decreased significantly over time, notwithstanding occasional peaks. This tells the game designer that something in the game is broken, it does not sustain activity. It is then the task of the designer to address this problem; refine game mechanics and playtest again and again until the negative trend is resolved. The next three sections present playtest results from three different rehabilitation centers: De Hoogstraat, Mytylschool, and Blixembosch. Each playtest addresses issues that were highlighted in the one playtest, with the purpose of sustaining desired behavioural patterns over time.

De Hoogstraat

The playtest at de Hoogstraat was conducted on the 22nd of November 2010 and involved 8 children with an ABI, some in wheelchairs and some who were able to walk. Of two players (player 1, sitting in a wheelchair, and player 2 who was able to stand) the behavioural patterns are captured in line-charts. Only WALK (moving into or out of the attacking zone), POINT (pointing at the sensor bar so the game knows the player's position), and ATTACK (acute fine motor control activity that triggers the attacking game mechanic) were found useful for further analysis.

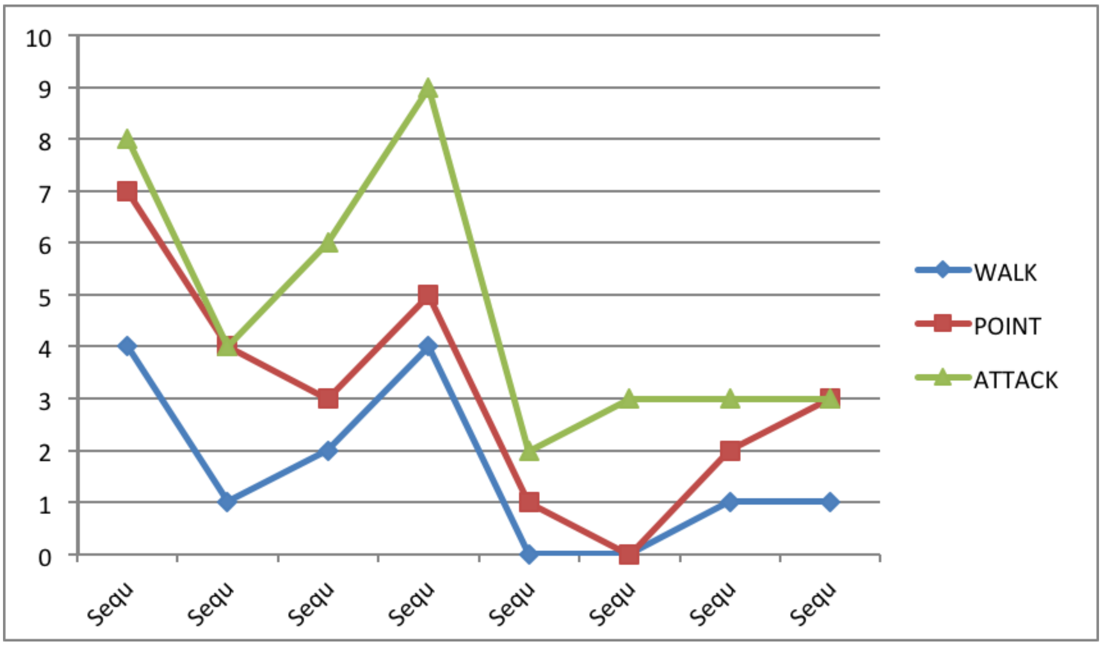

Figure 45: De Hoogstraat, player 1 (transcript)

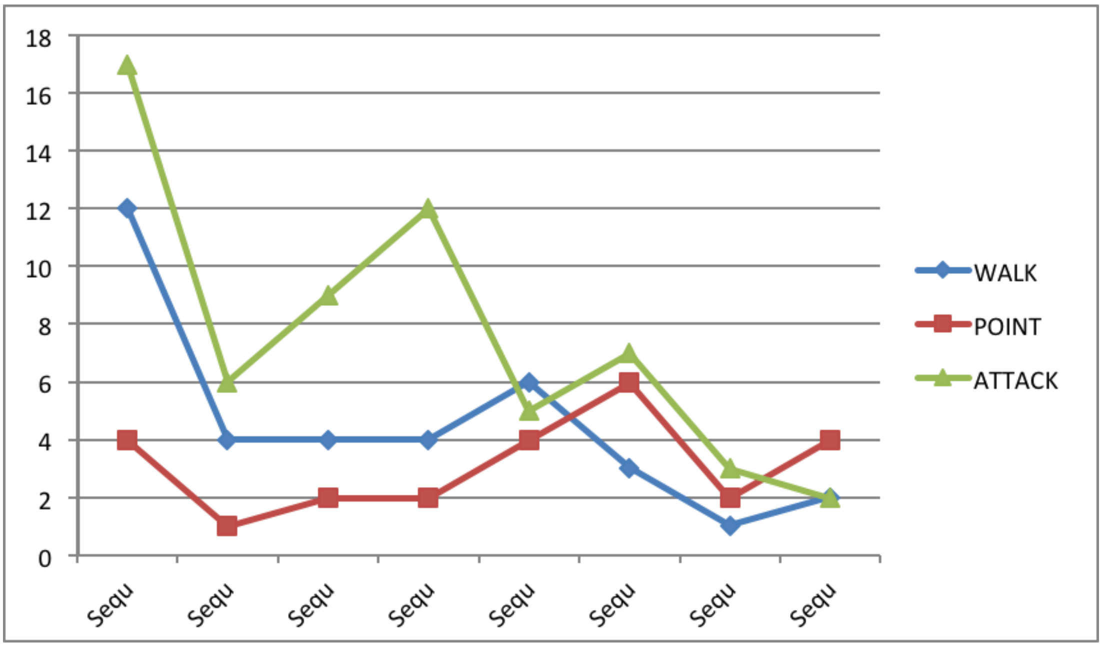

Figure 46: De Hoogstraat, player 3 (transcript)

Both diagrams (Figure 45 and Figure 46) show an overall decline in physical activity. From the results it seems that players do not point in the general direction of the sensor bar often enough, which is necessary for the game to know what the player's physical location is. This may break the gaming experience because correctly performed motions might be registered incorrectly as a result. It might also explain the peak in activity during the fourth battle sequence as players may be trying out different things.

Mytylschool

The playtest at the Mytylschool in Utrecht was carried out on the 2nd of February 2011. Four children contributed to this playtest, all of whom could stand, but one child was reportedly easily distracted. Three significant changes were made in reaction to the results of the playtest from De Hoogstraat (other changes can be found in Appendix C section Mytylschool case study review):

- To stimulate players to point in the general direction of the sensor bar more often, a part of the graphical user interface was moved to the player's cursor, e.g. when players move into the attacking zone their cursor changes into a sword and when they move into the defending zone their cursor changes into a shield. This design decision was made to entice players to keep pointing at the screen to see whether the attack and defense mechanics were available.
- Because the game can be very complex to understand the therapist was asked to play the prototype before the playtest actually took place, so that he can help the children who do not understand how the game works. Having the therapist play along with the children also gives the children an idea of how the game is supposed to be played.
- A new socio-emotional game element was added. After defeating two enemies the players would encounter a wall that could only be destroyed if the players timed their attacks exactly at the same time. This was meant to stimulate interpersonal dynamics and resulted into children starting counting, and helping others to synchronize their actions.

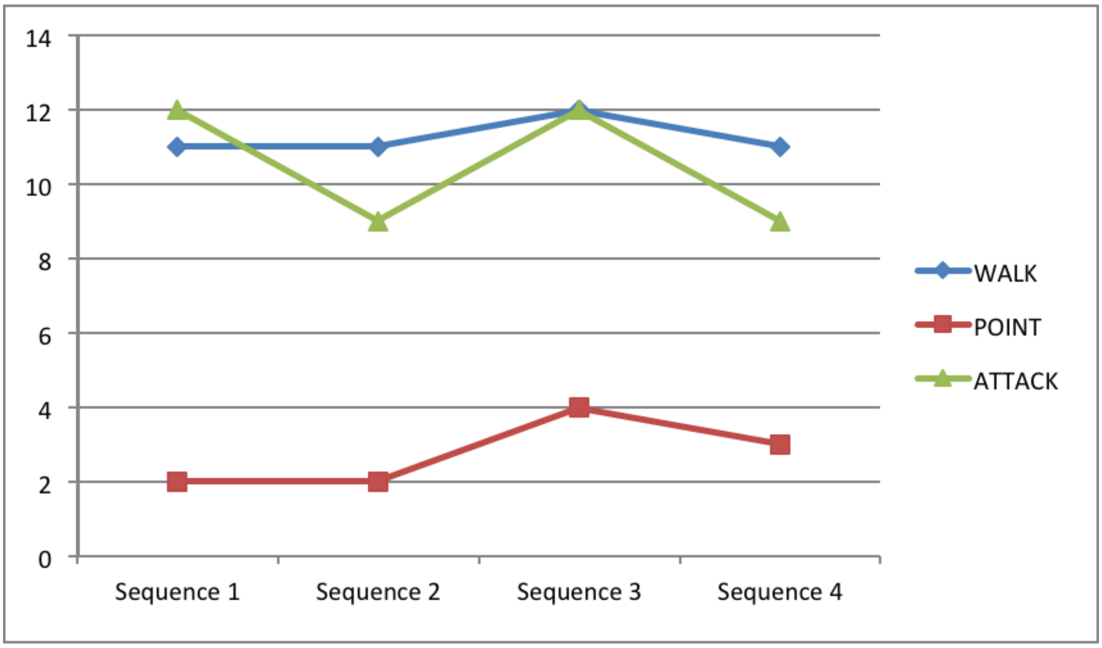

Figure 47: Mytylschool, player in grey (transcript)

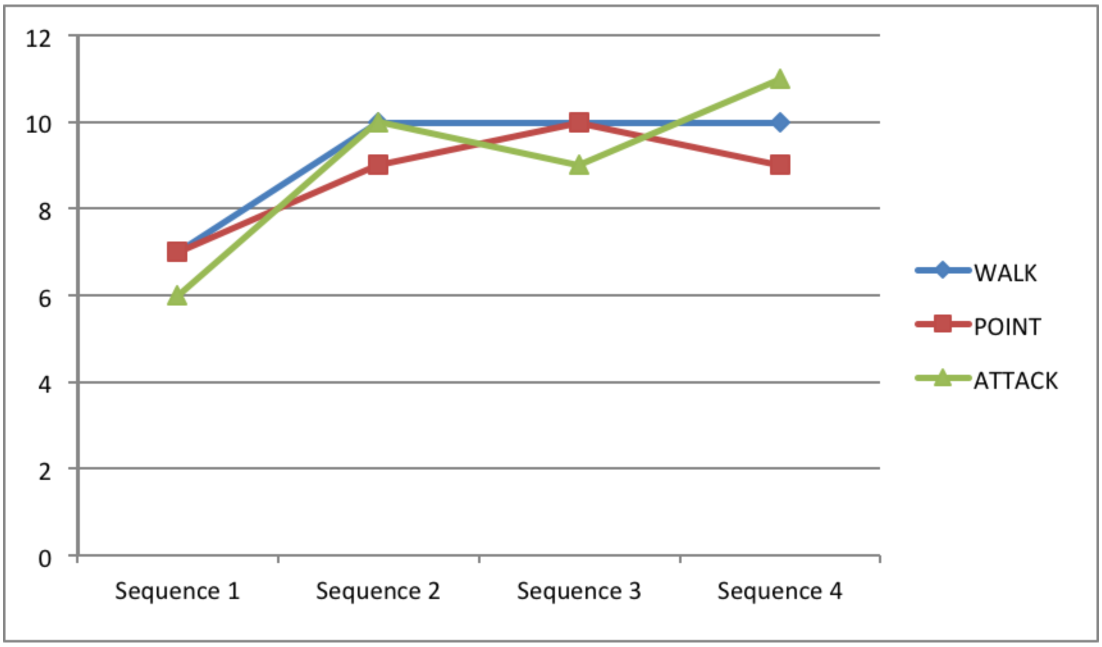

Figure 48: Mytylschool, player in white (transcript)

Although only four battle sequences were played, the results of the playtest showed significant improvements in the area of physical activity compared to the results from De Hoogstraat. This informed the notion that the overall decline in physical activity at the previous playtest was caused by players not pointing at the sensor bar often enough, which means that the game did not do a good job of telling the player why a certain action was not allowed.

Blixembosch

Very soon after the playtest at Mytylschool, another playtest was conducted at rehabilitation center Blixembosch in Eindhoven. This iteration of the prototype contained minimal changes in the areas of visual feedback and balancing of difficulty. The playtest was carried out with four people, of whom one was sitting in a wheelchair.

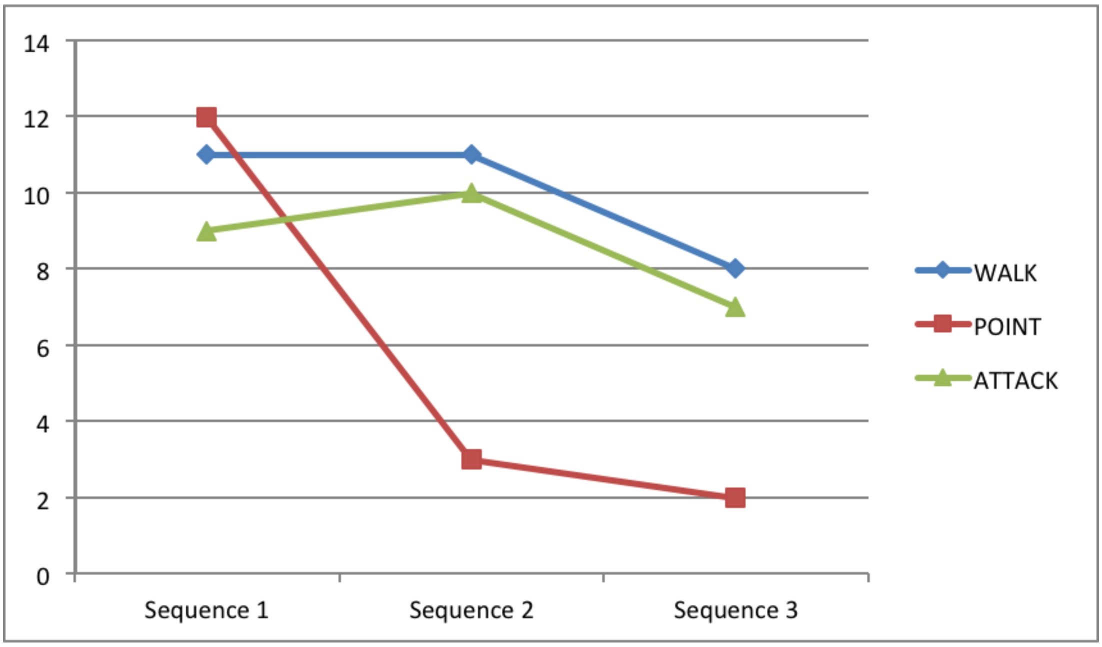

Figure 49: Blixembosch, walking boy (transcript)

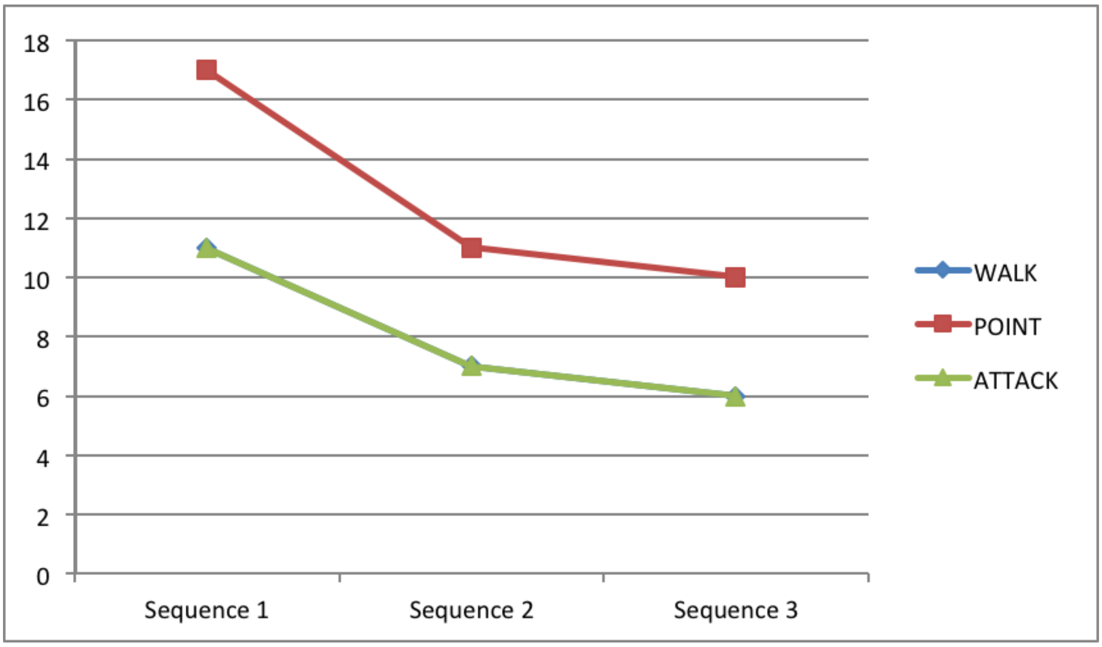

Figure 50: Blixembosch, standing girl (transcript)

Even though only two and a half battle sequences were completed, the graphs again show a decline in physical activity over time. This can be attributed to distracting factors during the playtest, the child in the wheelchair did not understand the game (and did not seem to have the motivation to learn how to play it correctly) and his constant flailing of the controller kept enemies in defensive states. This finding led to the decision that enemy attacking patterns could only be interrupted as a reward by skillful player performance.

Design Activities

Playtesting is said to be one of the most important activities a designer can engage in (Fullerton et al. 2004: 196), but it is not always clear what place it has in the design process. Therefore, using a simple web-based time tracking tool, all design activities for the concept-phase of *Project Dream* were logged over the course of one year (Appendix D section Research log). Subsequently the log entries were colour coded with the intention of identifying different categories of activity within the game design discipline.

2010-04-13	Niels Keetels	1: GATE	Health	Workingstructure mockup maken	0.50
2010-04-14	Niels Keetels	1: GATE	Health	Vervolgmeeting projectstructuur met Micah, Meindert en Richard	1.00
2010-04-14	Niels Keetels	1: GATE	Health	Aan klankbord presentatie werken	1.50
2010-04-15	Niels Keetels	1: GATE	Health	Klankbord voorbereiding + meeting	6.00
2010-04-19	Niels Keetels	1: GATE	Health	Prototype 'video assisted game' maken	5.00

Figure 51: Research Log Sample

The coding process highlighted four distinct categories, consisting of:

- Orange (research & design): prototyping ideas, testing hardware & software, reading reports, brainstorming, conceptualization, finding referential material, transcribing research material. These tasks were performed with the purpose of making informed design decisions. [96 hours]
- Green (presentation & documentation): creating presentations, writing documentation, board of experts meetings, writing newsletters. These tasks were performed with the purpose of disseminating knowledge. [35.9 hours]
- Blue (production & planning): production (programming, audio, visual

artwork) meetings, production planning, design iteration meetings. These tasks were performed with the purpose of actualizing design decisions. [65 hours]

- Pink (playtesting & preparation): prototype testing, prototype programming, playtest preparations, protocol writing, and playtest report writing. These tasks were performed with the purpose of facilitating the testing of the design. [60.5 hours]

From this information a diagram (Figure 52) was generated that provides insight into the breakdown of design activities.

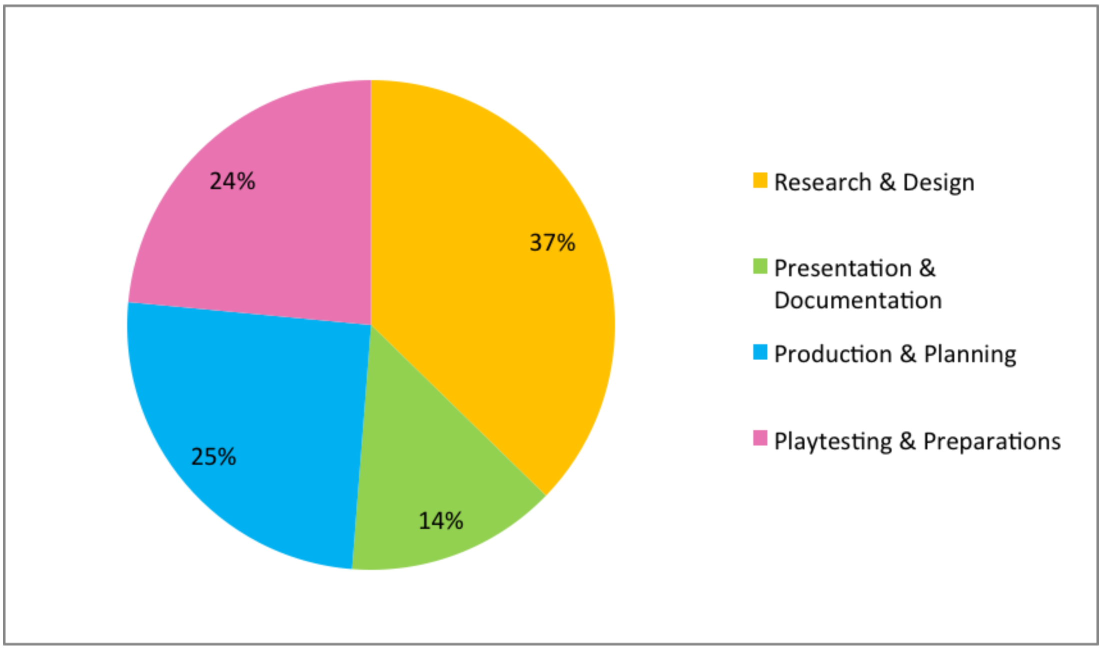

Figure 52: Breakdown of Design Activities

Unexpectedly, almost a quarter the time spent on *Project Dream* during the concept phase involved activities related to playtests.

Interviews

Semi-structured interviews were conducted with playtest participants to capture qualitative data about the game’s socio-emotional mechanics. These interviews were transcribed using mind mapping-software which allows for showing how conversations evolved. Horizontally connected blocks indicate that someone reacted to a previous statement, vertically connected blocks indicate in which order statements were made.

Clarity of mechanics

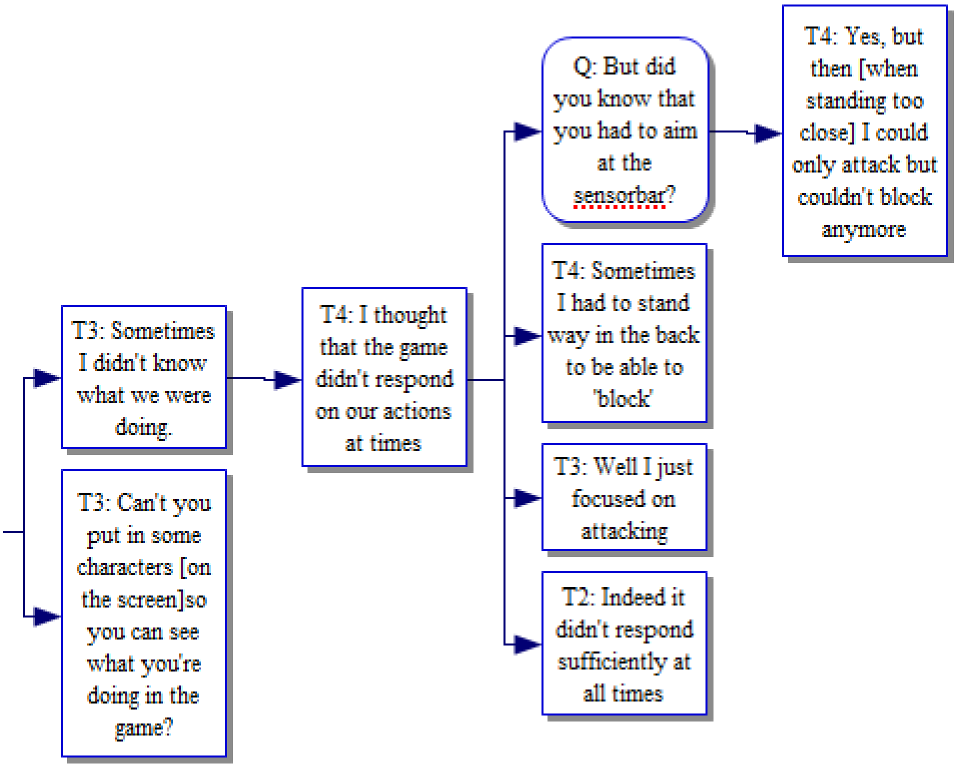

Figure 53: Quote from Interview Transcript 1 about the clarity of core gameplay

The quote (Figure 53) highlights a fundamental problem: the participants felt that the game was either broken or misinterpreted their intentions at times. This correlates with the conclusions made with regard to the results from the playtest at De Hoogstraat. The issue was addressed in the Mytylschool prototype by redesigning the cursor (aiming-reticule) to display available mechanics depending on the position of the player relative to the sensor bar.

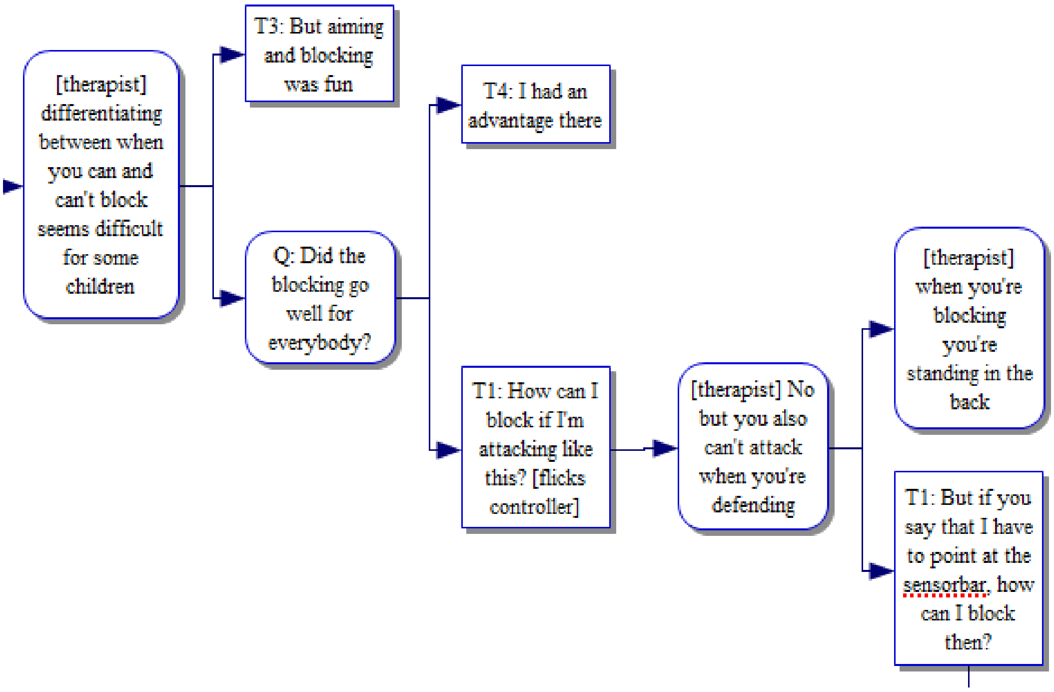

Figure 54: Quote from Interview Transcript 2 about the clarity of core gameplay

An interview from a different playtest-session with different participants highlighted the same issue (Figure 54).

Cooperation

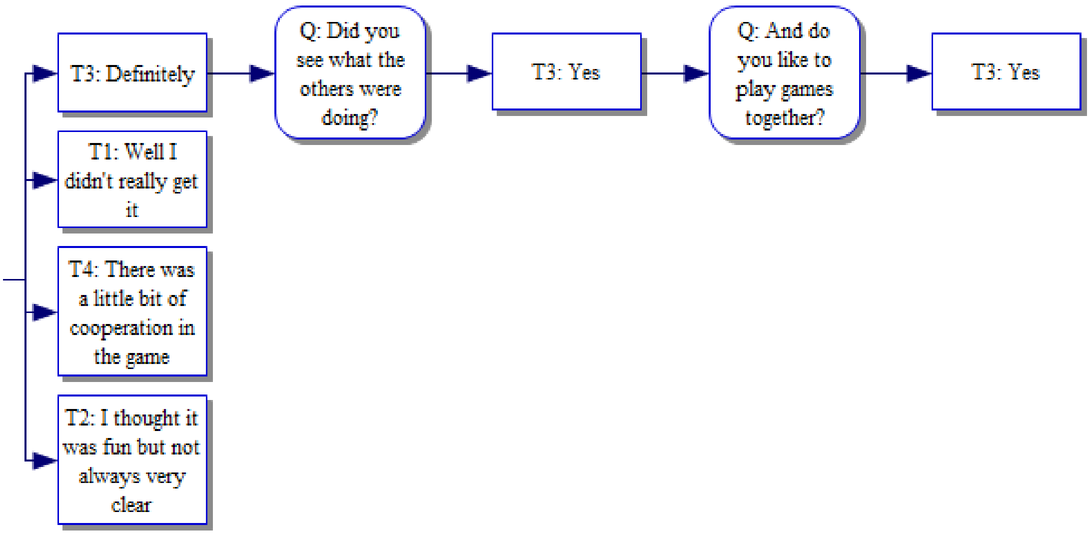

Figure 55: Quote from Interview Transcript 2 about cooperation

Some players had the feeling that they needed to cooperate, even though the socio-emotional mechanic was broken during the playtest at De Hoogstraat.

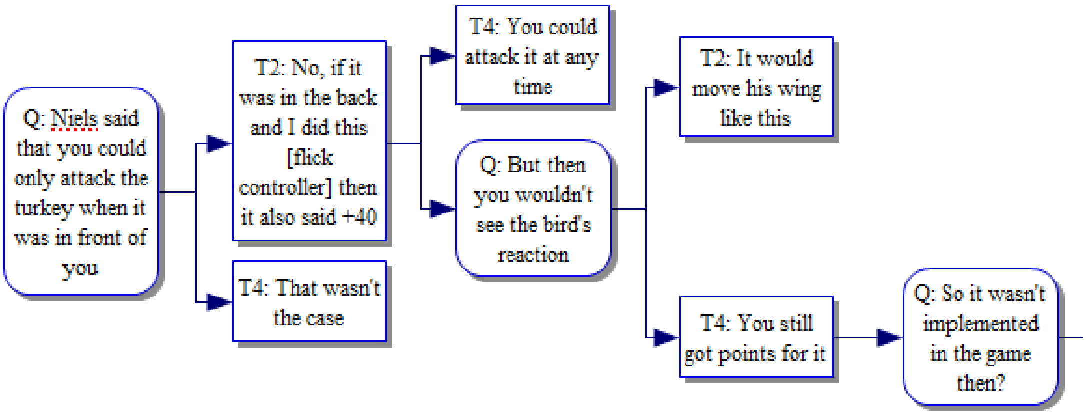

Figure 56: Quote from Interview Transcript 1 about software bugs

The quote from Figure 56 shows that bugs and unfinished features have a good chance of being discovered by playtesters. The lesson learned from this is that you cannot fool playtesters as they will find out any flaws in the game. Since the playtest at De Hoogstraat new iterations of prototypes were tested internally a week ahead of the actual playtest, so software bugs could still be fixed. For the Mytylschool and Blixembosch prototypes different socio-emotional interactions were designed to increase the sense of cooperation among players, by synchronizing their attacks players could deal an extra-large amount of damage to destroy otherwise indestructible obstacles.

Chapter 6: Conclusions and implications

This research project set out to explore a game design strategy for therapeutic effect that is focused on producing and predicting behavioural outcomes. The position was put forward that video games train specific competencies by throwing increasingly complex variations on a central challenge at the player that he or she has to resolve through interaction with the game's mechanics. Thus, a design strategy by which content, context, and game concept parameters are established, appropriate game mechanics are selected, and a meaningful context in which these mechanics are regulated is created, is worth investigating. On the basis of this proposition the following research question was introduced in the introduction of this exegesis:

What are the advantages and disadvantages of using a design strategy that emphasizes mechanics and interactions over rules and context?

From this research question the following objectives emerged:

- Establish a working definition for the term game mechanic;
- Outline the design decisions for selecting appropriate mechanics and interactions that produce intended behavioural outcomes;
- Propose a playtest strategy for validating design decisions;
- Evaluate the design strategy by linking outcomes back to mechanics and interactions.

The first research objective was achieved by consolidating three different perspectives on game mechanics: Mechanics as methods of agency, Mechanics as state transformations, and Mechanics as determinants of . From there, a notation standard was proposed with which game mechanics could be described in a coherent manner. The second objective was achieved in Chapter 2 by explaining how content parameters can be transformed into game mechanics, and this was demonstrated by outlining the design parameters and core mechanics of *Project Dream* in Chapter 3. For proposing a playtest strategy a case study protocol was written, containing instructions for the observation of player behavioural patterns. The data from these playtests was analysed and interpreted in Chapter 4, and used to inform subsequent design revisions until the design goals for *Project Dream* were achieved.

Research methods for applied game design

For this study a variety of investigative techniques were employed to capture the design thinking underpinning *Project Dream*. These were outlined in 'Chapter 4: Case study design and implementation' and also justified with regard to specific research objectives. The intention of this section is not to prescribe specific methods for applied game design in general but rather to discuss them in terms of value and effectiveness for this MPhil project.

Playtesting

The single most useful strategy that was used for this project was playtesting. The way playtesting was used for *Project Dream* was different to how it is often used for commercial game development in the sense that it was customized to improve its reliability as a data collection strategy. The two most important aspects of these customizations were the preparation and writing of the protocol and playtest reports. The protocol described how the data should be captured, analysed and interpreted, in addition to which outcomes were expected. This allowed for tests to be repeated with the same results. The playtest reports described the outcomes from the playtests and linked them to specific design decisions which revealed how small changes in the design sometimes led to significantly different behavioural outcomes. Visualizing outcomes in line charts is useful for demonstrating how this iterative process of testing and refining over time improves the prototypes with regard to the expected behavioural outcomes. Sometimes it can be hard to explain content experts why a certain change in the design was necessary, that is why getting quantifiable results from playtests is valuable. A particular disadvantage of the playtest strategy used in this study is that the transcription process is very arduous and time-consuming. When four children are playing the game a lot is happening at the same time, both in terms of player behaviour and in-game. Fortunately the children seemed to forget the presence of development team members and cameras while playing.

The playtest observation form contained behavioural patterns based on input from content experts; however, a particularly useful improvement would be to base the form on the categories found in the International Classification of Functioning, Disability, and Health[33] (ICF). This would benefit the international game design research community as datasets can be shared between local and international designers and researchers.

Semi-structured interviews

Interviewing children within the age group of 8 - 16 turned out to be much more complicated than anticipated. The interviews were conducted in small groups of four children and they were semi-structured to explore clarity issues with the game in depth. Although the children were encouraged to stray off topic, knowledge and language barriers made it difficult to reflect on the players' experiences and certain children would dominate the discussion. Furthermore, the quality of answers depended largely on who the interviewer was. When the designer asked questions directly the children seemed reluctant to voice negative opinions in general; however, when interviews were conducted in absence of the designer slightly more criticism was voiced regarding the *Project Dream* prototypes. Children may feel that they are criticizing the designer instead of the game. Still, some interview outcomes did not match playtest observations. For example, one particular issue that arose from an interview was that the game was difficult to understand while the in-game performances of the children that reported this did not suggest so at all. This can arguably be attributed to the state that the prototype was in, as its user feedback system (in terms of visuals, audio, and controller vibration) was not yet on the same level as many commercially released video games.

[33] The online ICF browser can be found at http://apps.who.int/classifications/icfbrowser/

An alternative interview approach that potentially avoids some of these difficulties is that of preparing two different prototypes for a playtest and discussing preferences between those prototypes during the interviews. At their age children can have a hard time discussing design choices so it may be worth it to focus more on what they do and do not like.

Transcribing the interviews was also quite time-consuming, it was sometimes hard to tell the children apart from low quality audio streams. Using mind-mapping software to visualize the structure of the conversation helped clarifying the context of the children's statements, but these graphs eventually became too large to print on A4-sized paper without cutting them up.

Colour coding

Colour coding was used as a visual tool to categorize design activities. The colours that were used had been chosen somewhat arbitrarily but for practical reasons it was necessary to choose a small number of very distinct ones. This meant that the categories were generally quite broad, for example, documentation and presentation are two different activities but they were put together in the same category because both are tools for communicating design decisions. Further distinction between some of the categories could have been made using additional colours, but it was not considered necessary because at the detail level some design activities show more overlap. Time logging was done using a web-based tool called 'fourteenDayz'[34] which incurred very little overhead. Colour coding these time log entries also consumed little time since the tool could export the complete log table in a very organized way. In the end, time logging and colour coding were useful strategies for obtaining an overview of how much time was spent on different design activities, but they did not afford enough detail to provide insight into when design decisions were actually made. The reason for this was that design activities overlapped significantly in practice; for example, many design decisions were made during production-related discussions, playtests, and other activities.

[34] fourteenDayz can be found at http://www.14dayz.com/site/

Advantages of the design strategy

The designer has the ability to support design decisions with test results: the playtests that were carried out for *Project Dream* generated relevant quantitative and qualitative data which guided further development of the prototypes, and eventually helped resolving the game's issues.

Problems concerning the effectiveness of the game are discovered early in the design and development process: one of the major risks of applied game development is that validation of the game's outcomes is usually performed at the end of the development cycle. *Project Dream* was designed and tested iteratively with the purpose of sustaining the targeted behavioural outcomes.

The designer only has to be a good game designer: *Project Dream* was realized without extensive knowledge about the treatment of children who sustain an acquired brain injury. The responsibility of defining a comprehensive set of design parameters is shared among content, context, and concept (game design) experts.

It stimulates genre-mixing: although *Project Dream*'s core mechanics borrow from genre conventions, the game's experience is truly novel. It is currently the only game of its kind.

It has the potential to appeal to wider audiences: because the game does not look like a game that is meant predominantly for the rehabilitation of children, people will be playing it with the idea that it is for entertainment in mind.

Disadvantages of the design strategy

It enforces an iterative design process: the strategy only works when frequent testing is possible, because design decisions are most often made with regard to issues that were highlighted by playtests. For *Project Dream* large parts of the game's source-code had to be changed or entirely rewritten to accommodate new design ideas.

The concept phase takes relatively long: it may take several prototype revisions until a design is validated, this means that early development costs are relatively high.

Playtesting is a very demanding task: conducting playtests properly, as well as transcribing and coding the video material takes a considerable amount of time. In chapter 5 it was found that playtesting related activities accounted for almost a quarter of the time spent on this MPhil research project.

Limitations of this research

The conclusions drawn from this research project are based on the findings obtained from a single case study which makes them vulnerable to criticism. One might be inclined to argue that since the design strategy has been developed through action research taking place in the context of children's rehabilitation, it could have an inherent bias toward designing applied video games with a therapeutic aim. Although it is acknowledged that this design strategy may not prove to be as effective for designing games with a different type of outcome, such as an applied video game with a didactical aim, the case study did highlight a number of key lessons that may be applied to the design of any applied video game.

Another potential point of critique regards the lack of comparison with other applied game design strategies. While Ian Bogost's (2007) *Procedural Rhetoric* and Elaine M. Raybourn's (2008) *Simulation Experience Design* were cited as two very distinct design strategies for designing applied video games, strategies from non-academic publications were omitted from the literature review. It should be noted that very few game design strategies from the academic field are actually supported by the type of evidential experience that is required for the proper comparison between different strategies.

Additionally, due to time constraints only four playtest sessions were carried out over the period of 8 months. These sessions were conducted at rehabilitation center De Hoogstraat in Utrecht, the Mytylschool for children with physical disabilities in

Utrecht, rehabilitation centre Blixembosch in Eindhoven, and internally at the Applied Game Design office. Among the participants were 23 children with an acquired brain injury and 4 without. However, it should be noted that this study aimed for analytical rather than statistical analysis; outcomes from playtests were addressed and integrated into new prototypes.

Further research

The design strategy proposed in this exegesis is found to be valuable for generating game ideas that need to satisfy a set of behavioural requirements and its key advantages and disadvantages have been highlighted. However, with the purpose of developing it into an applied game design method a number of areas need further investigation. Firstly, mechanics and interactions for regulating interpersonal behaviour were not adequately investigated in this research project because of a problem with its implementation at two out of four playtests. Second, the design strategy was proven to work with the specific context of children's rehabilitation, other contexts have not been explored. Third, the amount of play sessions (battle sequences) that could be arranged depended on the duration of therapeutic sessions, which varied between different revalidation centers. More consistency in this regard would have produced more reliable data.

Although testing the applied game design strategy for outcomes other than training competencies was out of scope of this exegesis, a highly provisional pilot project was carried out with the aim of exploring the value of the design strategy for didactic purposes. While the MPhil research project was almost reaching its end the author gave a group of seven 3rd year interaction design and game design & development students the assignment to create a game that models the complexities of reaching a parliamentary support agreement (the Dutch model) using a hybrid approach between the *procedural rhetoric* strategy (Bogost 2007) and the strategy outlined in this exegesis. The main distinguishing feature of this approach is that it is not the context that is symbolic, rather it is the game's mechanics and interactions that are modeled after abstractions of real-life phenomena. The students were explicitly told not to use any form of iconic references in the game in order to accentuate the what-you-see-is-not-what-you-get principle, and with the purpose of refraining from editorializing its execution the project was supervised by colleague Lies van Roessel. In three months' time the students designed, developed and tested two game concepts, one of which could be classified as an action game (Figure 57 and the other as a puzzle game.

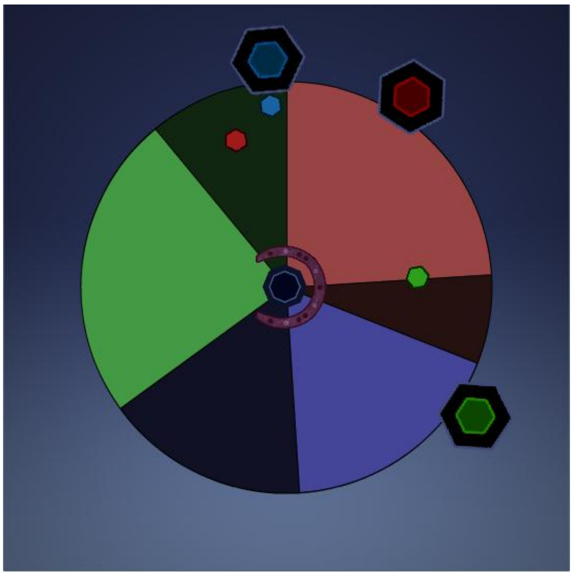

Figure 57: Student project action game prototype

The interesting thing about both prototypes is that they depict the same model, the process of reaching a parliamentary support agreement, but used different mechanics associated with different video game genres. In the action game the core mechanics involved catching and deflecting coloured balls which symbolized acceptance and refusal of different party plans and incentives. The core mechanics of the puzzle game were more complex and involved distributing groups of points across a grid which symbolized the negotiation of political compromises and concessions. One particular finding from this student project was that playtesters were unable to guess what real-life phenomenon these prototypes depicted, which adds to the impression that some form of iconic representation is necessary to guide the contextualization process when designing for didactic outcomes.

Discussion

Conclusions drawn from this study highlighted a topic that deserves to be addressed in this exegesis. This final section is meant to initiate a discussion about the responsibilities of the game designer with regard to the value of the outcomes that an applied game produces. When an applied game design strategy is focused on simulation, the game designer has to familiarize themselves with fields of knowledge other than his own, to the point where he becomes an expert in a small area that is only of temporary relevance for the particular game. Adversely, the design strategy that is presented in this exegesis only requires tacit knowledge about game mechanics and interactions, which can be acquired by designing games.

In the case study it was the advisory board of experts that determined what the behavioural outcomes should be, and the game designer was responsible for designing an applied game that produced these outcomes. The playtests were carried out only with the intention of validating the design; to determine whether or not the game's mechanics and interactions brought about the intended player behaviour patterns. The tests were not designed to examine the therapeutic value of the game, which is something therapeutic experts can determine much more effectively. This means that context experts are not only responsible for explicating the desired outcomes in sufficient detail, but also for examining the value of these outcomes. It follows therefore, that a game designer should only be responsible for designing good games. To this extent he should carry out the necessary tasks to ensure that the game meets its intended outcomes, without bearing responsibility for the value of these outcomes [insofar as ethics allow] .

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Appendix A: Tables and figures

Serious games taxonomy

	Games for Health	Advergames	Games for Training	Games for Education	Games for Science and Research	Production	Games as Work
Government & NGO	Public Health Education & Mass Casualty Response	Political Games	Employee Training	Inform Public	Data Collection / Planning	Strategic & Policy Planning	Public Diplomacy, Opinion Research
Defense	Rehabilitation & Wellness	Recruitment & Propaganda	Soldier/Support Training	School House Education	Wargames / planning	War planning & weapons research	Command & Control
Healthcare	Cybertherapy / Exergaming	Public Health Policy & Social Awareness Campaigns	Training Games for Health Professionals	Games for Patient Education and Disease Management	Visualization & Epidemiology	Biotech manufacturing & design	Public Health Response Planning & Logistics
Marketing & Communications	Advertising Treatment	Advertising, marketing with games, product placement	Product Use	Product Information	Opinion Research	Machinima	Opinion Research
Education	Inform about diseases/risks	Social Issue Games	Train teachers / Train workforce skills	Learning	Computer Science & Recruitment	P2P Learning Constructivism Documentary?	Teaching Distance Learning
Corporate	Employee Health Information & Wellness	Customer Education & Awareness	Employee Training	Continuing Education & Certification	Advertising / visualization	Strategic Planning	Command & Control
Industry	Occupational Safety	Sales & Recruitment	Employee Training	Workforce Education	Process Optimization Simulation	Nano/Bio-tech Design	Command & Control

Figure 58: Serious games taxonomy (Sawyer and Peter 2008)

Games for health taxonomy

	Personal	Professional Practice	Research / Academia	Public Health
Preventative	Exergaming Stress	Patient Communication	Data Collection	Public Health Messaging
Therapeutic	Rehabitainment Disease Management	Pain Distraction CyberPsychology Disease Management	Virtual Humans	First Responders
Assessment	Self-Ranking	Measurement	Inducement	Interface/Visualization
Educational	First Aide Medical Information	Skills / Training	Recruitment	Management Sims
Informatics	PHR	EMR	Visualization	Epidemiology

Figure 59: Games for health taxonomy (Sawyer and Peter 2008)

Appendix B: *Project Dream* materials

Embedding the game into therapeutic practice

One of the reasons why context experts are crucial for the design of an applied game is to gain acceptance for the game's use in therapeutic practice. Although the embedment plan of *Project Dream* is beyond the scope of this MPhil research project, it does inform certain design decisions that incorporate important content and context design parameters. One such decision is that the duration of a play session, from starting the game until finishing a level, should not exceed 20 minutes. This affords revalidation therapist with sufficient time to discuss training goals with patients and evaluate treatment outcomes. Another design decision that was made to satisfy the contextual conditions of therapeutic practice is that players should be able to drop out of the game and rejoin at any time without pausing the game or putting the other players at a disadvantage.

Game and player-class customization

With the aim of addressing the main limitation of using COTS video games for therapeutic practice (see Chapter 2: Commercial off-the-shelf video games for rehabilitation), *Project Dream* affords the ability to customize game and player-class settings to fulfill specific therapeutic needs without interrupting the play session. For example, the precision with which an individual player needs to aim can be adjusted to his or her physical abilities. Although the exact specifications are not planned yet, this could be achieved by a direct-link connection between the game and a smartphone or tablet device. At the same time these touch-screen devices allow for runtime monitoring of use.

Domestic use

One of the key parameters for the design of the game is the ability to extend treatment toward domestic use. For this, the 16kb of EEPROM[35] storage in the Wii controller is used to store player progress and customization settings, allowing patients to carry their personalized game-data between therapeutic setting and home environment. The therapist would also be able to establish treatment goals and save them to the controller. At one of the advisory board of experts meeting the view was expressed that therapists prefer to think in terms of skill bandwidths rather than absolute values, which is something that had to be accounted for in the design. An example of how this might be used is that the therapist sets the goal for a patient to achieve an attack or defense between 40% and 70%.

[35] EEPROM stands for Electrically Erasable Programmable Read-Only Memory, which can be used to store small amounts of data.

Playtesting competencies letter

The following text was sent out to therapists when arranging playtests.

The Applied Game Design programme is currently working on an 'applied video game' for the Nintendo Wii that can be used for the rehabilitation of children with an acquired brain injury (ABI) within the age group of 8 – 16. The game is designed to aid with the rehabilitation of motor, social-emotional, and cognitive skills, both in the clinical and domestic environment, and is particularly useful for (small) group therapy. Although for the player the game seems like a fun action/adventure game that does not appear to serve any particular purpose other than to entertain, it actually produces outcomes that satisfy several therapeutic goals through play and interaction. The game carries the working title *Project Dream*, and its core gameplay involves position-sensitive activities; the game knows where the players are in the physical space which forms the primary control method. When designing the video game a specific set of therapeutically desired or interesting outcomes were identified, such as walking to a specific place to train dynamic balance, and these outcomes were subsequently transformed into meaningful actions within the context of the game (game mechanics). The design philosophy underpinning *Project Dream* is that game design essentially means designing player behaviour.

Playtesting

The 'playtest' is a common method used in the video game industry to verify whether the target audience for which the game is developed thinks a video game is fun. For this research project however, it is adopted and modified with the purpose of validating design decisions. This is done, for example, by testing whether the designed game mechanics actually bring about the intended player behaviour patterns. For this reason it is desirable to playtest with the target audience already in the early design phases of the game.

Key areas of interest for playtesting

For the prototype that is currently in development the game mechanics regarding static and dynamic balance are the most important to playtest. The prototype revolves around a combat scenario in which the players need to cooperate to defeat an enemy. The predicted behavioural patterns are outlined below:

A	Standing still with or without axillary crutches
B	Walking with or without axillary crutches toward the television
C	Walking with or without axillary crutches away from the television

Behavioural pattern A is meant to train static balance whereas patterns B and C are meant to train dynamic balance. The following game mechanics are designed to produce these outcomes:

1	Moving into the attacking zone	B
2	Moving into a defense zone	C
3	Standing into a defense zone	A

In addition to static and dynamic balance, the game also regulates fine motor skills such as aiming/pointing and making a ‘slashing’ motion.

A	Controlled throwing / hitting motion
B	Acute throwing / hitting motion
C	Pointing at the screen
D	Synchronizing the movement of both arms
E	Assuming a posture

These patterns are regulated by the following game mechanics:

1	Defend by holding Wii remote + nunchuck up in the air	D,E
2	Attack as a sword-wielder	B
3	Modify the status of another player (i.e. healing, shielding, etc.)	C, E

Participation

With the purpose of playtesting the game we ask for a specific set of abilities from testers. A candidate needs to be able to move in physical space (with or without axillary crutches), and should be capable of pointing at the television screen with the Wii remote. He or she should meet the following requirements:

- Between 8 and 16 years old
- Is able to walk
- Can use both hands (for Wii remote and Nunchuck extension controller)

Testers are preferably assigned in groups of four, which is the maximum amount of players that *Project Dream* supports.

Appendix C: Case study materials

Case study protocol[36]

October 31, 2010

Project Dream is the working-title of a video game that is currently in development for children with an acquired brain-injury within the age group of 8 to 16 and is specifically designed as a motivational context for training motor, socio-emotional, and cognitive skills. Its genre is best described as an action role-playing game that can be played by up to four players cooperatively both in a clinical and domestic setting. The primary design philosophy that underpins *Project Dream* alludes to Walt Disney's famous quote "I would rather entertain and hope that people learn something than educate and hope they were entertained". Thus, the game is designed also to appeal to children who are not in need of therapeutic care.

In this research project the term *applied games* is used to denote games that are specifically designed to generate real-world behavioural outcomes. For the development of an applied game for children's rehabilitation it is problematic that there are very few successful examples to learn from. Furthermore, with the current emergence of sensor-enhanced control-interfaces such as the Nintendo Wii, Sony Move and Microsoft Kinect, and also a general lack of literature with a focus on designing games for behavioural outcomes, and development time of console video games taking on average 24 months (Petrillo et al. 2009, 16), developers of applied games have little choice other than to invent their own strategies and methods.

Introduction to the case study and purpose of protocol

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[36] Large portions of the case study protocol have been rewritten; see Chapter 4: Case study design and implementation.

The aim of the case study proposed in this document is to validate the design decisions that support *Project Dream*. Because the long development cycles of a console title often delay its validation until the final stages of development, which is a risky endeavor, several playtests with and without the target audience were conducted in the early stages of development to inform subsequent design iterations. Note that the term *playtest* is used here in a slightly different sense than often proposed in game design literature—rather than testing whether the game achieves the intended player experience goals (Fullerton et al. 2004: 248) we're more interested in whether the intended behavioural outcomes are achieved. Because of the nature of the design thinking behind *Project Dream*, which emphasizes mechanics and interactions over rules and content, it's possible to trace behavioural outcomes back to their root in mechanics. The scope of the *Project Dream* prototype includes one map or level with three battle sequences and two navigational choices. One individual play session is estimated to take about 15 minutes; however, the levels are designed specifically with replay value in mind, and some intended behavioural patterns are expected only to occur after repeated play session. Although the final version will provide several customizable options, the prototype offers a choice of three different predefined character classes, each embodying a specific set of therapeutic needs (one is aimed at training motor skills, another at training cognitive skills, and the last one is a mixture of both).

A1 Case study questions, hypotheses and propositions

The case study serves two purposes. The first is to validate the design decisions underpinning *Project Dream*. The second is to advance the overarching research question of how, given a set of therapeutic requirements, a video game can be designed at the level of game mechanics and interactions to motivate and coordinate behavioural outcomes. The proposition then, is that a design strategy that promotes game mechanics and interactions over rules and context not only advocates an outcome-oriented design process but also provides the designer with tools to validate design decisions.

A2 Theoretical framework for the case study

According to the therapists the rehabilitation of children with non-acquired brain injury involves three key points of interest:

- Training of gross and fine motor skills (e.g. throwing and pointing)
- Training of static and dynamic balance (e.g. standing still and walking)
- Training of cognitive skills (e.g. memorization)
- Training of socio-emotional skills (e.g. communication)

In addition to these behavioural outcomes it was important that the game can be played both in a clinical and in a domestic environment, that it respects differences in gaming literacy, that it can be customized to adapt to the player's therapeutic needs, and that behavioural statistics are accessible to the therapist.

A3 Role of protocol in guiding the case study investigator

Assistants for playtest observation are Applied Game Design researchers Lies van Roessel (lies.vanroessel@kmt.hku.nl) and Willemijn Prins (willemijn.prins@kmt.hku.nl). *Project Dream* game designer and project lead Niels Keetels' role is to give instructions to the children who are going to play the prototype and to stand by for potential technical problems.

Data collection procedures

The data collection procedures are outlined in sections "Guidelines for playtest observation" and "

Semi-structured interview guidelines" of Appendix C. Playtest sessions will be recorded on video; the players as well as the game have to be clearly visible.

B1 Names of sites to be visited, including contact persons

The playtest of *Project Dream* is to be conducted on Monday the 22nd of November 2010 at rehabilitation clinic De Hoogstraat in Utrecht, The Netherlands. Contact person at De Hoogstraat is children's rehabilitation therapist Jose Ermers (j.ermers@dehoogstraat.nl) . Preparations for the playtest will be planned and executed in collaboration with children's rehabilitation therapist Joep Janssen (j.janssen@dehoogstraat.nl). In an email conversation we have agreed with Joep to playtest the game with two groups of four children who sustain an acquired brain injury within the age group of 8 to 16 years old.

B2 Data collection plan

[This section has been rewritten; see Chapter 4: Case study design and implementation section Implementation]

B3 Expected preparations prior to site visits

We, the researchers from the Applied Game Design programme, will be bringing the following hardware to rehabilitation center De Hoogstraat:

- A laptop capable of running *Project Dream*
- A laptop to record video with Logitech webcam drivers pre-installed
- Two Logitech webcams
- Four pre-synchronized Wii remotes
- Two Nyko wireless sensor bars
- One voice recorder for interviews

Based on prior experience with playtesting at De Hoogstraat we will assume access to a large television with RGB input, as well as an RGB-cable that can be connected to the laptop for video-output.

De Hoogstraat case study review

Contributors

Joep Janssen	Rehabilitation therapist
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Niels Keetels	Researcher
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Time and location

This playtest was carried out on the 22nd of November 2010 at rehabilitation center De Hoogstraat in Utrecht, The Netherlands. Two playtest sessions were run from 10:00am to 11:00am.

Research aim and objectives

The playtest of *Project Dream* at rehabilitation center De Hoogstraat was carried out with the purpose of determining whether the game's position-based mechanics produced and sustained desired behavioural patterns in the area of dynamic balance (e.g. walking and running). This means that for this particular session only the swordfighter-class was tested, because that class embodies therapeutic needs in the area of gross motor abilities.

De Hoogstraat

Rehabilitation center De Hoogstraat is a forerunner in The Netherlands for using video games in children's rehabilitation therapy. De Hoogstraat was selected for the playtest because they are specialized in the treatment of children with an ABI within the age group of 8 to 16. Additionally, children from De Hoogstraat are already familiar with playing games for therapy, and the therapists are able to assist with the playtest.

Prototype modifications

- Points are displayed above the player user-interface after a successful attack. Across many game genres the convention of having to accumulate points is used. Giving points to the player is an effective feedback mechanism for telling the player that he has done something that will increase his winning chances.

- The user-interface will notify the player when he is targeted by an enemy. Knowing when to defend is crucial to become better at playing the game. In addition to a vibration/rumble notification in the Wii controller, an arrow is displayed above the player's user-interface when he is being targeted.

- The user-interface shows whether the player's position is known by the game.
  When a player points at the sensor bar an eye-icon is displayed above the player's user-interface so that the player knows that he is pointing at the sensor bar.

- Skill-upgrade reward
  After successfully defeating the first enemy of the game all players get to vote for either increased damage or healing rates. This feature was meant to stimulate socio-emotional behaviour.

Review

Each playtest reminds of the immense variety of disabilities. The course of action is to define the target audience for *Project Dream* more precisely for future playtests so that design decisions can be tested more effectively. Unfortunately this means that the game is going to exclude patients with particular disabilities from participating. It is also a good idea to play the game with the therapist before carrying out the playtest, so that he can help the children to understand the game better. The main problem with the playtest prototype was that players thought that the game did not always respond correctly to their actions, and that it was not always clear when they could attack the enemy.

Mytylschool case study review

Contributors

Joost van de Kreeke — Rehabilitation therapist

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Niels Keetels — Researcher
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Time and location

This playtest was carried out on the 2nd of February 2011 at the Mytylschool in Utrecht, The Netherlands. One playtest session was carried out between 10:30 and 12:30.

Summary

After the playtest results from De Hoogstraat (22nd of November 2010) were evaluated a new design iteration was conceived to address the lack of clarity of game mechanics, most notably in the area of user feedback. At the Mytylschool in Utrecht, a primary school for children with disabilities, a new prototype was tested with three children with cognitive and social-emotional therapeutic needs. Improvements were

made in the area of user-interface design which successfully addressed the clarity issue of the previous playtest.

Research aim

The playtest at De Hoogstraat from the 22nd of November revealed confusion concerning the clarity of mechanics among players; player movement did not always match our expectations and in interviews some players reported that the blocking mechanic did not always work. Through a playtest review this issue was attributed to insufficient user feedback in the areas of sound, graphics, and controller vibration.
The playtest at the Mytylschool was carried out with the purpose of testing whether the changes made to the *Project Dream* prototype of 22 November 2010 led to sustained behavioural patterns in the area of gross motor activity.

The Mytylschool

The Mytylschool in Utrecht is a special primary and middle school with internal rehabilitation facilities, providing care and support for children within the age group of 4 – 13 with multiple handicaps. They have adopted video games for both individual and group therapy from rehabilitation center De Hoogstraat, and because of their positive stance toward applied video games they were considered a good partner for playtesting *Project Dream*.

Prototype modifications

- A bubble icon around the enemy is displayed when a player successfully hits the enemy but the attack is blocked. This design decision was made in reaction to confusion in the Hoogstraat playtest (22 November 2010) surrounding doing damage.
- A shield / sword / bow cursor is displayed on the screen when pointing, in addition to the shield / sword / bow icons in the user-interface. This design decision was made to motivate players to keep pointing at the sensor bar so

that the game can estimate the distance between the players and the sensor bar as often as possible. At the Hoogstraat playtest (22 November 2010) attacking and blocking would often fail because the game did not know where people were.

- The upgrade-choosing mechanic was removed, since the game was not balanced the upgrades were meaningless and didn't produce the social dynamics that were expected.
- The healing mechanic was added, enabling players to restore a quarter of another player's health-bar when pointing & clicking on that player's user-interface. The healing action used the same gauge as the attacking action did with the same recharge time, so it becomes a strategic decision whether to attack or heal.
- A wall obstacle was introduced; this obstacle could only be 'defeated' when players time their attacks at the exact same time. This obstacle makes it necessary to communicate and work together.
- The turkey enemy shoots projectiles at the player's user-interface when attacking so that there's an extra layer of feedback for being attacked.
- Enemies have health-bars again for the time being which is an extra layer of feedback for successfully hitting something.
- A character selection screen was made so children can choose the role (with accompanying gameplay patterns) that they want to play.
- A playfield calibration screen was added so the playtest can be set up much quicker than before.

Review

The improvements that were made to the user-interface (attacking and defending icons that appear on screen when the player is standing in the right 'zone' on the grid) solved two major problems that were identified at the previous playtest. There was much less confusion about the attacking and blocking mechanic, because the new icons would show whether they were available. Not seeing any icon reminded the player to point the Wii controller at the sensor bar, solving the problem of the game not knowing the physical position of the player.

Blixembosch case study review

Contributors

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Time and location

This playtest was carried out on 18 February 2011 at rehabilitation center Blixembosch in Eindhoven, The Netherlands. One playtest session was carried out between 14:00 and 14:30.

Summary

On 18 February 2011 an almost identical version of the Mytylschool prototype (carried out on 2 Februari 2011) was playtested at rehabilitation center Blixembosch in Eindhoven. The most important change from the previous prototype was that the attacking and defending icons had been removed from the permanent user-interface and instead were connected to the player's aiming reticle, with the aim of making players more aware about the fact that they have to point the Wii controller at the sensor bar at all times.

Research aim

The playtest at Blixembosch in Eindhoven was carried out shortly after the one at Mytylschool in Utrecht (2 February 2011). A new design decision had been made to ensure that the game receives enough distance-data from the Wii controller to calculate the physical position of the player: the availability of the attacking and blocking mechanic would be connected to the player's aiming reticle, which is only visible when players aim at the sensor bar.

Rehabilitation center Blixembosch

Rehabilitation center Blixembosch in Eindhoven is interesting for the purpose of playtesting *Project Dream* because they do not have a 'video game therapy' program yet, but they are interested in the potential of video games for therapeutic effect.

Prototype modifications

- It is no longer necessary to hold the Wii remote upright to block. Instead, moving away from the television while pointing at the sensor bar will automatically result into blocking (as indicated by the changing of the on-screen cursor when pointing). This modification was made because a player's first reaction was often to hold the controller upright and then move backwards, resulting into the game not knowing where the player was in the physical environment.
- When one or more players are hit by an enemy attack the camera will shake, this provides all players with the feedback that someone has been hit and might need healing.
- The on-screen cursor-size can be changed in-game. This was done in reaction to the cursor being hardly visible on small television screens.

Review

The design decision of connecting the attacking and blocking icons to the player's aiming reticle made players more aware of the need to keep pointing the Wii controller at the sensor bar, resulting in less failed attempts to defend or attack.

However, it did not procedure significantly different results in the area of player behavioural patterns, compared to the previous playtest at Mytylschool in Utrecht.

Playtest observation sheet

[on the next page]

Physical Balance		Physical Balance
Standing still with or without axillary crutches	STILL	
Walking with or without axillary crutches toward the television	TO FRONT	
Walking with or without axillary crutches away from the television	TO BACK	Comment: record each battle sequence seperately!

Social-Emotional		Social-Emotional
A decision is being made by voting	VOTE	
A decision is being made by persuasion	PURSUADE	
A decision is being made by command	COMMAND	
A decision is being made arbitrarily	ARBITRARY	
Something is verbally requested from another player(s)	VERBAL	
Something is explicitly but not verbally requested from another player(s)	OTHER	

Cognition		Cognition
Start a short motor activity after a specific visual or audio cue	CUE	
The time one battle takes (from enemy appearance to disappearance)	TIME	

Fine and gross motor skills		Fine and gross motor skills
Controlled throwing / hitting motion	CONTROLLED	
Acute throwing / hitting motion	ACUTE	
Pointing at the screen	POINT	
Synchronizing the movement of both arms	SYNC	
Take a particular stance	STANCE	

Figure 60: Playtest observation sheet

Guidelines for playtest observation

The structure of the following section is as follows. We distinguish between four areas of interest for the treatment of acquired brain injury: social-emotional, cognitive, fine motor skills, and physical balance. The first three areas were specifically identified by our board of experts, physical balance was distinguished from motor skills because the game (Project Dream) has two general modes of input: position-based for ambulant players and precision-based for stationary players. For each area the player behaviour patterns, (game) mechanics, and data collection guidelines are specified.

Physical Balance

Project Dream is designed to play while standing and accommodates for standing still or walking using axillary crutches, hence the core mechanic of the melee class is position-based. For the sake of clarity, a mid-rage velocity[37] and at least two steps is considered walking.

Player behaviour patterns

A Standing still with or without axillary crutches
B Walking with or without axillary crutches toward the television
C Walking with or without axillary crutches away from the television

Behavioural pattern A is meant to train static balance whereas patterns B and C are meant to train dynamic balance.

Mechanics

[37] Beck et al. (1981: 1453) distinguish between slow (0.81m/sec), midrange (1.04m/sec) and fast (1.25m/sec) walking velocity in growing children.

1	Moving into the attacking zone	B
2	Moving into a defense zone	C
3	Standing into a defense zone	A

The melee character class stimulates position-based play meaning that the position of the player relative to the television has meaningful in-game consequences. Being ‘in’ the *attacking zone* is representative of a distance between the player and the Wii sensor bar within approximately two meters. The *defense zone* is representative of a distance of more than two meters but the exact dimensions and location of this zone varies during play. An enemy might for example only attack players on the left side of the playing-field meaning that the right side is now a defense zone.

Data Collection Guidelines

Occurrences of all physical balance player behaviour patterns can easily be observed and counted. However, they should only be counted for players who’ve chosen a melee character class so the results should be normalized. Note that we’re particularly interested in how play patterns evolve over time thus it is necessary to log every battle-sequence (from the moment that an enemy appears to the moment where it’s been defeated) separately.

Social-Emotional

Social-emotional skills are in context of Project Dream concerned with interpersonal communication and dealings. Compared to melee class players the support classes are given more mechanics and challenges involving social-emotional skill in order to make the game engaging for both types of players.

Player behaviour patterns

A1 A decision is being made by voting
A2 A decision is being made by persuasion
A3 A decision is being made by command

A4	A decision is being made arbitrarily	
B	Something is verbally requested from another player(s)	
C	Something is explicitly but not verbally requested from another player(s)	

Behavioural pattern A[1-4] are meant to stimulate interpersonal communication whereas B and C are more concerned with individual presentation.

Mechanics

1	Choosing a direction for navigation	A1–A4
2	Choosing a direction for skill development	A1–A4
3	Modify the in-game status of other player(s)	B, C

These mechanics are available to all character classes. Choosing directions for navigation is a short-term decision whereas choosing directions for skill development are long-term decisions.

Data Collection Guidelines

All six player behaviour patterns are observable and quantifiable for any player class. Unfortunately we don't consider long-term decisions measurable within a single case study-- i.e. mechanic 2 is designed to take effect over several iterations of play.

Cognition

Cognitive skills that are accounted for in Project Dream involve in particular concentration and pattern recognition. An example for the former is looking for enemy attack *cues,* such as a sudden flash in the eyes. The latter, pattern recognition, involves memorizing the attacking patterns of different enemy types in subsequent battles.

Player behaviour patterns

A Start a short motor activity after a specific visual or audio cue

It should be noted that mindlessly hacking and slashing doesn't have an effect in Project Dream. The idea is to only hit when it counts, hence the first behaviour pattern says 'start attacking when it counts'. This type of gameplay is also seen in Nintendo's *Punch-Out* and Capcom's *Monster Hunter* series. The graphics and sound cues repeat over subsequent battles with enemies and over time players are expected to memorize the attacking patterns of the enemy types.

Mechanics

1	Start attacking at the moment when the enemy drops guard	A
2	Guard when the enemy signals an attacking cue	A
3	Modify the status of another player (i.e. healing, shielding, etc.)	A

Data Collection Guidelines

There is only one player behaviour pattern for this category but we're particularly interested in the differences in play between subsequent battle-sequences. As mentioned before every battle-sequence should generate its own research data record.

Fine and gross motor skills

In Project Dream this category is concerned with fine and gross arm and hand movement such as pointing and throwing.

Player behaviour patterns

A Controlled throwing / hitting motion

B Acute throwing / hitting motion

C Pointing at the screen

D	Synchronizing the movement of both arms	
E	Take a particular stance	

Mechanics

1	Defend by holding Wii remote + nunchuck up in the air	D,E
2	Attack as a sword-wielder	B
3	Modify the status of another player (i.e. healing, shielding, etc.)	C, E

Data Collection Guidelines

For this playtest there won't be controlled motions (the software doesn't take velocity of motion into account, it only checks whether acceleration exceeds certain thresholds) and at the time of writing this protocol it is still uncertain whether pointing using IR sensors will be supported. Other than player behaviour

Semi-structured interview guidelines

Unfortunately a playtest alone will not yield enough data for validating all design decisions, the social-emotional dynamics in particular may not be susceptible to observation and measurement. Hence, with the purpose of capturing qualitative data in addition to the quantitative data gathered from the playtest observations a number of questions have been formulated.

The interview is to be conducted right after the group of children has played the prototype of Project Dream in an area separate from the playtest-setup (because another group might be playing the game). It's important that all players from one playtest session are present at the interview, which typically means four interviewees per session. Although all questions are targeted at individuals the advantage of having the other players involved is that you might get more information and interesting discussions.

Data Collection Guidelines

A voice-recorder is used to record all interview sessions. As the interviewer should direct her attention to the discussion and, whenever possible, may ask formulate additional questions for further inquiry, she is not responsible for taking notes and transcribing. To emphasize the qualitative nature of the interview no closed questions are asked. For example, instead of "did you do well in combat?" we ask "how did you do in combat?".

- How did you do in combat?
- Did you have the idea that you were becoming better at playing the game?
- Are there things you did not like about the game?
- What type of game do you normally play?
- Etcetera

Appendix D: Research log and transcripts

Research log

The following 7 pages contain colour-coded scans of the research log of the year 2010. The log only covers activities related to the design & development of the practical element of this research project: *Project Dream*.

- Orange (research & design): prototyping ideas, testing hardware & software, reading reports, brainstorming, conceptualization, finding referential material, transcribing research material. These tasks were performed with the purpose of making informed design decisions. [96 hours]
- Green (presentation & documentation): creating presentations, writing documentation, board of experts meetings, writing newsletters. These tasks were performed with the purpose of disseminating knowledge. [35.9 hours]
- Blue (production & planning): production (programming, audio, visual artwork) meetings, production planning, design iteration meetings. These tasks were performed with the purpose of actualizing design decisions. [65 hours]
- Pink (playtesting & preparation): prototype testing, prototype programming, playtest preparations, protocol writing, and playtest report writing. These tasks were performed with the purpose of facilitating the testing of the design. [60.5 hours]

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Team member: **All** Start date: **2007-12-01**
Projects: **1: GATE** End date: **2010-12-31**
Categories: **Health**

Date	Team member	Projects	Categories	Description	Time
2010-01-04	Niels Keetels	1: GATE	Health	Sprint overleg met Brian & Charissa	1.00
2010-01-04	Niels Keetels	1: GATE	Health	GlovePie script tutorials bekijken	2.00
2010-01-04	Niels Keetels	1: GATE	Health	Prototype software	2.00
2010-01-11	Niels Keetels	1: GATE	Health	Sprint update met Brian en Charissa	1.00
2010-01-11	Niels Keetels	1: GATE	Health	Game design idee uitdiepen	1.00
2010-01-12	Niels Keetels	1: GATE	Health	Wii scripts geschreven voor zagen, hameren en metselen	1.00
2010-01-12	Niels Keetels	1: GATE	Health	Bespreken voortgang GameJam #2	0.50
2010-01-13	Niels Keetels	1: GATE	Health	Extra Wii bewegingen en nunchuck toegevoegd	1.00
2010-01-13	Niels Keetels	1: GATE	Health	Presentatie voorbereiden	1.00
2010-01-13	Niels Keetels	1: GATE	Health	Presentatie	1.00
2010-01-13	Niels Keetels	1: GATE	Health	Documentatie uitbreiden & project uploaden	1.00
2010-01-21	Niels Keetels	1: GATE	Health	Brian's stageevaluatie	1.00
2010-01-21	Niels Keetels	1: GATE	Health	GATE gamejam filmpje compileren voor AGD borrel	1.00
2010-01-25	Niels Keetels	1: GATE	Health	Bespreken MotionJam #3 game met Charissa	0.50
2010-01-25	Niels Keetels	1: GATE	Health	Werken aan MotionJam #3 game	5.00
2010-01-26	Niels Keetels	1: GATE	Health	MotionJam #3 voorbereidend werk	3.00
2010-01-26	Niels Keetels	1: GATE	Health	Aan bever zwemgame werken	2.00
2010-01-27	Niels Keetels	1: GATE	Health	1e klankbordmeeting datum prikken	1.00
2010-01-27	Niels Keetels	1: GATE	Health	Afronden technisch experiment	3.00
2010-02-01	Niels Keetels	1: GATE	Health	Update graphics van Charissa voor bevergame	0.50
2010-02-02	Niels Keetels	1: GATE	Health	Meindert op de hoogte brengen van planning health	1.00
2010-02-02	Niels Keetels	1: GATE	Health	Gesprek met Meindert over generieke stijl	2.00
2010-02-08	Niels Keetels	1: GATE	Health	Projectvoorstel lezen en naar Meindert	1.00

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Figure 61: Research log scan 1

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				terugkoppelen als design argumenten	
2010-02-09	Niels Keetels	1: GATE	Health	Presentatie / discussie generic style van technisch oogpunt	1.00
2010-02-09	Niels Keetels	1: GATE	Health	Relevante bevindingen van Groot Klimmendaal documenteren	1.00
2010-02-10	Niels Keetels	1: GATE	Health	Gedragspatronen benoemen voor concept health	2.00
2010-02-10	Niels Keetels	1: GATE	Health	Afmaken groot klimmendaal verslag	1.00
2010-02-15	Niels Keetels	1: GATE	Health	Patterns for Game Design uitzoeken	1.50
2010-02-16	Niels Keetels	1: GATE	Health	Wii docs upzoeken voor Meindert	1.00
2010-02-16	Niels Keetels	1: GATE	Health	Art tech pipeline bespreken	1.00
2010-02-16	Niels Keetels	1: GATE	Health	Gesprek met Gerard van Wolferen	1.00
2010-02-16	Niels Keetels	1: GATE	Health	Meeting met Jeroen, Willempje en Meindert over generic style	0.50
2010-02-22	Niels Keetels	1: GATE	Health	Voorbereiding brainstorm	1.00
2010-02-22	Niels Keetels	1: GATE	Health	Health brainstorm met charissa en meindert	1.50
2010-02-24	Niels Keetels	1: GATE	Health	Kijken met Meindert naar problemen met Maya	0.50
2010-02-24	Niels Keetels	1: GATE	Health	Brainstorm zelf en later met Meindert. Heeft 1 serieuze en 3 minder serieuze ideeen opgeleverd	2.50
2010-03-01	Niels Keetels	1: GATE	Health	Voorbereiden presentatie aan De Waag	1.00
2010-03-01	Niels Keetels	1: GATE	Health	GATE update met de Waag over pilots	2.00
2010-03-01	Niels Keetels	1: GATE	Health	Doornemen verslag Lies & Charissa	0.50
2010-03-01	Niels Keetels	1: GATE	Health	Doornemen en feedback collision-voorstel van Meindert	0.50
2010-03-02	Niels Keetels	1: GATE	Health	Health update met Micah en Lies	0.50
2010-03-02	Niels Keetels	1: GATE	Health	Ontwerp methods / tools zoeken	1.50
2010-03-02	Niels Keetels	1: GATE	Health	Klankbordgroep bespreken / documenteren	0.50
2010-03-03	Niels Keetels	1: GATE	Health	View nieuwe concepten bedacht	2.00
2010-03-03	Niels Keetels	1: GATE	Health	Play Matrix invullen met nieuwe concepten	0.40

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Figure 62: Research log scan 2

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2010-03-22	Niels Keetels	1: GATE	Health	Overleg Jeroen over Wii / iPhone games	0.50
2010-03-22	Niels Keetels	1: GATE	Health	Klankbord meeting plannen + bespreken met Jeroen	0.50
2010-03-23	Niels Keetels	1: GATE	Health	Gratis vector drawing tool zoeken voor one page designs	1.00
2010-03-23	Niels Keetels	1: GATE	Health	Ontwerp prototypen in XNA	5.00
2010-03-24	Niels Keetels	1: GATE	Health	Bever prototype verder uitwerken in XNA	5.00
2010-03-29	Niels Keetels	1: GATE	Health	Uitwerken: TV assisted game concept	4.00
2010-03-29	Niels Keetels	1: GATE	Health	Lightbeams, ambient occlusion en meer grafische truuks bespreken voor Wii met Meindert	2.00
2010-04-06	Niels Keetels	1: GATE	Health	Nieuwe werkpaketten opstellen	1.00
2010-04-06	Niels Keetels	1: GATE	Health	Presentatie voorbereiden + presenteren	2.00
2010-04-12	Niels Keetels	1: GATE	Health	Overleg voorbereiding klankbordmeeting	1.00
2010-04-12	Niels Keetels	1: GATE	Health	Presentatie voorbereiden	2.00
2010-04-12	Niels Keetels	1: GATE	Health	Afstemming health planning met Richard mbt muziek en geluid stages	0.50
2010-04-13	Niels Keetels	1: GATE	Health	Workingstructure vergadering met Meindert	1.50
2010-04-13	Niels Keetels	1: GATE	Health	Workingstructure mockup maken	0.50
2010-04-14	Niels Keetels	1: GATE	Health	Vervolgmeeting projectstructuur met Micah, Meindert en Richard	1.00
2010-04-14	Niels Keetels	1: GATE	Health	Aan klankbord presentatie werken	1.50
2010-04-15	Niels Keetels	1: GATE	Health	Klankbord voorbereiding + meeting	6.00
2010-04-19	Niels Keetels	1: GATE	Health	Prototype 'video assisted game' maken	5.00
2010-04-26	Niels Keetels	1: GATE	Health		5.00
2010-04-27	Niels Keetels	1: GATE	Health		3.00
2010-05-10	Niels Keetels	1: GATE	Health	Tools & pipeline bespreking met Meindert	1.00
2010-05-10	Niels Keetels	1: GATE	Health	One-page design bespreking met Meindert	1.00
2010-05-10	Niels Keetels	1: GATE	Health	Thema bespreking voor 2e en 3e	1.50

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Figure 63: Research log scan 3

Reports | 14Dayz.com - Time Tracking Made Simple 27-12-10 23:57

				prototype met Meindert	
2010-05-11	Niels Keetels	1: GATE	Health	Testdag prototypen voorbereiden	4.00
2010-05-17	Niels Keetels	1: GATE	Health	Planning tot midterm met Meindert	2.00
2010-05-17	Niels Keetels	1: GATE	Health	Pluginsysteem voor AGDBuild maken	3.00
2010-05-19	Niels Keetels	1: GATE	Health		0.00
2010-05-31	Niels Keetels	1: GATE	Health	Health update	0.25
2010-06-01	Niels Keetels	1: GATE	Health	Little Nemo in Slumberland kijken met Meindert voor thema-keuze	2.00
2010-06-01	Niels Keetels	1: GATE	Health	Onderzoekmeeting met Lies en Meindert	1.00
2010-06-08	Niels Keetels	1: GATE	Health	Unity onder de knie krijgen	7.00
2010-06-09	Niels Keetels	1: GATE	Health	Unity stress test maken	1.00
2010-06-09	Niels Keetels	1: GATE	Health	Healthpilot belichtingtest	3.00
2010-06-09	Niels Keetels	1: GATE	Health	Health thema bespreking met Meindert en Fatih	2.00
2010-06-11	Niels Keetels	1: GATE	Health	Update meeting	0.25
2010-06-11	Niels Keetels	1: GATE	Health	Unity engine features bekijken	1.50
2010-06-14	Niels Keetels	1: GATE	Health	Controllers diepte laten meten in Unity	7.00
2010-06-15	Niels Keetels	1: GATE	Health	User interface voor prototype in Unity	8.00
2010-06-16	Niels Keetels	1: GATE	Health	LitSphere shader en unity prototype uitbouwen	6.00
2010-06-21	Niels Keetels	1: GATE	Health	Playtest Hoogstraat voor GATE promo film	2.00
2010-06-23	Niels Keetels	1: GATE	Health	Thema materiaal verzamelen	5.00
2010-08-10	Niels Keetels	1: GATE	Health	Volgende stappen Wii implementatie bespreken met Duncan	3.00
2010-08-16	Niels Keetels	1: GATE	Health	Rendering techniek (belichting in vertices) bekijken met Meindert	1.50
2010-08-30	Niels Keetels	1: GATE	Health	3e jaars project en stage bespreken met Meindert	3.00
2010-08-30	Niels Keetels	1: GATE	Health	Duncan planning	1.00
2010-09-07	Niels Keetels	1: GATE	Health	Introductie GATE health pilot aan stagiaires	2.00
2010-09-07	Niels Keetels	1: GATE	Health	Nieuwe planning maken	2.50
2010-09-08	Niels Keetels	1: GATE	Health	Gedetailleerde planning voor september & october	2.00

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Figure 64: Research log scan 4

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				stagiaires	
2010-09-08	Niels Keetels	1: GATE	Health	Interns inlichten over nieuwe planning & voorbereidend werk op volgende week maandag	2.00
2010-09-08	Niels Keetels	1: GATE	Health	Planning overleg met Willempje + afspraken klankbord text	0.50
2010-09-08	Niels Keetels	1: GATE	Health	Klankbord update text schrijven	2.00
2010-09-08	Niels Keetels	1: GATE	Health	Planning doornemen met Richard	0.50
2010-09-09	Niels Keetels	1: GATE	Health	Planning besproken met Meindert	1.50
2010-09-09	Niels Keetels	1: GATE	Health	Planning besproken met Duncan	1.00
2010-09-09	Niels Keetels	1: GATE	Health	Planning uittekenen / Gantt chart	3.00
2010-09-09	Niels Keetels	1: GATE	Health	Klankbord update schrijven	1.00
2010-09-13	Niels Keetels	1: GATE	Health	Nieuwe weekplanning bespreken	1.00
2010-09-13	Niels Keetels	1: GATE	Health	Bekijken van werk Hans en Ian	2.00
2010-09-15	Niels Keetels	1: GATE	Health	Shader testje met Meindert voor pilot	1.00
2010-09-20	Niels Keetels	1: GATE	Health	Ian en Hans' werk bespreken en nieuwe opdrachten geven	1.00
2010-09-20	Niels Keetels	1: GATE	Health	Met Meindert en Duncan bespreken hoe ver de game nu staat	0.50
2010-09-22	Niels Keetels	1: GATE	Health	Met Duncan priotiteit van taken bespreken	0.50
2010-09-22	Niels Keetels	1: GATE	Health	Met Meindert visualisatie van de hub bespreken	0.50
2010-09-22	Niels Keetels	1: GATE	Health	Stijlreferenties voor hub zoeken	0.50
2010-09-23	Niels Keetels	1: GATE	Health	Planning Gantt chart maken	2.00
2010-09-23	Niels Keetels	1: GATE	Health	Nieuwsbrief aanpassingen maken	1.00
2010-09-23	Niels Keetels	1: GATE	Health	HUD design bespreking met Ian	1.00
2010-09-27	Niels Keetels	1: GATE	Health	Dragon Quest Swords spelen en bespreken (inspiratiebron)	1.50
2010-09-27	Niels Keetels	1: GATE	Health	Nieuwe weekplanning malen met Meindert	1.00
2010-09-27	Niels Keetels	1: GATE	Health	Ian en Hans werk besrpeken + nieuwe taken geven	0.50
2010-09-29	Niels Keetels	1: GATE	Health	Unity 3 testen	2.00
2010-10-04	Niels Keetels	1: GATE	Health	Bespreken imlementatie nieuwe	1.00

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Figure 65: Research log scan 5

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				HUD met Ian en Duncan	
2010-10-04	Niels Keetels	1: GATE	Health	Concrete afspraken maken met Stan Koch	2.00
2010-10-05	Niels Keetels	1: GATE	Health	Ian briefen voor nieuwe taken	0.50
2010-10-06	Niels Keetels	1: GATE	Health	Met Duncan stappen richting playtest doornemen	1.00
2010-10-11	Niels Keetels	1: GATE	Health	Levelediting overleg met Meindert, Duncan en Richard	1.50
2010-10-11	Niels Keetels	1: GATE	Health	Health update met Willempje	0.50
2010-10-12	Niels Keetels	1: GATE	Health	Unity folder opties testen	0.50
2010-10-12	Niels Keetels	1: GATE	Health	Camera-pad techniek en prototype-level bespreken	1.00
2010-10-18	Niels Keetels	1: GATE	Health	Health taken bespreken met Ian en Hans	1.00
2010-10-18	Niels Keetels	1: GATE	Health	Lies playtest research bespreking	0.50
2010-10-19	Niels Keetels	1: GATE	Health	Duncan's werk aan de praat zien te krijgen (bluetooth werkt maar niet)	3.00
2010-11-01	Niels Keetels	1: GATE	Health	Outline playtest protocol	3.00
2010-11-03	Niels Keetels	1: GATE	Health	Playtest protocol schrijven voor 22 november	4.00
2010-11-08	Niels Keetels	1: GATE	Health	Bespreking muziek & audio met Richard en Stan	1.50
2010-11-08	Niels Keetels	1: GATE	Health	Handout materiaal verzamelen + mailen naar ehulp	0.50
2010-11-08	Niels Keetels	1: GATE	Health	Technische voortgang voor playtest bespreken met Duncan	0.50
2010-11-09	Niels Keetels	1: GATE	Health	Presentatiemateriaal van Jeroen en mij verzamelen	1.00
2010-11-09	Niels Keetels	1: GATE	Health	Playtestonderzoek	1.00
2010-11-09	Niels Keetels	1: GATE	Health	Unity vijand gedrag voor playtest programmeren	1.00
2010-11-09	Niels Keetels	1: GATE	Health	eHulp presentatie materiaal bij elkaar plakken	2.00
2010-11-15	Niels Keetels	1: GATE	Health	Ian en Hans instrueren voor planning	0.50
2010-11-15	Niels Keetels	1: GATE	Health	GATE Health Asset project presentatie bijwonen	1.00
2010-11-15	Niels Keetels	1: GATE	Health	Muziek bespreking	1.00

http://agd.14dayz.com/site/en/mainmenu/reports/?projectId=4901...-31&order=Date&direction=ASC&subtotalField=none&showPage=print Pagina 6 van 7

Figure 66: Research log scan 6

				met Stan Koch	
2010-11-15	Niels Keetels	1: GATE	Health	Ian's animaties verwerken in prototype	1.00
2010-11-16	Niels Keetels	1: GATE	Health	Vijand gedrag programmeren	3.00
2010-11-16	Niels Keetels	1: GATE	Health	Bespreken wat voor morgen af moet zijn met Duncan, Ian en Hans	1.00
2010-11-17	Niels Keetels	1: GATE	Health	Playtest pilot	2.00
2010-11-17	Niels Keetels	1: GATE	Health	Code mergen met Duncan	2.00
2010-11-18	Niels Keetels	1: GATE	Health	Laatste aanpassingen maken aan playtest-prototype met Duncan	6.00
2010-11-22	Niels Keetels	1: GATE	Health	Playtest bij De Hoogstraat	2.00
2010-11-23	Niels Keetels	1: GATE	Health	Unity engine keuze verder beschrijven	1.50
2010-11-23	Niels Keetels	1: GATE	Health	Playtest verslagje maken	2.00
2010-11-24	Niels Keetels	1: GATE	Health	Begonnen met transcriptie playtest gegevens	2.00
2010-11-24	Niels Keetels	1: GATE	Health	Project proposal schrijven voor Project Dream animatie	1.00
2010-11-29	Niels Keetels	1: GATE	Health	Muziek bespreking met Stan, Richard, Meindert en Duncan	2.00
2010-11-29	Niels Keetels	1: GATE	Health	Michael Jackson onderzoek	0.50
2010-11-30	Niels Keetels	1: GATE	Health	Playtest nabespreking	2.00
2010-11-30	Niels Keetels	1: GATE	Health	Playtest case study report schrijven	3.00
2010-11-30	Niels Keetels	1: GATE	Health	Met Duncan nieuwe taken tot volgende playtest bespreken	1.00
2010-12-01	Niels Keetels	1: GATE	Health	Playtest introductiebrief schrijven	2.00
2010-12-01	Niels Keetels	1: GATE	Health	Playtest report (Hoogstraat) schrijven	2.00
2010-12-06	Niels Keetels	1: GATE	Health	Nieuwe kortetermijn planning doornemen met Ian, Hans en Duncan	3.00
2010-12-14	Niels Keetels	1: GATE	Health		0.00
				Report total:	275.40

Figure 67: Research log scan 7

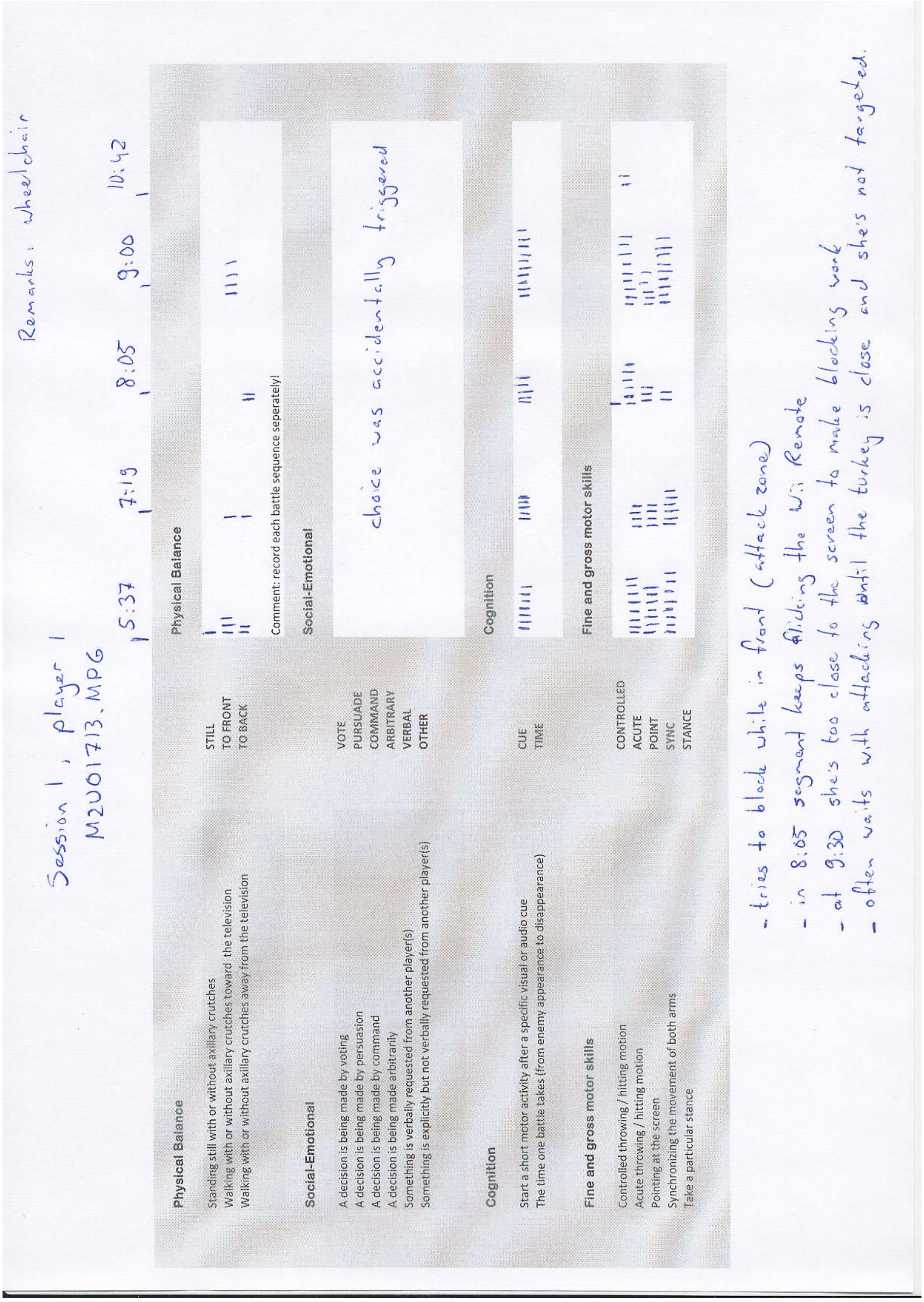
Playtest transcripts

List of keywords:

ACUTE	the player performs an acute fine motor activity with the controller;
CUE	the player performs an activity after an explicit visual or audio cue;
POINT	the player uses the controller to aim at the Wii sensor bar;
SYNC	the player uses the controller (and extension controller) to block;
TO BACK	the player moves away from the television screen;
TO FRONT	the player moves toward the television screen;

The horizontal axis of the charts represent the battle sequences (repeated play sessions) that have been completed. The vertical axis represents the frequency of occurrence of the activity that is specified by the keyword.

De Hoogstraat transcripts



Session 1, player 1
M2U01713.MPG

Remarks: wheelchair

5:37 | 7:19 | 8:05 | 9:00 | 10:42

Physical Balance

Standing still with or without axillary crutches — STILL
Walking with or without axillary crutches toward the television — TO FRONT
Walking with or without axillary crutches away from the television — TO BACK

Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting — VOTE
A decision is being made by persuasion — PURSUADE
A decision is being made by command — COMMAND
A decision is being made arbitrarily — ARBITRARY
Something is verbally requested from another player(s) — VERBAL
Something is explicitly but not verbally requested from another player(s) — OTHER

choice was accidentally triggered

Cognition

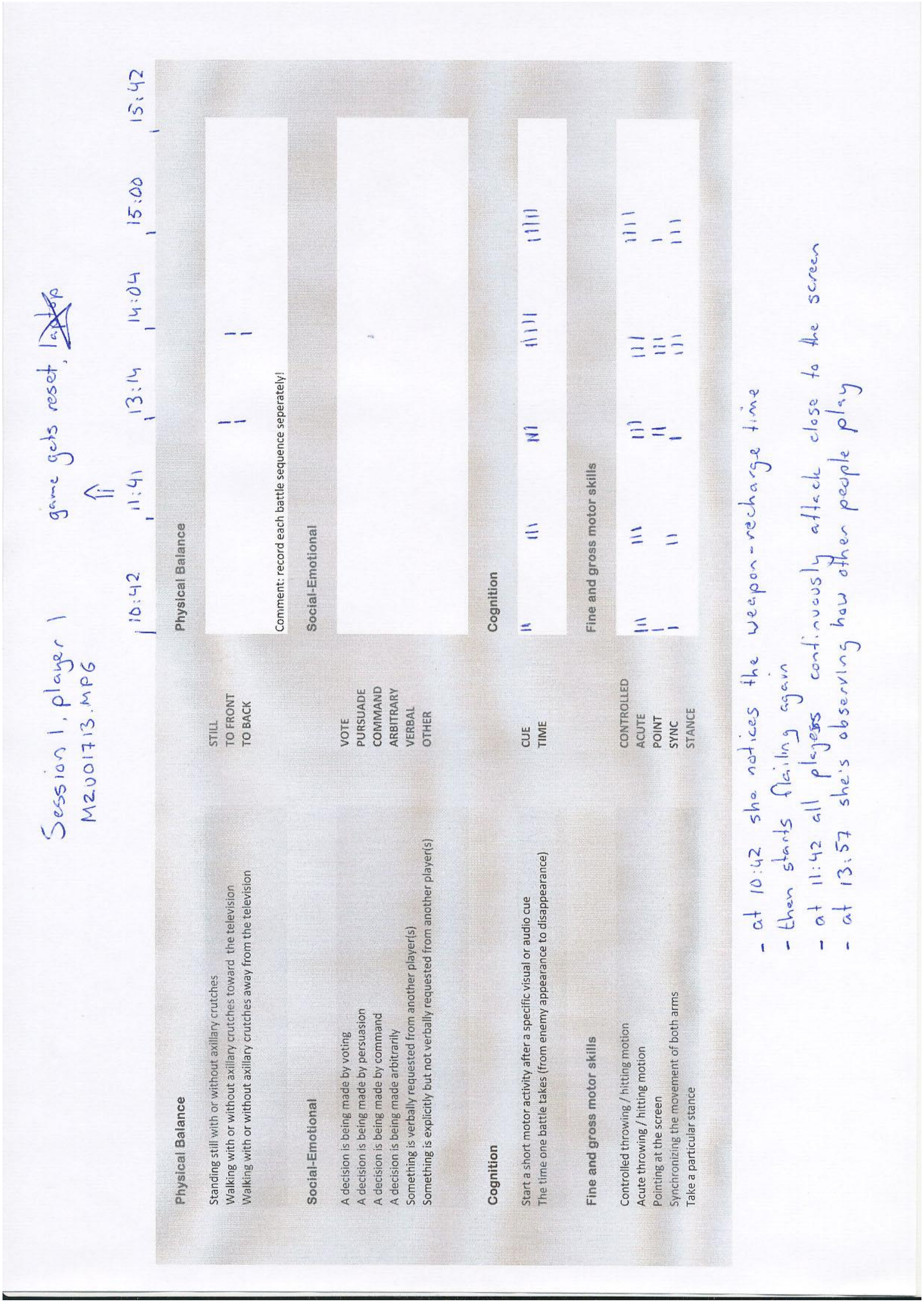
Start a short motor activity after a specific visual or audio cue — CUE
The time one battle takes (from enemy appearance to disappearance) — TIME

Fine and gross motor skills

Controlled throwing / hitting motion — CONTROLLED
Acute throwing / hitting motion — ACUTE
Pointing at the screen — POINT
Synchronizing the movement of both arms — SYNC
Take a particular stance — STANCE

- tries to block while in front (attack zone)
- in 8:05 segment keeps flicking the Wii Remote
- at 9:30 she's too close to the screen to make blocking work
- often waits with attacking until the turkey is close and she's not targeted.

Figure 68: De Hoogstraat transcript, player 1 scan 1



Session 1, player 1
M2U01713.MPG

game gets reset, ~~laptop~~

10:42 11:41 13:14 14:04 15:00 15:42

Physical Balance

Standing still with or without axillary crutches — STILL
Walking with or without axillary crutches toward the television — TO FRONT
Walking with or without axillary crutches away from the television — TO BACK

Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting — VOTE
A decision is being made by persuasion — PURSUADE
A decision is being made by command — COMMAND
A decision is being made arbitrarily — ARBITRARY
Something is verbally requested from another player(s) — VERBAL
Something is explicitly but not verbally requested from another player(s) — OTHER

Cognition

Start a short motor activity after a specific visual or audio cue — CUE
The time one battle takes (from enemy appearance to disappearance) — TIME

Fine and gross motor skills

Controlled throwing / hitting motion — CONTROLLED
Acute throwing / hitting motion — ACUTE
Pointing at the screen — POINT
Synchronizing the movement of both arms — SYNC
Take a particular stance — STANCE

- at 10:42 she notices the weapon-recharge time
- then starts flailing again
- at 11:42 all players continuously attack close to the screen
- at 13:57 she's observing how other people play

Figure 69: De Hoogstraat transcript, player 1 scan 2

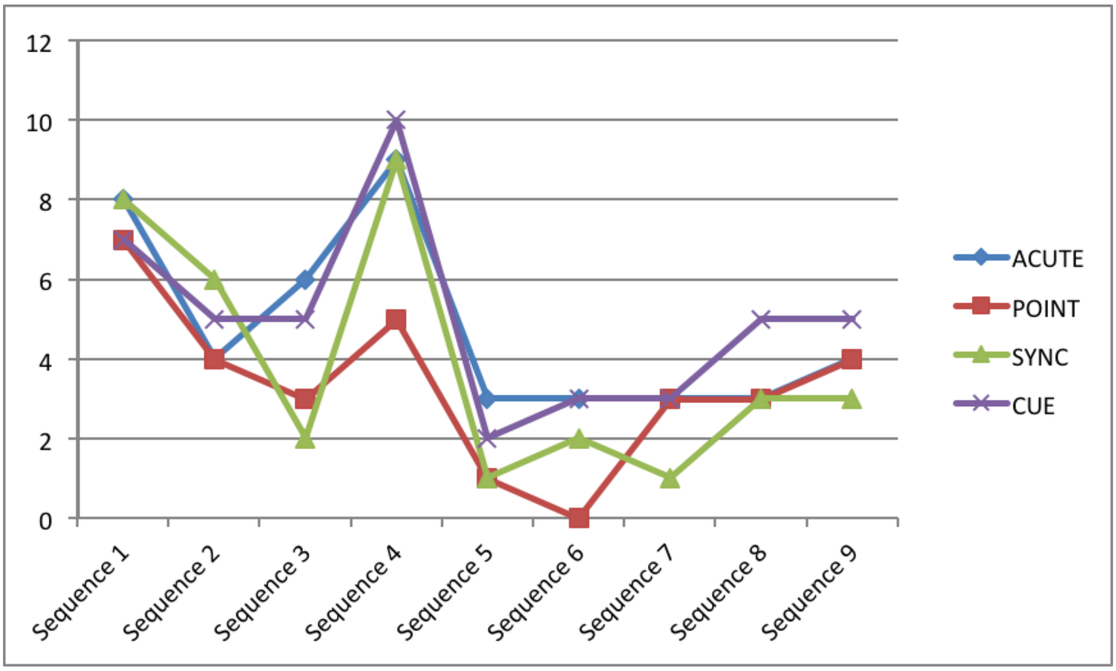


Figure 70; De Hoogstraat, player 1 transcript chart 1

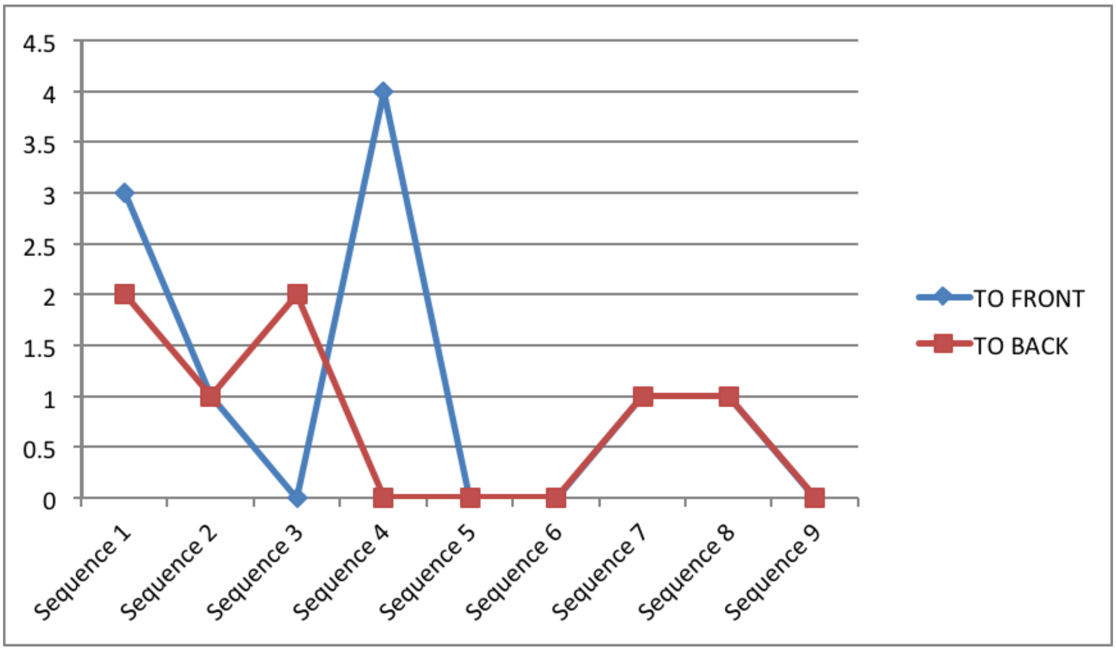
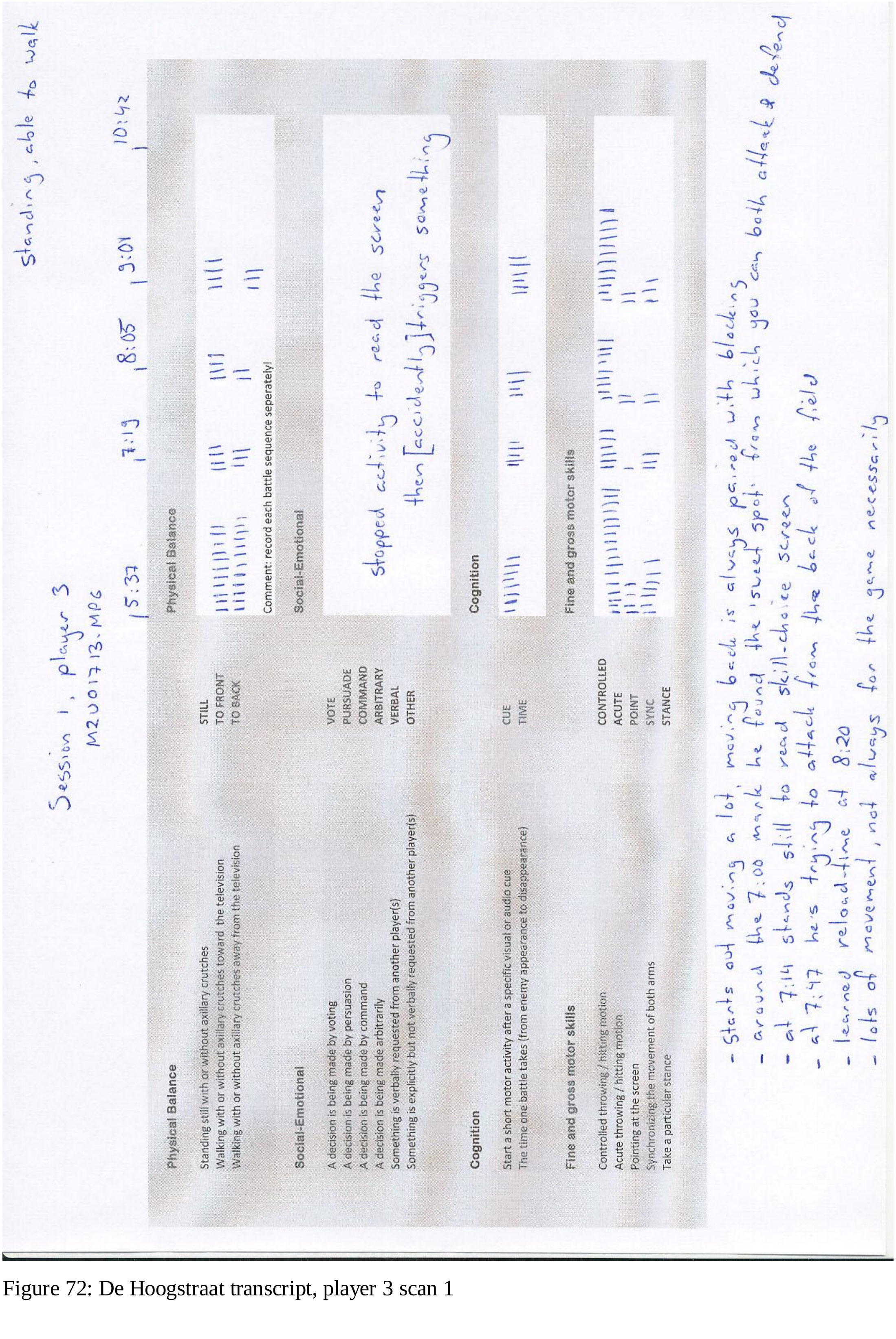


Figure 71: De Hoogstraat, player 1 transcript chart 2



Session 1, player 3
M2U01713.MPG

standing, able to walk

5:37 7:19 8:05 9:01 10:42

Physical Balance

Standing still with or without axillary crutches — STILL
Walking with or without axillary crutches toward the television — TO FRONT
Walking with or without axillary crutches away from the television — TO BACK

Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting — VOTE
A decision is being made by persuasion — PURSUADE
A decision is being made by command — COMMAND
A decision is being made arbitrarily — ARBITRARY
Something is verbally requested from another player(s) — VERBAL
Something is explicitly but not verbally requested from another player(s) — OTHER

stopped activity to read the screen then [accidently] triggers something

Cognition

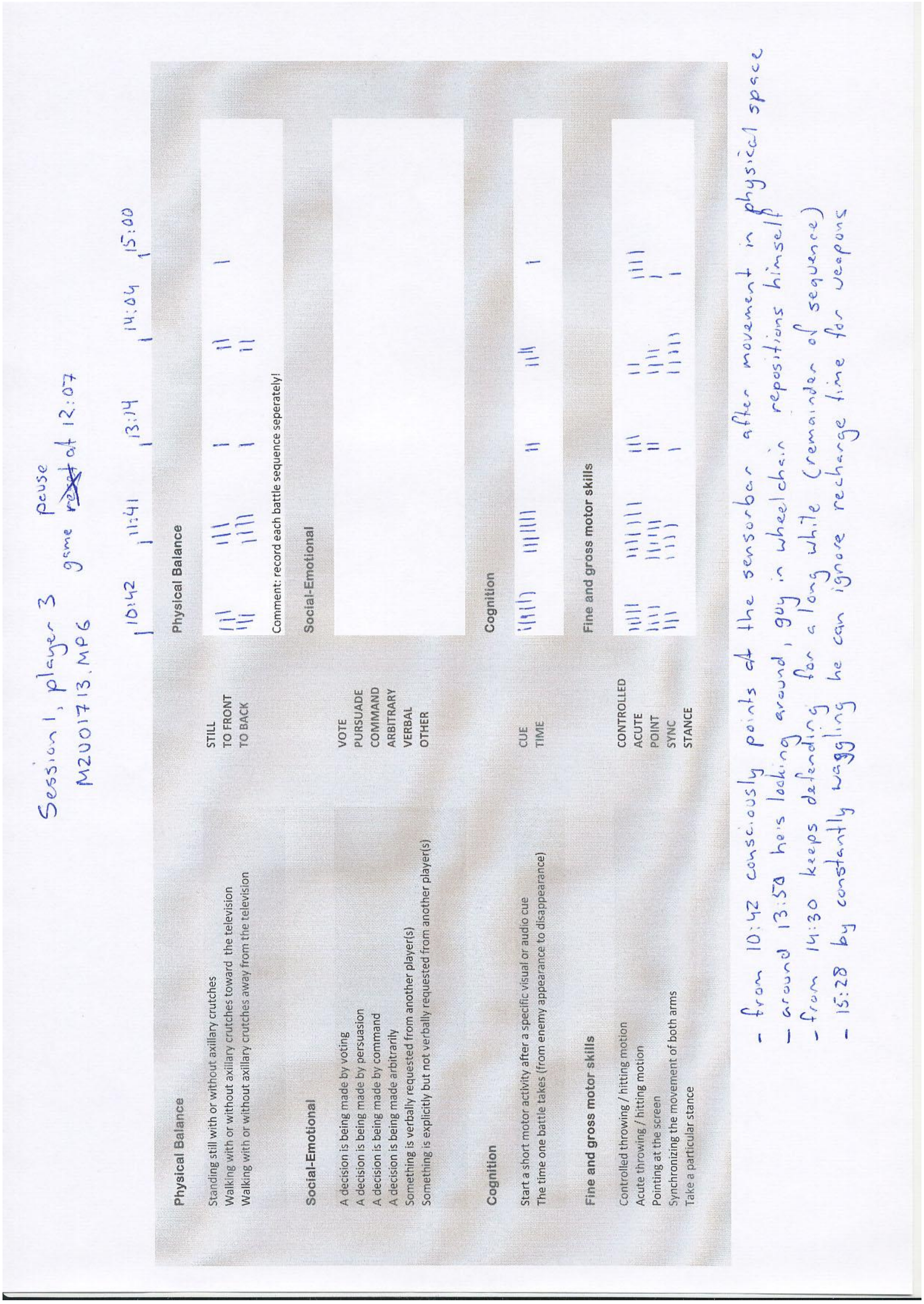
Start a short motor activity after a specific visual or audio cue — CUE
The time one battle takes (from enemy appearance to disappearance) — TIME

Fine and gross motor skills

Controlled throwing / hitting motion — CONTROLLED
Acute throwing / hitting motion — ACUTE
Pointing at the screen — POINT
Synchronizing the movement of both arms — SYNC
Take a particular stance — STANCE

- Starts out moving a lot, moving back is always paired with blocking
- around the 7:00 mark he found the 'sweet spot' from which you can both attack & defend
- at 7:14 stands still to read skill-choice screen
- at 7:47 he's trying to attack from the back of the field
- learned reload-time at 8:20
- lots of movement, not always for the game necessarily

Figure 72: De Hoogstraat transcript, player 3 scan 1



Session 1, player 3
M2U01713.MP6
game pause ~~reset~~ at 12:07

10:42 11:41 13:14 14:04 15:00

Physical Balance

Standing still with or without axillary crutches — STILL
Walking with or without axillary crutches toward the television — TO FRONT
Walking with or without axillary crutches away from the television — TO BACK

Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting — VOTE
A decision is being made by persuasion — PERSUADE
A decision is being made by command — COMMAND
A decision is being made arbitrarily — ARBITRARY
Something is verbally requested from another player(s) — VERBAL
Something is explicitly but not verbally requested from another player(s) — OTHER

Cognition

Start a short motor activity after a specific visual or audio cue — CUE
The time one battle takes (from enemy appearance to disappearance) — TIME

Fine and gross motor skills

Controlled throwing / hitting motion — CONTROLLED
Acute throwing / hitting motion — ACUTE
Pointing at the screen — POINT
Synchronizing the movement of both arms — SYNC
Take a particular stance — STANCE

- from 10:42 consciously points at the sensorbar after movement in physical space
- around 13:50 he's looking around, guy in wheelchair repositions himself
- from 14:30 keeps defending for a long while (remainder of sequence)
- 15:28 by constantly waggling he can ignore recharge time for weapons

Figure 73: De Hoogstraat transcript, player 3 scan 2

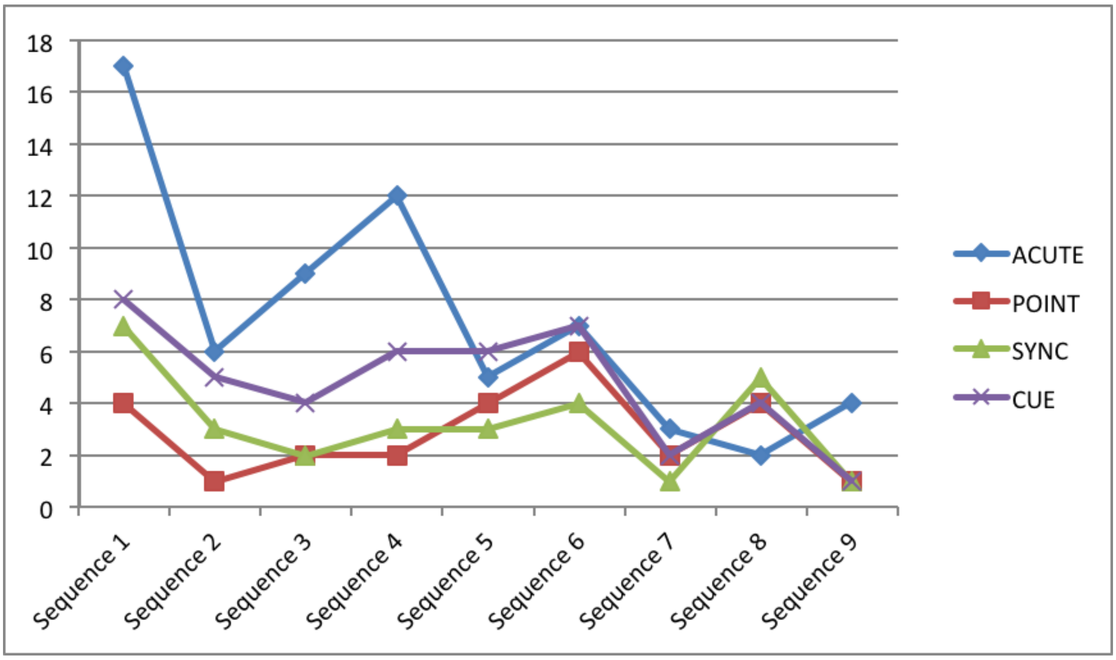


Figure 74: De Hoogstraat, player 3 transcript chart 1

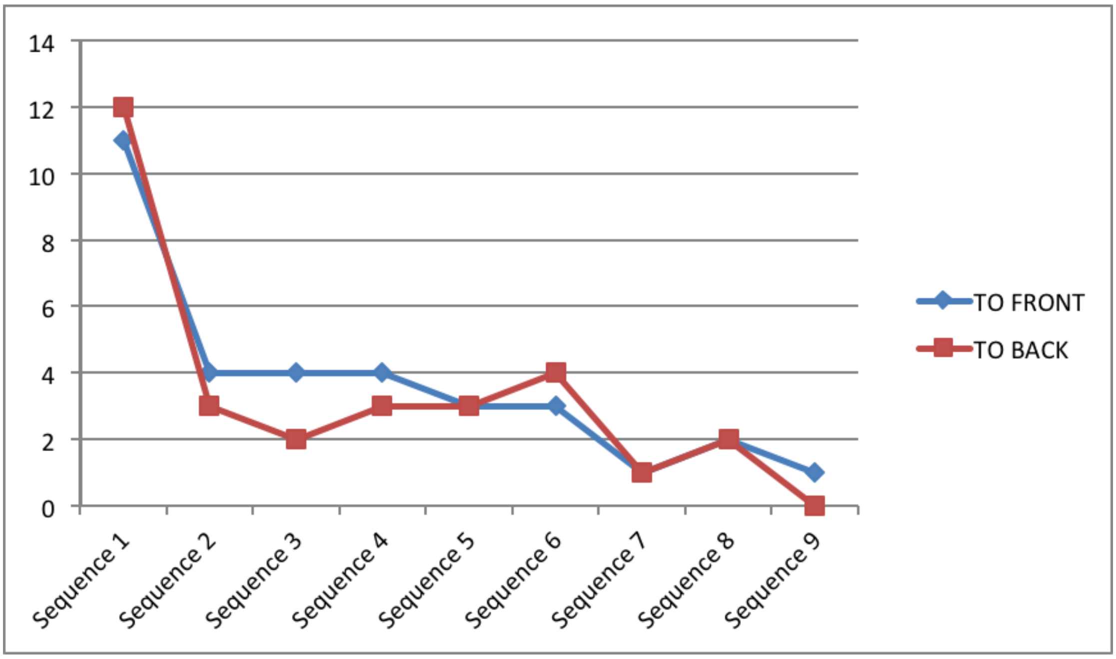


Figure 75: De Hoogstraat, player 3 transcript chart 2

Mytylschool transcripts

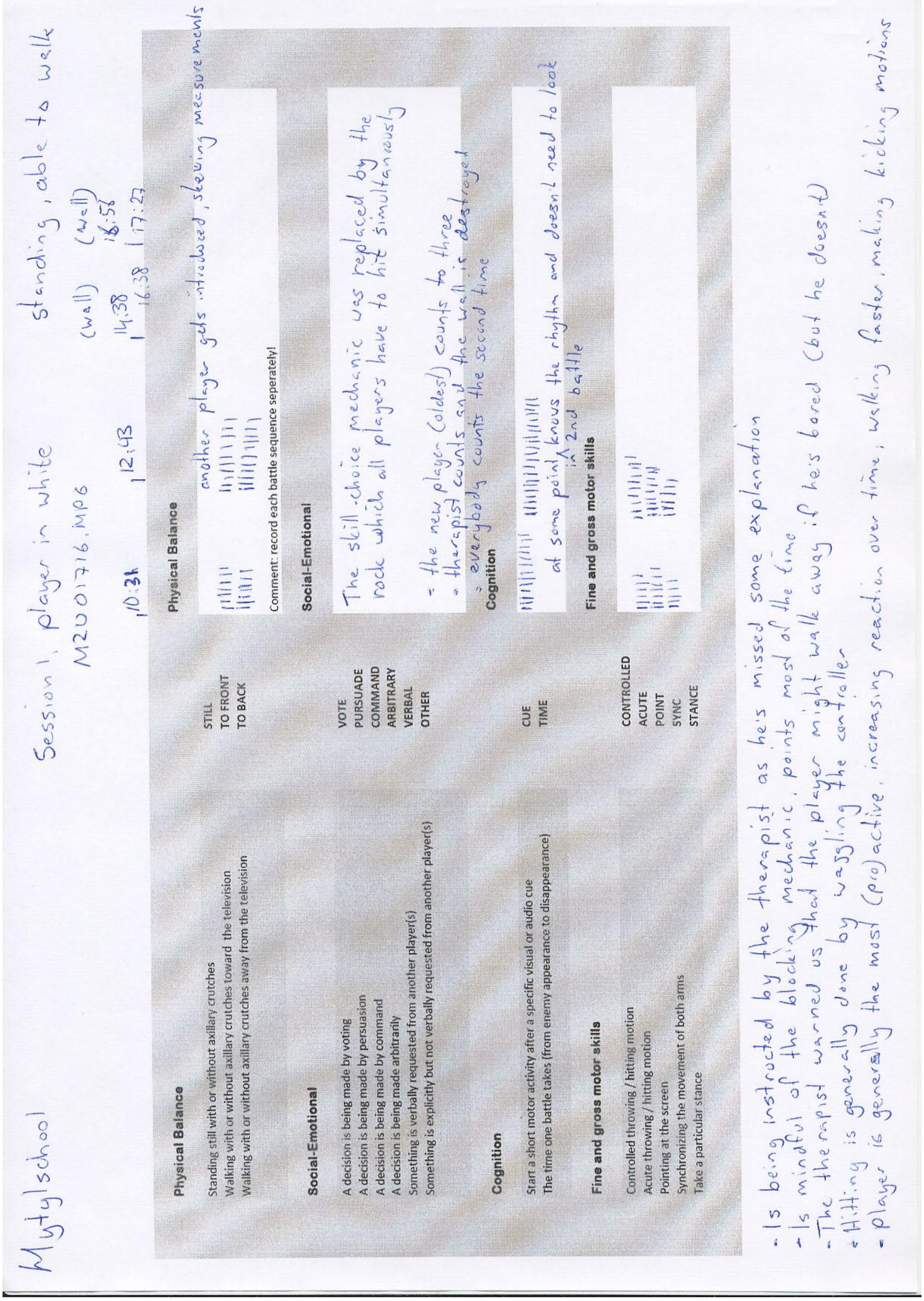
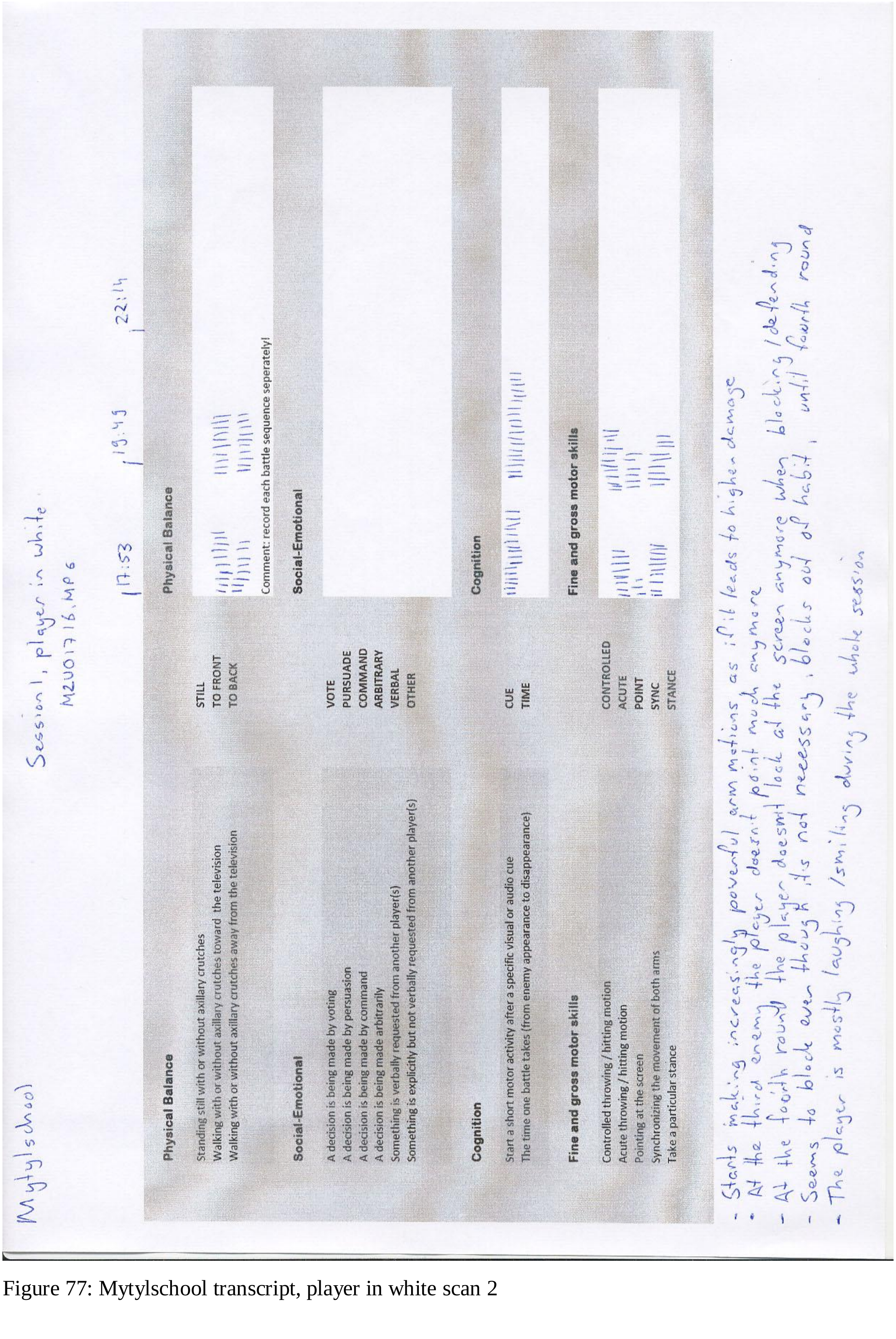


Figure 76: Mytylschool transcript, player in white scan 1



Mytylschool

Session 1, player in white
M2U01716.MP6

17:53 19:49 22:14

Physical Balance

Standing still with or without axillary crutches	STILL	
Walking with or without axillary crutches toward the television	TO FRONT	
Walking with or without axillary crutches away from the television	TO BACK	
		Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting	VOTE
A decision is being made by persuasion	PURSUADE
A decision is being made by command	COMMAND
A decision is being made arbitrarily	ARBITRARY
Something is verbally requested from another player(s)	VERBAL
Something is explicitly but not verbally requested from another player(s)	OTHER

Cognition

Start a short motor activity after a specific visual or audio cue	CUE
The time one battle takes (from enemy appearance to disappearance)	TIME

Fine and gross motor skills

Controlled throwing / hitting motion	CONTROLLED
Acute throwing / hitting motion	ACUTE
Pointing at the screen	POINT
Synchronizing the movement of both arms	SYNC
Take a particular stance	STANCE

- Starts making increasingly powerful arm motions, as if it leads to higher damage
- At the third enemy the player doesn't point much anymore
- At the fourth round the player doesn't look at the screen anymore when blocking / defending
- Seems to block even though it's not necessary, blocks out of habit, until fourth round
- The player is mostly laughing / smiling during the whole session

Figure 77: Mytylschool transcript, player in white scan 2

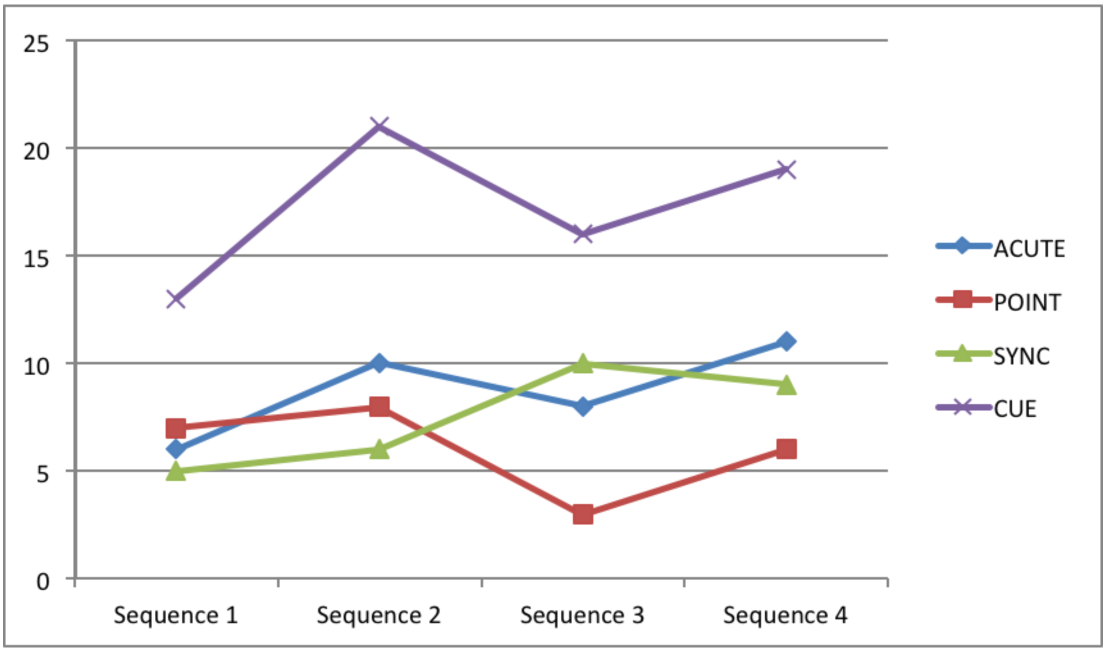


Figure 78: Mytylschool, player in white clothes transcript chart 1

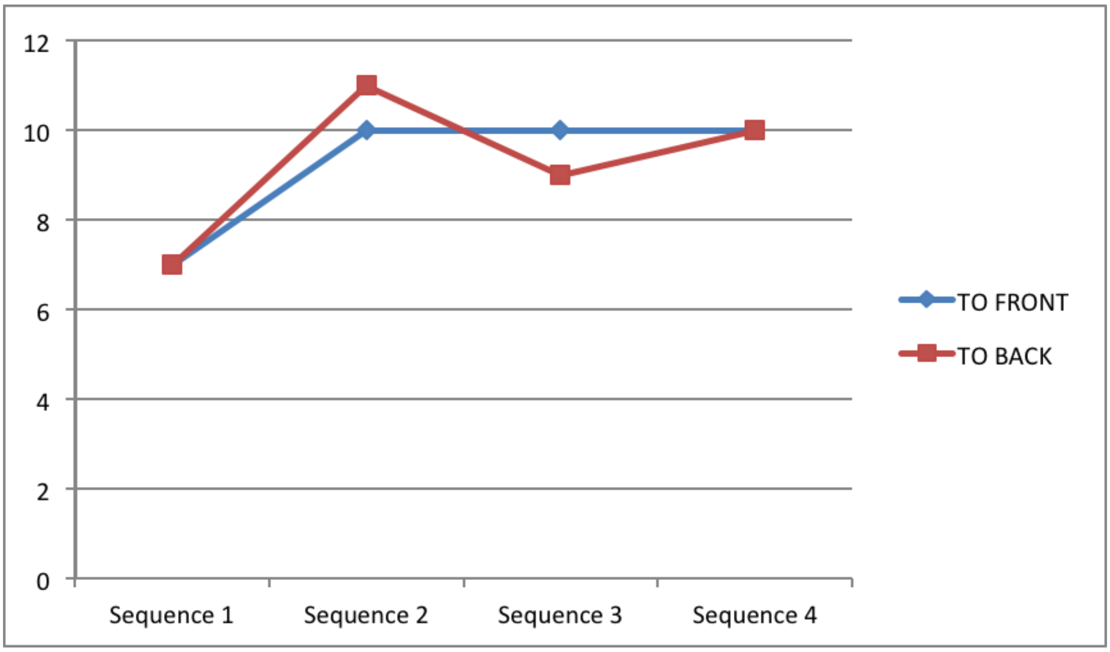
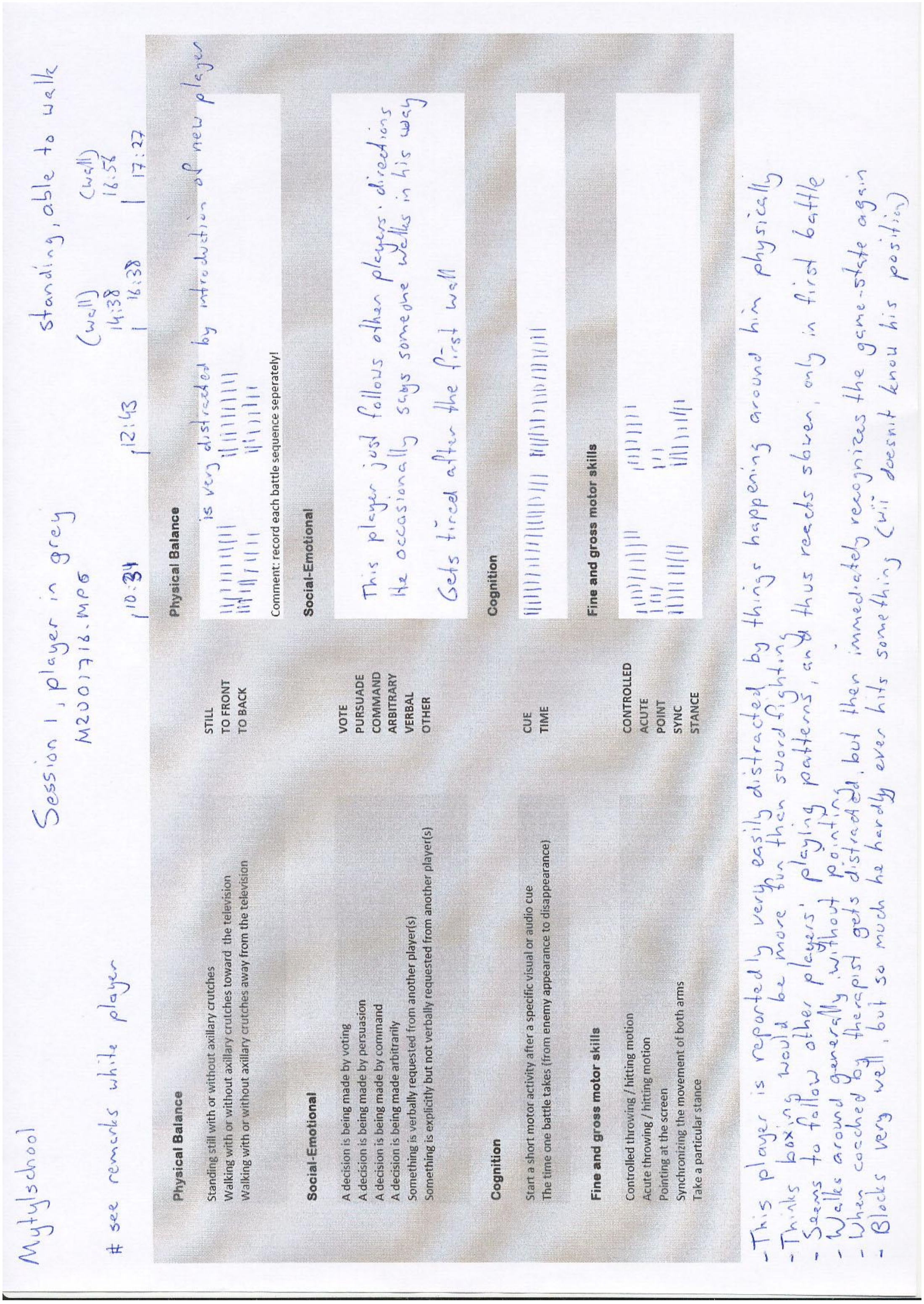


Figure 79: Mytylschool, player in white clothes transcript chart 2



Mytylschool

Session 1, player in grey
M2001718.MP6

standing, able to walk

see remarks white player

10:34 12:43 (wall) 14:38 16:38 (wall) 16:56 17:27

Physical Balance

Standing still with or without axillary crutches	STILL	is very distracted by introduction of new player
Walking with or without axillary crutches toward the television	TO FRONT	
Walking with or without axillary crutches away from the television	TO BACK	

Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting	VOTE
A decision is being made by persuasion	PURSUADE
A decision is being made by command	COMMAND
A decision is being made arbitrarily	ARBITRARY
Something is verbally requested from another player(s)	VERBAL
Something is explicitly but not verbally requested from another player(s)	OTHER

This player just follows other players. directions
He occasionally says someone walks in his way
Gets tired after the first wall

Cognition

Start a short motor activity after a specific visual or audio cue	CUE
The time one battle takes (from enemy appearance to disappearance)	TIME

Fine and gross motor skills

Controlled throwing / hitting motion	CONTROLLED
Acute throwing / hitting motion	ACUTE
Pointing at the screen	POINT
Synchronizing the movement of both arms	SYNC
Take a particular stance	STANCE

- This player is reportedly very easily distracted by things happening around him physically
- Thinks boxing would be more fun then sword fighting
- Seems to follow other players' playing patterns, and thus reacts slower, only in first battle
- Walks around generally without pointing
- When coached by therapist gets distracted, but then immediately recognizes the game-state again
- Blocks very well, but so much he hardly ever hits something (wii doesn't know his position)

Figure 80: Mytylschool transcript, player in grey scan 1

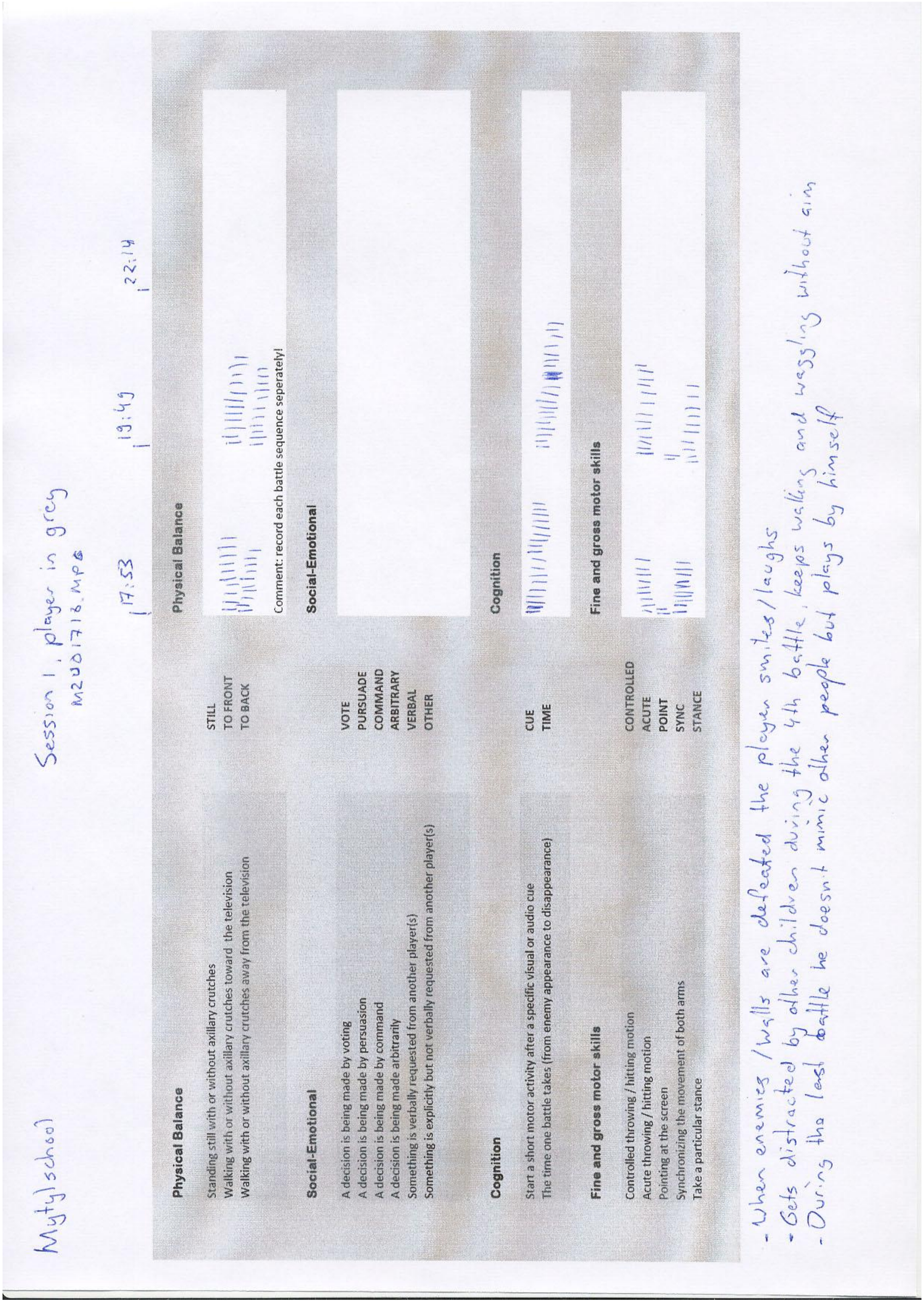


Figure 81: Mytylschool transcript, player in grey scan 2

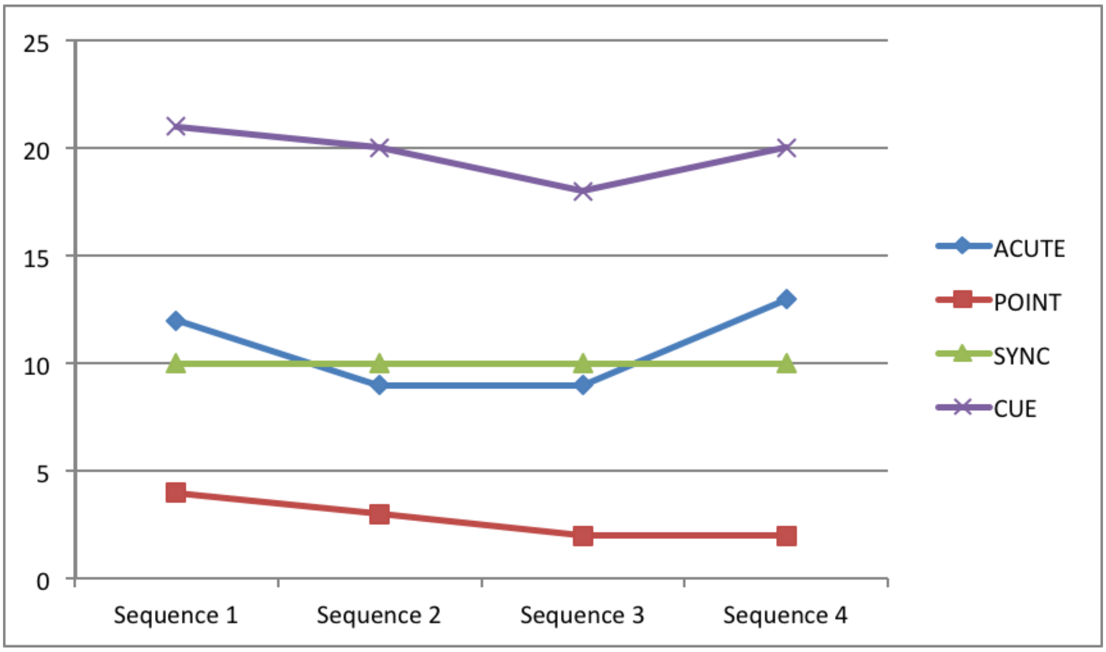


Figure 82: Mytylschool, player in grey clothes transcript chart 1

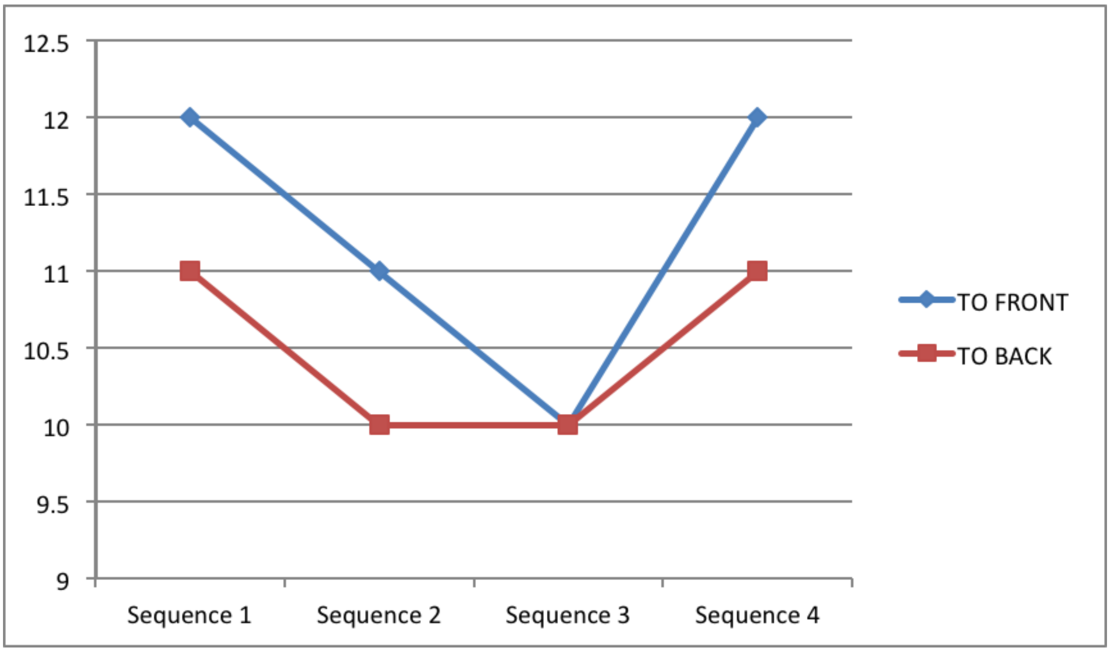
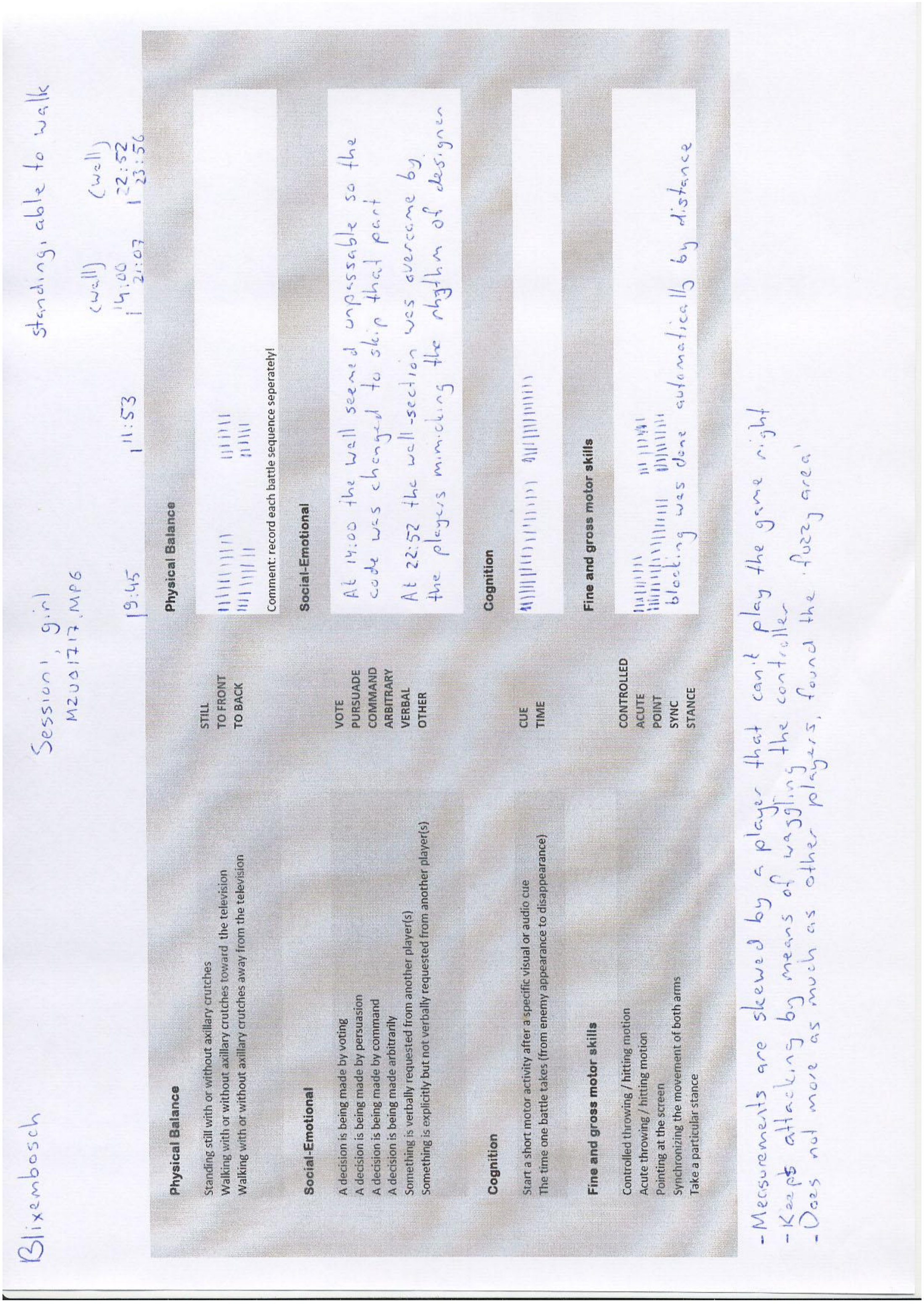


Figure 83: Mytylschool, player in grey clothes transcript chart 2

Blixembosch transcripts


Blixembosch

Session 1, girl
M2U01717.MPG

standing, able to walk

19:45 | 11:53 | 14:00 (wall) 21:07 | 22:52 (wall) 23:56

Physical Balance

Standing still with or without axillary crutches — STILL
Walking with or without axillary crutches toward the television — TO FRONT
Walking with or without axillary crutches away from the television — TO BACK

Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting — VOTE
A decision is being made by persuasion — PURSUADE
A decision is being made by command — COMMAND
A decision is being made arbitrarily — ARBITRARY
Something is verbally requested from another player(s) — VERBAL
Something is explicitly but not verbally requested from another player(s) — OTHER

At 14:00 the wall seemed unpassable so the code was changed to skip that part
At 22:52 the wall-section was overcome by the players mimicking the rhythm of designer

Cognition

Start a short motor activity after a specific visual or audio cue — CUE
The time one battle takes (from enemy appearance to disappearance) — TIME

Fine and gross motor skills

Controlled throwing / hitting motion — CONTROLLED
Acute throwing / hitting motion — ACUTE
Pointing at the screen — POINT
Synchronizing the movement of both arms — SYNC
Take a particular stance — STANCE

blocking was done automatically by distance

- Measurements are skewed by a player that can't play the game right
- Keeps attacking by means of waggling the controller
- Does not move as much as other players, found the 'fuzzy area'

Figure 84: Blixembosch transcript, girl

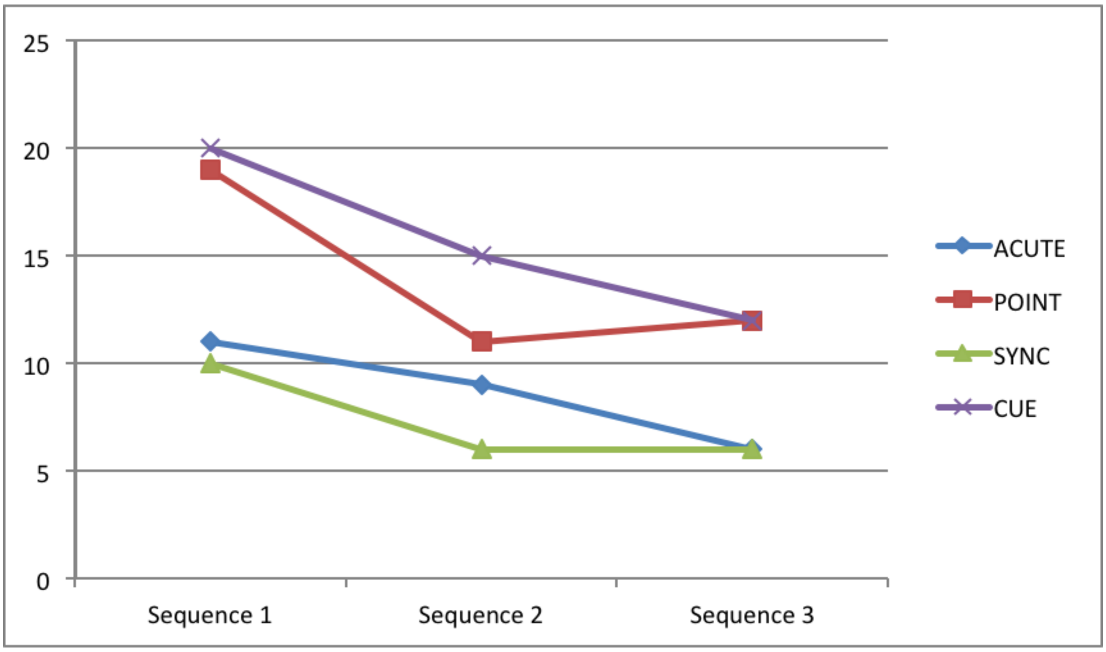


Figure 85: Blixembosch, girl transcript chart 1

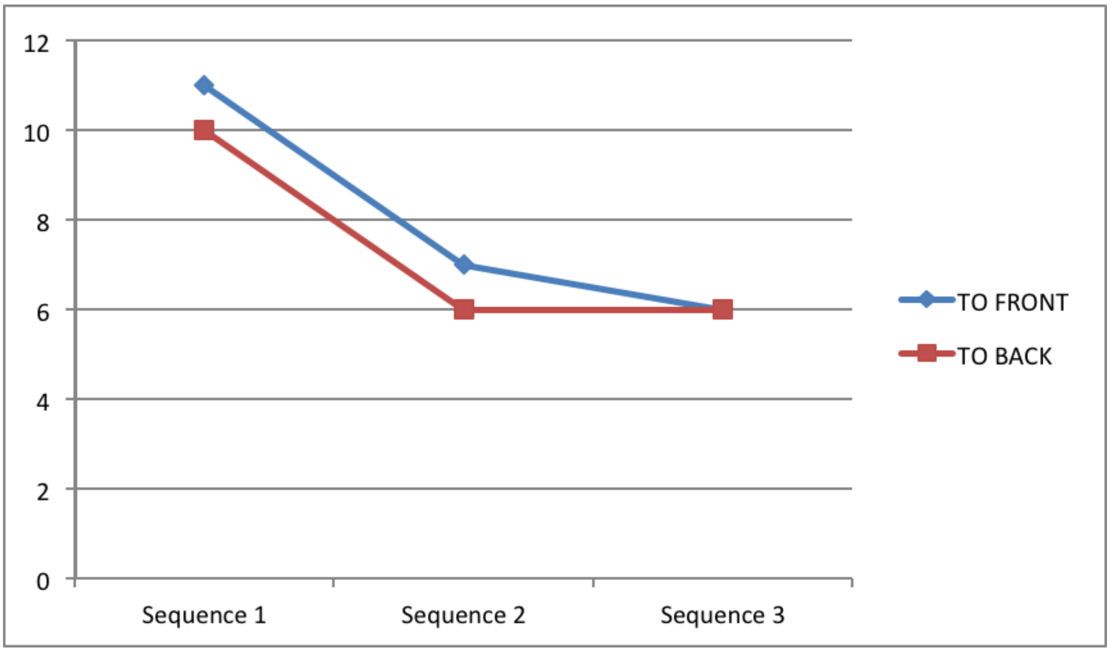
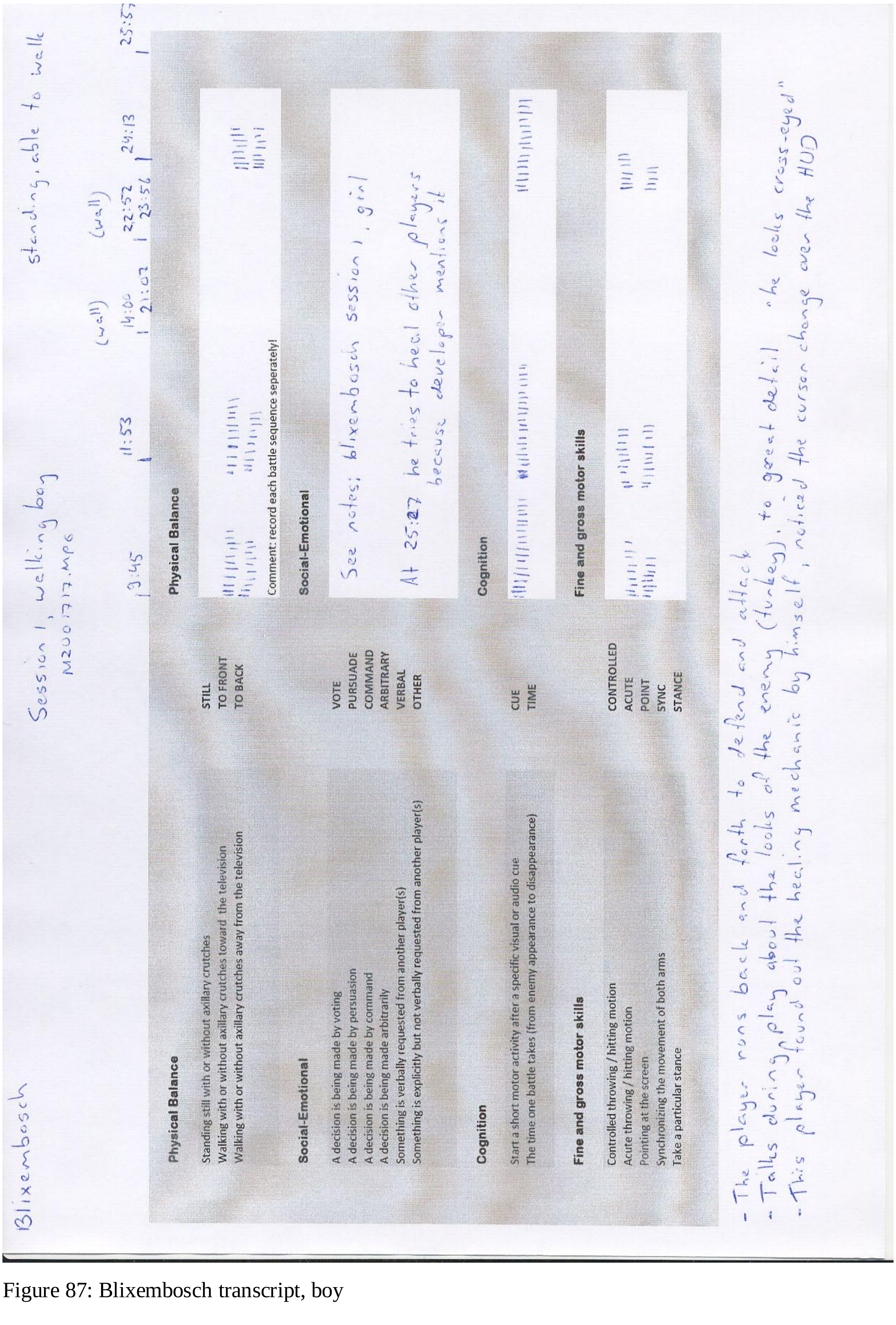


Figure 86: Blixembosch, girl transcript chart 2


Blixembosch

Session 1, walking boy
M2001717.MPG

standing, able to walk

(wall) (wall)

13:45 11:53 14:06 21:07 22:52 23:56 24:13 25:57

Physical Balance

Standing still with or without axillary crutches — STILL
Walking with or without axillary crutches toward the television — TO FRONT
Walking with or without axillary crutches away from the television — TO BACK

Comment: record each battle sequence seperately!

Social-Emotional

A decision is being made by voting — VOTE
A decision is being made by persuasion — PURSUADE
A decision is being made by command — COMMAND
A decision is being made arbitrarily — ARBITRARY
Something is verbally requested from another player(s) — VERBAL
Something is explicitly but not verbally requested from another player(s) — OTHER

See notes; blixembosch session 1, girl

At 25:27 he tries to heal other players because developer mentions it

Cognition

Start a short motor activity after a specific visual or audio cue — CUE
The time one battle takes (from enemy appearance to disappearance) — TIME

Fine and gross motor skills

Controlled throwing / hitting motion — CONTROLLED
Acute throwing / hitting motion — ACUTE
Pointing at the screen — POINT
Synchronizing the movement of both arms — SYNC
Take a particular stance — STANCE

- The player runs back and forth to defend and attack
- Talks during play about the looks of the enemy (turkey), to great detail "he looks cross-eyed"
- This player found out the healing mechanic by himself, noticed the cursor change over the HUD

Figure 87: Blixembosch transcript, boy

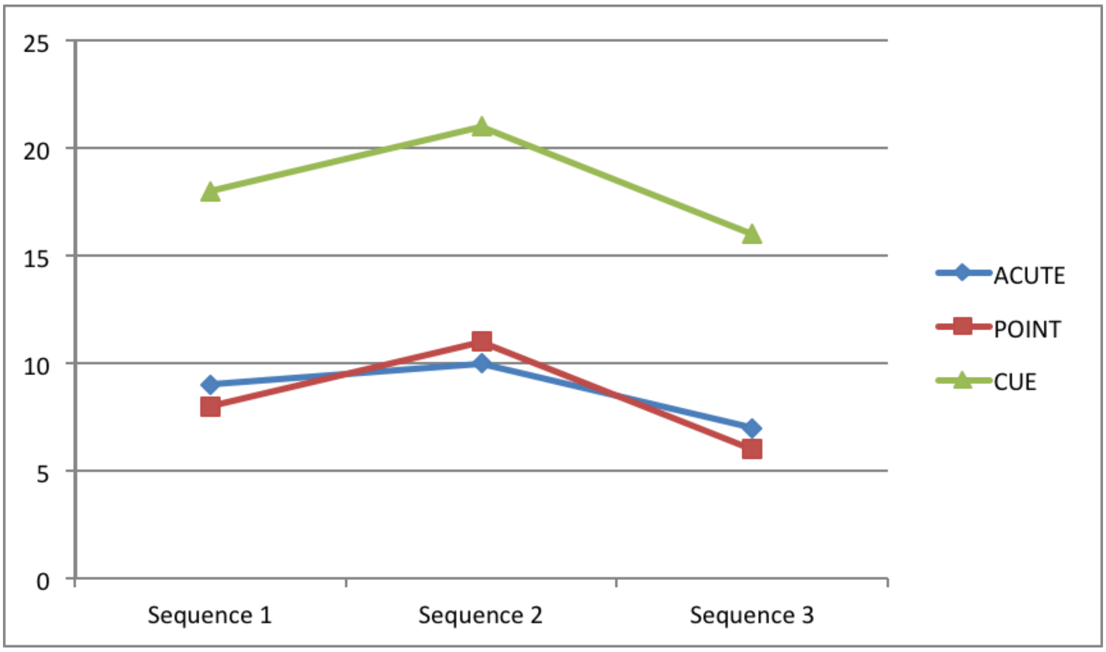


Figure 88: Blixembosch, standing boy transcript chart 1

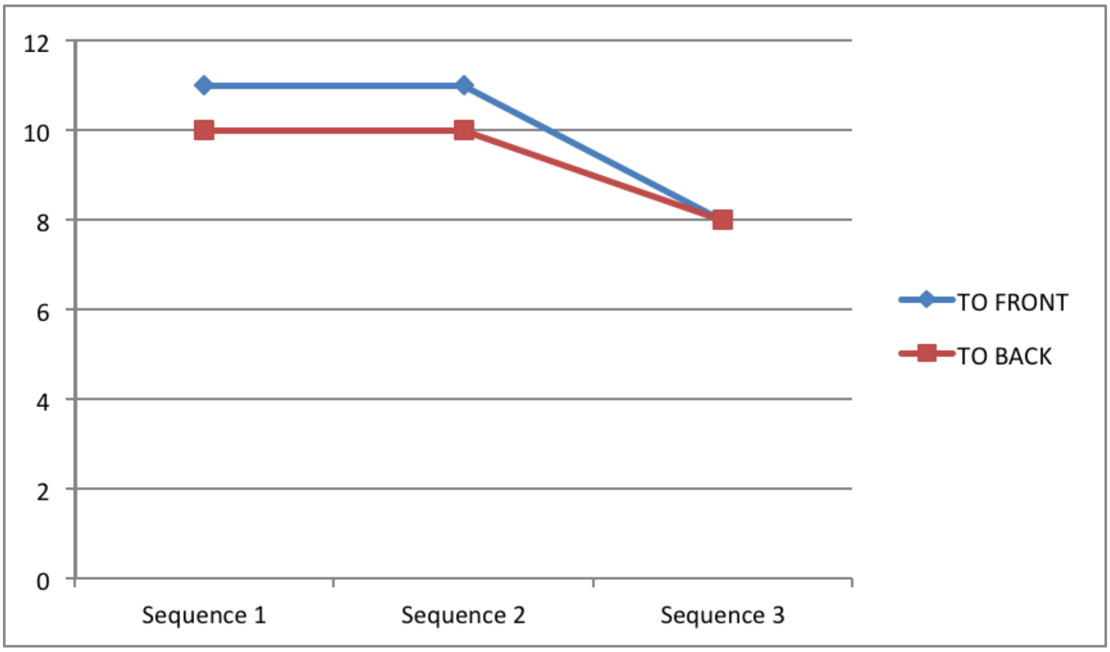


Figure 89: Blixembosch, standing boy transcript chart 2

Interview transcripts

Interview transcript 1

These are the transcripts of the interviews from the playtest at De Hoogstraat on the 22nd of November 2010 in Utrecht, The Netherlands. Q is the interviewer (Lies van Roessel), T1, T2, T3 and T4 are children within the age group of 8 – 16 with an acquired brain injury.

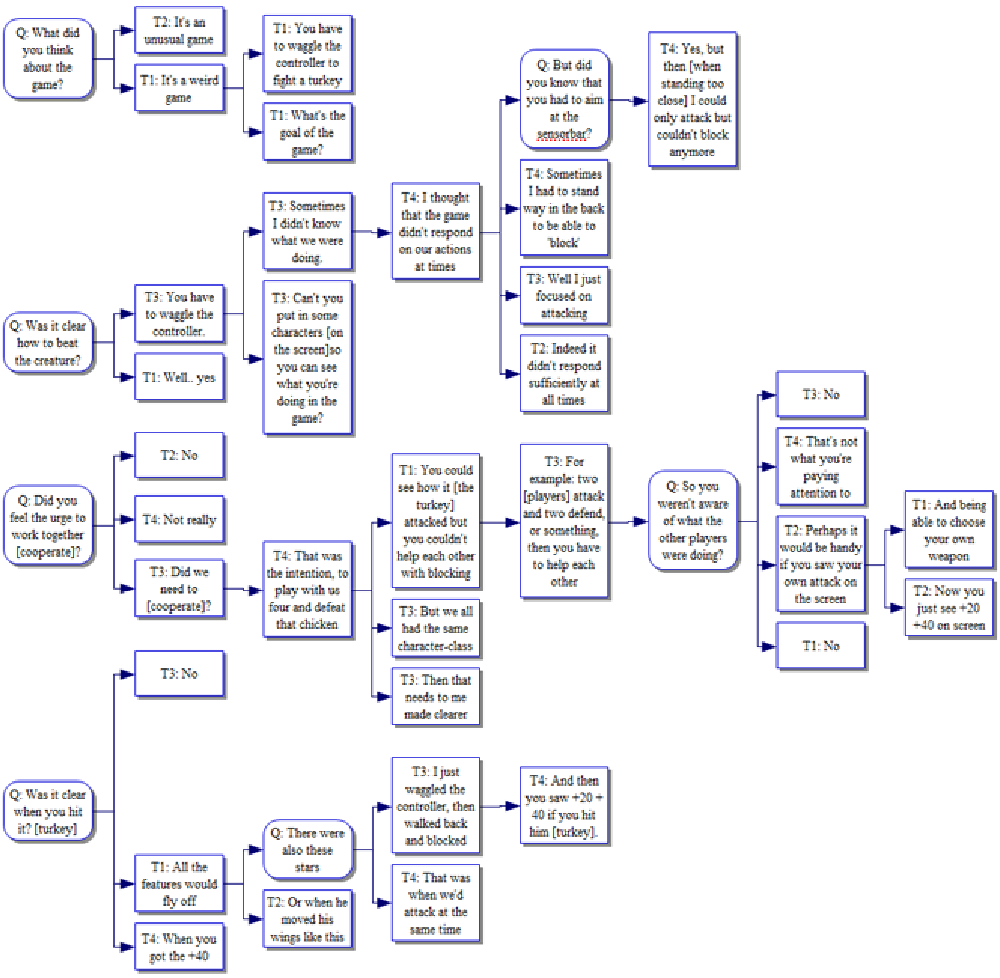


Figure 90: Interview transcript 1

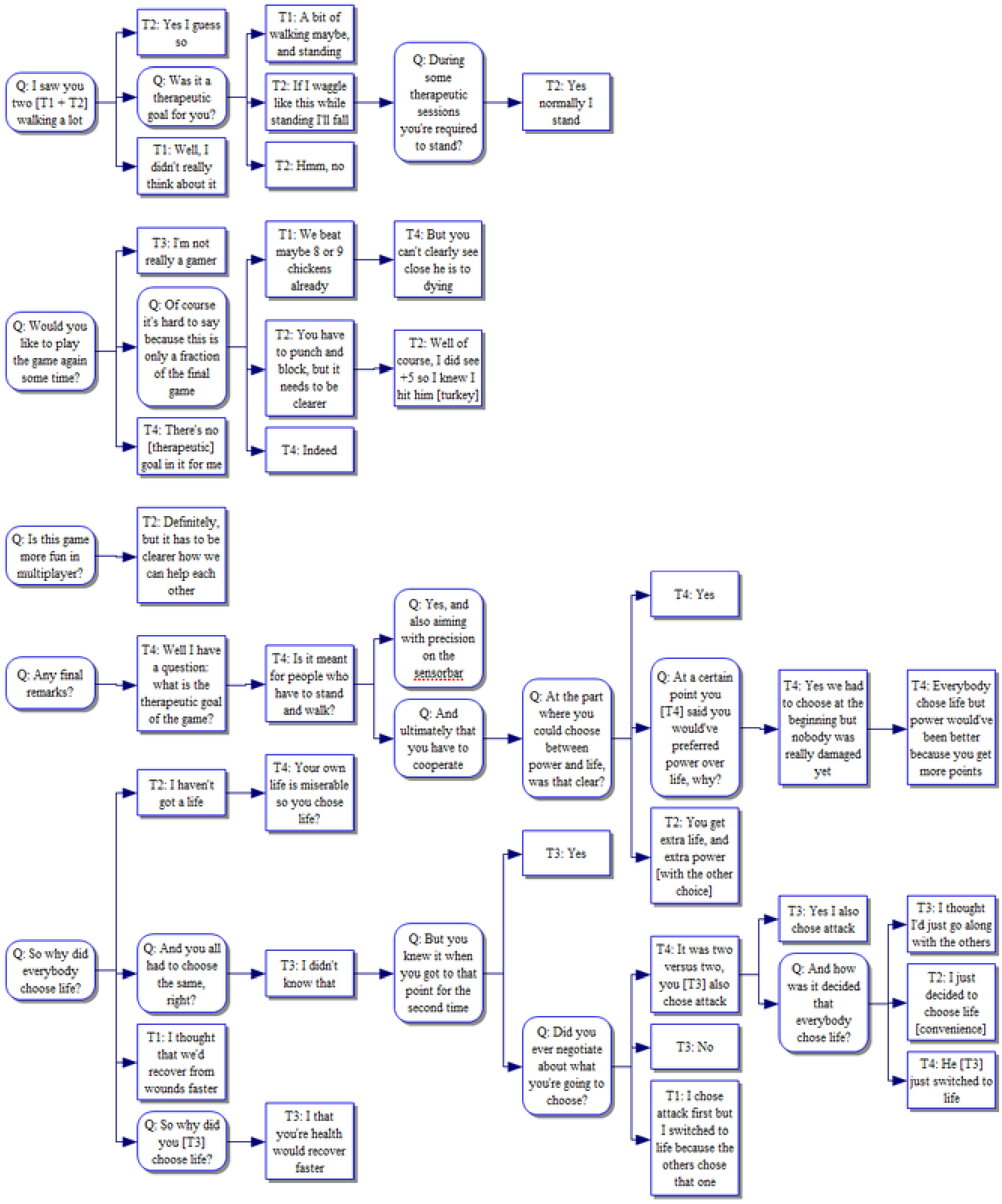


Figure 91: Interview transcript 2

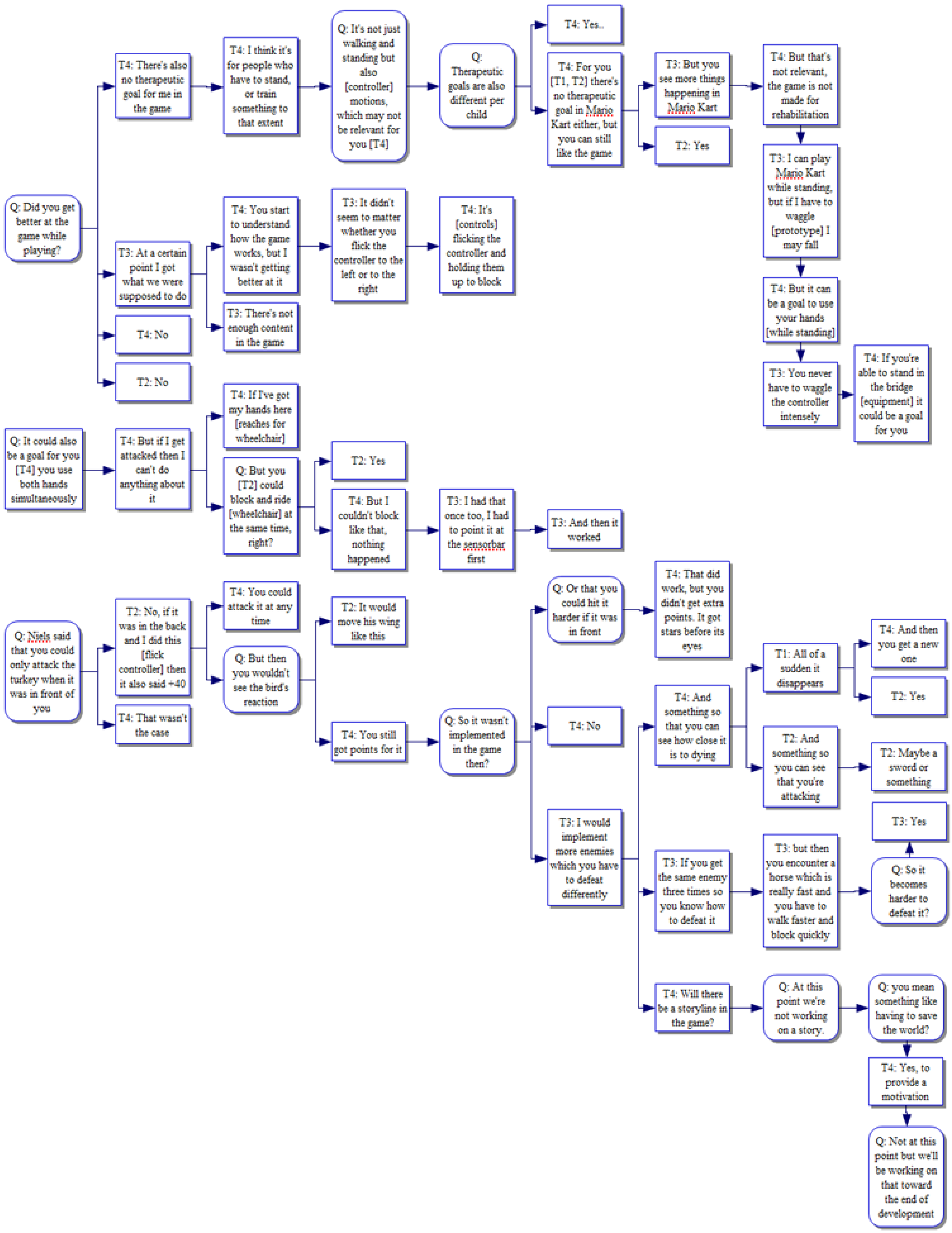


Figure 92: Interview transcript 3

Interview transcript 2

This is a transcript from the 2nd playtest session at De Hoogstraat on the 22nd of November 2010 in Utrecht, The Netherlands. Q is the interviewer (Lies van Roessel), T1, T2, T3 and T4 are a different group of children within the age group of 8 – 16 with an acquired brain injury. Since these candidates were younger a rehabilitation therapist [therapist] joined the conversation.

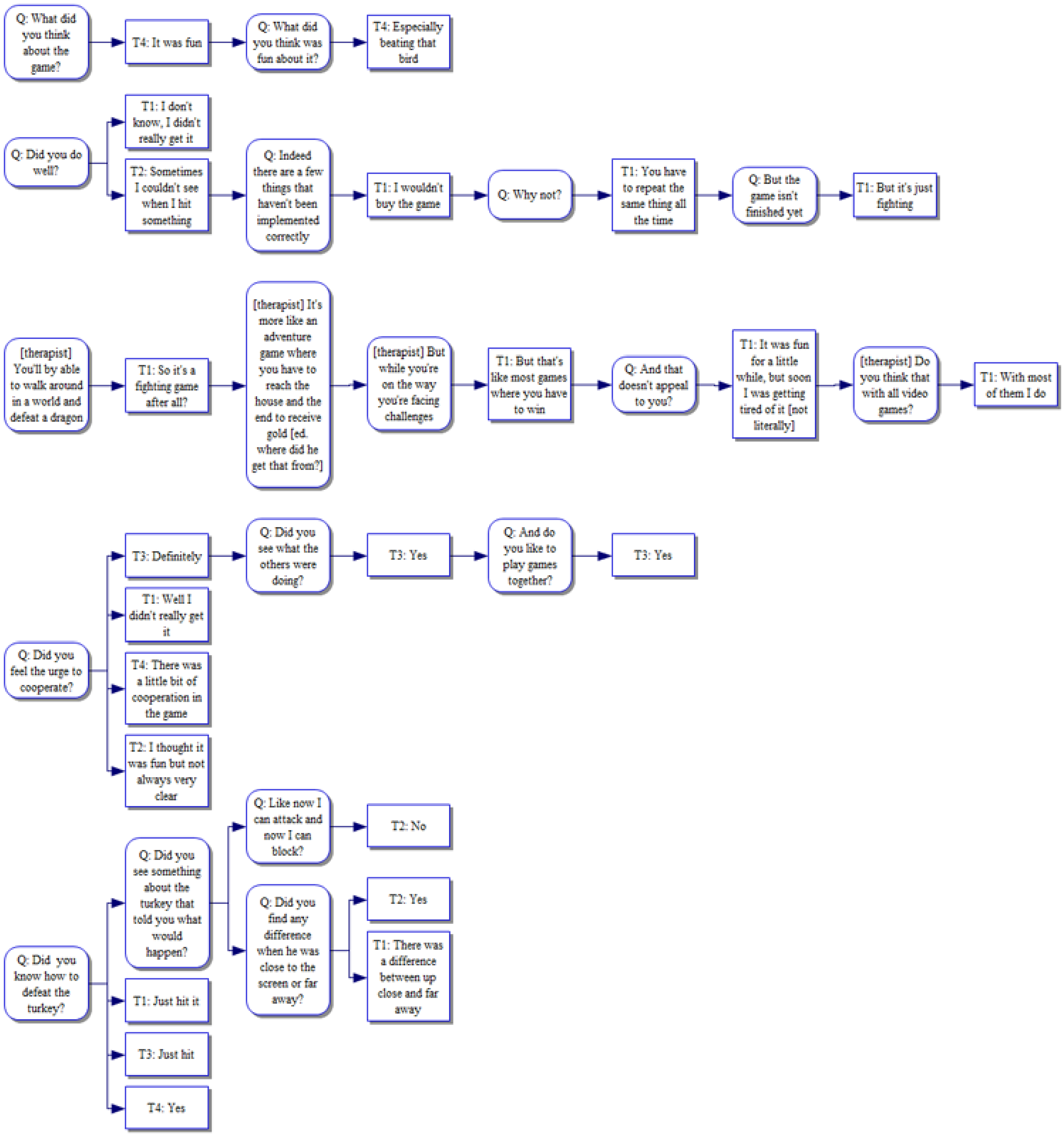


Figure 93: Interview transcript 4

Figure 94: Interview transcript 5

Appendix E: DVD contents

The DVD that is included with the hardcopy version of this exegesis contains a collection of electronic supplementary material. All videos are encoded in MPEG-4 (extension .mp4) format.