

Adaptive Technologies in Digital Games: The Influence of Perception of Adaptivity on Immersion

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The most exciting phrase to hear in science,
the one that heralds new discoveries, is not 'Eureka!' but '*That's funny...*'

— Isaac Asimov

Abstract

Digital games with adaptive technologies offer more tailored experiences to their players, as gameplay is based on the players' performances and behaviours in the game. This could potentially lead to better gaming experiences. Though it is also possible that just the mere expectation of clever AI could affect players' first impressions and subsequently their perceived experiences. At the present moment, there is little empirical evidence supporting this claim.

This research aims to gather empirical evidence to test the hypothesis that players' expectations of an adaptive digital game have an effect on their immersion. For this, three studies were conducted. First, preferences were explored as a form of expectations that could influence immersion. The results show no effect of preferences with regards to the visual perspective on immersion. A more controlled manipulation in the form of game descriptions was then used in the subsequent experiments. Participants played a game without adaptive features while being told that the game was adapting to their performance. As a result, players who believed that the game had adaptive AI experienced higher levels of immersion than the players who were not aware of it. Similarly, when playing the game twice people felt more immersed in the session that was supposedly adapting to their behaviour, in spite of experiencing the same gameplay as in the other session.

This effect was then explored in more detail in games with adaptive features. For this, two games were developed to adapt in two distinct ways to players' performance in the game. Immersion was affected differently depending on the precision of information about these adaptive features. More detailed information prompts players to change their tactics to incorporate the adaptation into their play and experience the benefits of this feature. Merely being aware of the adaptation leads to more immersion, regardless of its presence in the game. Similarly, the presence of an adaptive feature in the game leads to heightened sense of immersion, which is enhanced by the precision of information players receive about it. Evidence also suggests that this effect is durable.

Overall, this research provides empirical evidence to support the hypothesis that players' expectations of adaptive features in single-player games have a positive effect on immersion. This is a valuable contribution to the theoretical understanding of immersion, while it also provides some insights into the potential precautions that should be considered when conducting experiments into player experience in the lab and 'in the wild', both in academic studies and during player testing sessions run by game developers.

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Declaration

I, Alena Denisova, declare that this thesis is a presentation of original work and I am the sole author. Chapter 3 presents collaborative work and clearly states the contributions of this author and the collaborators. This work has not previously been presented for an award at this or any other university, and all sources are acknowledged as references.

Some of the material contained in this thesis has appeared in the following published or awaiting publication papers:

1. A. Imran Nordin, **Alena Denisova**, Paul Cairns. (2014). Too Many Questionnaires: Measuring Player Experience Whilst Playing Digital Games. In *Proceedings of the Seventh York Doctoral Symposium on Computer Science and Electronics (YDS)*, York, United Kingdom, October 2014.
2. **Alena Denisova** and Paul Cairns. (2015). First Person vs. Third Person Perspective in Digital Games: Do Player Preferences Affect Immersion? In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (ACM CHI)*, Seoul, Korea, April 2015.
3. **Alena Denisova** and Paul Cairns. (2015). The Placebo Effect in Digital Games: Phantom Perception of Adaptive Artificial Intelligence. In *Proceedings of the ACM SIGCHI Annual Symposium on Computer-Human Interaction in Play (ACM CHI PLAY '15)*, London, United Kingdom, October 2015.
4. **Alena Denisova** and Paul Cairns. (2015). Adaptation in Digital Games: The Effect of Challenge Adjustment on Player Performance and Experience. In *Proceedings of the ACM SIGCHI Annual Symposium on Computer-Human Interaction in Play (ACM CHI PLAY '15)*, London, United Kingdom, October 2015.
5. **Alena Denisova**, A. Imran Nordin, and Paul Cairns. (2016). The Convergence of Player Experience Questionnaires. In *Proceedings of the ACM SIGCHI Annual Symposium on Computer-Human Interaction in Play (ACM CHI PLAY '16)*, Austin, Texas, United States, October 2016.

Introduction



“There are things known and there are things unknown, and in between are the doors of perception.”

Aldous Huxley, 1954

NOWADAYS digital games are a popular means of entertainment not only amongst children and teenagers, but also amongst adults of various ages, and the diversity of the audience is growing steadily (Entertainment Software Association (ESA), 2016; UK Interactive Entertainment (Ukie), 2016). With the rapid growth in technological progress, more advanced machines are being built, and as a result digital games are being popularised even more due to their increasing availability. People play digital games in the comfort of their own homes, while commuting to work, in a queue or while waiting for a bus, in competitions and championships for a gaming title – anywhere at any point in time modern technology allows players of any age with a variety of tastes and interests to immerse themselves into the virtual worlds of digital games.

While there is a considerable number of digital games available on various platforms with new products being created every day, only few of them become popular hits that are widely played by millions of gamers, a most recent example being *Pokemon Go*. Some digital games are only massively enjoyed for a short period of time before the interest dies down, like *Flappy bird*; while others provide long-term entertainment for their players – some games, like *Final Fantasy* series, are made into a media franchise based on the success of the first games in the series, and some digital games with frequently updated content can be played for several months or even years, e.g. *World of Warcraft* (WoW). The success of these games is being widely discussed in online forums and articles by players, as well as analytically studied by digital games researchers, like Bessièrè, Seay, and Kiesler (2007) and Livingston et al. (2014), in order to establish what exactly makes peo-

Research of digital games has become prevalent with their growing popularity

ple play them in the first place, and what makes players return to play again.

Challenge in digital games

Games technology, from the hardware players use to interact with the game to the in-game elements, plays a vital role in shaping players' experiences. Challenge is amongst some of the more valued factors that contribute to this overall experience (Adams, 2014). Designing games with appropriate level of difficulty and learning curve that is suitable for all players is, however, not that simple: the game should be challenging enough to keep players interested, while at the same time not overly hard, so that players do not feel frustrated or overwhelmed. As sets of skills and previous experiences vary between individual players, it poses a challenge for designers who want to be inclusive of the diverse audience of their games. A common method for dealing with this issue is, then, to have a discrete set of difficulty levels for players to choose from – a system that is adaptable to the player. However, an alternative, though not extensively studied, approach is to provide players with a more tailored experience by using a dynamic adjustment of the difficulty in the game: a concept commonly referred to as Dynamic Difficulty Adjustment/Balancing (DDA), or, more generally, *adaptive technologies*.

Adaptive technologies
Perception of digital games technologies

Gaming experiences, however, also differ between players based on their individual perceptions and attitudes toward the game and certain gaming concepts. Players' perceptions of games can be affected by the reviews they read online (Livingston, Nacke, and Mandryk, 2011), or by their previous experiences of similar games and knowledge about them in general (O'Brien and Toms, 2008). Players form preferences, which can help them in difficult choices, while it can also limit players with regards to the options they might never explore. Nonetheless, little is yet known about how players' perceptions of digital games technology affect their experience of playing those games. In particular, with the growing interest in making gaming experiences more tailored to each player with the use of adaptive technologies, more research is required in order to understand how players' attitudes toward and perceptions of such adaptations affect their gaming experiences.

1.1 Research Motivation

Adaptive technologies are a well-recognised concept in gaming communities, which refers to the ability of a digital game to match a

player's actions in an intelligent and appropriate manner (Spronck, 2005). This involves modifying the challenge of the game based on the player's skills, typically modifying behaviour of the non-player characters with accordance to the player's behaviour. The concept is being widely explored in digital game industry to ensure playability for a wider range of players – many algorithms and models are being developed in order to learn from the player (Charles and Black, 2004; Houlette, 2004).

Changing the level of challenge in a game makes it possible to balance game play to the skills of the player, potentially providing better gaming experiences and prolonging the period of play. The hope is that adaptive game technology can be used to moderate the challenge levels for each person, help players avoid getting stuck, adapt gameplay more to one's preferences, or even detect players abusing the game design to their advantage (Charles et al., 2005). In multiplayer games, where the difference in skill and experience between players can be large, adaptive algorithms are used more frequently than they appear in single player games, where the main challenge is to beat the game AI. Difficulty adjustment (Hunicke, 2005), matchmaking, asymmetric roles, and skill and aim assistance (Vicencio-Moreira, Mandryk, and Gutwin, 2015) are amongst most common techniques, which are believed to improve player experience. When a player feels that the game is responsive to them as an individual, they may feel more immersed in the game world, and they experience a heightened sense of enjoyment when the game matches their abilities (Sherry, 2004).

*Benefits of
adaptive
technologies*

However, skill balancing in multi-player digital games is not always perceived as fair. When playing against another player who is evidently being helped by the difficulty balancing algorithms can cause frustration. Similarly, one might feel discouraged knowing that they are playing against a stronger opponent, and the reason why they are still not losing is mostly due to the factors outside their own skills (Gerling et al., 2014).

*Perception of
fairness with
regards to
adaptivity*

In single-player games, on the other hand, adaptive technologies have the potential to be perceived more positively, as they allow players to have a smooth progression through the game and enjoy it regardless of their skill level. Having a positive expectation of a potentially beneficial feature like this could positively influence players' immersion levels. According to Douglas and Hargadon (2001), players develop schemas based on generic concepts and their knowledge in order to guide their expectations. Hence, immersion occurs as a result of a player being absorbed in the world of familiar schema – when all

their expectations are met. Knowing that a digital game has adaptive technology, which is potentially beneficial to one's gameplay, can lead to an increased immersion due to such expectations.

However, no empirical evidence yet exists to back up or refute this hypothesis. Learning more about the effect of players' perception of adaptive technologies in games is important to be addressed and researched not only in order to expand the current knowledge about immersion and player experience in general, but the findings could also be of interest to game developers, who could use this knowledge in order to gain insights into their target market. Therefore, the aim of this thesis is to explore how players perceive adaptive technology in digital games and whether this perception affects their immersive experience of the game.

1.2 Research Question and Objectives

Research question The main research question addressed in this thesis is, therefore:

Does the information players know about adaptive features in a digital game influence their immersion?

The expectations players have about a game are based on the information they know about it before they get to play it. Thus, players' awareness and perception of adaptive technologies prior to their first encounter with the game can be crucial to their first experience. If this is the case, this effect should be explored in more detail.

Research objectives The objectives of this thesis, therefore, are:

- To explore how player awareness of adaptive features in and knowledge about them in a digital game affect their immersion.
- To explore whether the accuracy of information players know about adaptive features of a digital game affects their immersion.
- To explore whether the precision of information players know about adaptive features of a digital game affects their immersion.
- To explore the durability of the effect of information about adaptive features in a digital game on immersion.

1.3 Research Approach and Methodology

The research was primarily based on a series of quantitative controlled laboratory studies in order to address the research question and objectives as this thesis aims to empirically evaluate the effect of information-infused expectations of adaptive technology in digital games on player immersion.

To answer the main research question, a series of empirical studies have been conducted. The primary methodology in this thesis focuses on a quantitative approach, which allows us to study a specific phenomenon in a controlled environment. This method allows the experimenter to control the experimental manipulations, and reduce the number of confounds that might otherwise be found 'in the wild', increasing the internal validity of the experiments, though reducing environmental validity (Cairns and Cox, 2008). Moreover, this approach follows the general conventions used in player experience research, where quantitative studies are often used to test a specific hypothesis, such as whether one's immersion in a digital game is influenced by their expectations of the game – the hypothesis being tested in this thesis. Deception plays a major role in the manipulations used in the studies, so in order to obtain robust effects, quantitative measures are detrimental to this style of work. Qualitative research, on the other hand, allows to gather more detailed responses about players' perception of adaptive technology, however they are self-reported and do not necessarily allow us to test the subtle effect that players might not necessarily notice otherwise. Therefore, the primary method chosen for this work was an experimental approach. In order to be able to gain further insight into the interpretation of the results, additional lightweight qualitative data was also collected at the end of some experiments to avoid experimental and confirmation bias.

*Research
methodology*

The qualitative data collected used open-ended questions at the end of these studies was used purely to inform the discussion of the quantitative results, and therefore was not analysed using formal methods. Participants' responses were grouped based on common themes, which were then used to gain further insight into the interpretation of the results from the analysis of quantitative data. Generally, the qualitative responses allowed to check whether the manipulation used in the experiments had an effect of players' perception of the game, while also having an effect on player experience, as measured using a questionnaire.

Generalisability To ensure the generalisability of the results, the sample sizes collected in the studies were estimated from effect sizes obtained in related studies, if applicable. The collected samples are within the appropriate range, and the numbers are comparable with the numbers of participants typically recruited for the studies in the player experience field.

Ecological validity Additionally, to provide the most realistic environmental set-up for the experiment, majority of the studies described in this thesis, unless otherwise stated, were conducted in the Home Lab, in the Department of Computer Science at the University of York. This purpose built flat was designed to have the look and feel that many technology users might find in their homes, which provides more ecological validity when gathering data. Studies that were not run in the Home Lab due to its availability were conducted in a dark quiet room in the University's Library to avoid any distractions and minimise the effect of the surroundings on game play.

Study I
Measuring PX Overall, six studies have been conducted in order to explore the effect of players' expectations of adaptive features in digital games on their immersion, with an additional study that was aimed at gathering information about available tools to make an informed decision when choosing the most suitable questionnaire to measure immersion. This study was conducted online to gather a large number of responses from a diverse audience of game players. The results showed the convergence of the three widely used questionnaires, and the decision was made to use the Immersive Experience Questionnaire (IEQ) (Jennett et al., 2008) to measure player experience.

Study II Three studies, described in **Part III**, were aimed at exploring whether players' expectations affect their experience of playing a digital game, where the expectations either came from players' previous experiences of a game in the form of preferences (Chapter 5), or when reading about a digital game prior to their first encounter with it. The point of view through which players see the game world was used as an experimental manipulation when evaluating the effect of players' preferences with regards to the viewpoint on immersion. The first-person perspective was more immersive than its third-person counterpart in a game that provides a choice between the two camera viewpoints. While players' personal preferences of perspectives did not have a significant effect on immersion.

Preferences are, however, a pseudo-independent variable, as they differ between players based on many factors, and are difficult to control in experiments. A more controlled manipulation was used in the

other two studies (Chapter 6), where players were given some information about a potentially useful feature in a digital game in order to explore how immersion might change based on the expectations set by the game description. In one study, participants played a survival game twice. The two sessions did not differ in the settings, however the players were told that one of the sessions had an adaptive technology, which changes gameplay based on their performance, and that the other session supposedly did not have this feature. In both cases players were engaged in a randomly generated session with the same gameplay. The results showed that players believed that the game had adaptive AI, which resulted in a subconscious increase in their reported levels of immersion. Additionally, to avoid the bias of explicit comparison of the two sessions, another study was conducted to test the hypothesis that players who are only exposed to the game once would feel more immersed when being aware of the adaptive AI's presence, while those who are not would feel less immersed. The results were on par with the ones obtained in the previous study: players who believed that the game had adaptive AI perceived the game as more fun and felt more immersed in it than the players who did not know about its existence.

Study III

Study IV

To explore this effect in more detail, three additional studies were designed, in which we manipulated players' perception of games by providing players with different information about adaptive features in them. They are described in **Part IV** of this thesis. These studies were aimed at exploring the effect of information in more detail using different games and types of adaptation. Chapter 7 describes a timer adaptation, which was developed in order to test if this simple adaptation has an effect on immersion. The findings showed that this adaptation is enough to improve players' experience of the game. This adaptation was then used to evaluate how different amounts of information players know about the adaptive technology affects immersion in the game with or without this feature (Chapter 8). Players were told either full information about the precise mechanics of the timer, or were only exposed to the fact that it was adapting to them in some way, while a third group of players were not told anything about the timer at all. The results showed that, despite the increase in immersion when playing with the adaptive timer, players also felt more immersed when being aware of the timer than not being aware of it, and knowing the full details increased immersion the most. Interestingly, the amount of information affected immersion regardless

Study V

Study VI

of the presence of the adaptation, however it was most effective when players also experienced the adaptive timer.

Study VII Finally, the effect of information was evaluated with regards to the duration of a gaming session (Chapter 9). Using a different game and a more conventional style of adaptation, the results demonstrated that players felt more immersed when being aware of this kind of adaptation too, and interestingly, the results suggest that the effect is durable.

1.4 Research Scope

Thesis goal This aim of this thesis is to explore how players' perception of adaptive technologies affect immersion, and the extent to which the perception alone affects this experience. Such knowledge will contribute to the theoretical understanding of the concept of immersion in digital games. To achieve the outlined goal, it is essential that certain research boundaries are identified.

Concept of immersion Firstly, definitions of immersion, as well as different models of this experience, are reviewed in detail in the literature review. The theoretical concept of immersion used in this thesis was operationalised by Brown and Cairns (2004), who defined immersion as a graded experience that does not depend on game genres or types. Additionally, the research done by Jennett et al. (2008) contributed to the understanding of the concept, and the IEQ developed by the researchers is used in this thesis to measure immersion levels of digital game players.

Manipulations Immersion is manipulated using a stimulus external to the game in the form of information players receive prior to each gaming session. Additionally, some experiments also have stimuli that are internal to the game – game features, such as an adaptive technology or the visual perspective. In some experiments players are exposed to both stimuli in order to explore the effect of information about adaptive features in games.

Adaptive technologies While adaptive technologies have been a popular topic amongst player experience researchers in recent years, for example Depping et al. (2016), Klarkowski et al. (2016), and Vicencio-Moreira, Mandryk, and Gutwin (2015), the majority of the work appears to focus on multiplayer digital games, players' perception of balancing techniques, and their fairness in competitive play. However, adaptive technology is not as well studied in single-players games, despite the obvious interest and its usefulness in this domain. As single-player games are not as competitive as multiplayer games, the role of difficulty balancing is

often perceived more positively, as it allows players to avoid getting stuck, and provides a tailored experience for players with different skills and abilities. Therefore, more research is needed to gain further insights into the changes in player experience as players grow aware of adaptive features in single-player digital games.

Single-player games differ in their types and genres, which ultimately affects the amount of time, money, and effort players put into playing them. This thesis focuses on casual single-player games, and single-player games that allow for the casual engagement. A casual game, as used in the context of this research, is a digital game that is suitable for players with various levels of experience, i.e. it “is for everyone” (Juul, 2009). This kind of game provides a quick engagement, and does not require much financial or time investment in order to be able to play it, yet ultimately can be enjoyed for longer periods of time. Therefore, gameplay of the games used in this research is kept as simple as possible to avoid confounds, and is mainly focused on gathering objects and fighting off enemies in order to make progress either by levelling up or by increasing the player’s score. Amongst these games are some commercial games, such as *Skyrim* and *Don’t Starve*, as well as games that are developed and modified specifically for the purpose of this research. Evidently, *Skyrim* is not a casual game, however the quest players complete in one of the experiments is similar to the other games in the sense that the players have to collect objects and defeat monsters in order to find a “Golden Claw”. In this context, their game engagement is casual – no special skills are required to be able to complete this quest, which makes it suitable for players with any levels of experience.

*Single-player
casual games*

*Games used in
this research*

One of the games chosen for the experiments with adaptive technologies is *Don’t Starve*. The game generates random worlds each time players load it from the beginning, and does not actually have adaptive AI. However, due to the nature of the game, it is suitable for an experiment aimed at exploring players’ perception of this technology based solely on their expectations of it. Commercial games, on the other hand, are not entirely suitable for exploring how the information affects immersion in games with adaptive features, as they do not have the option of switching adaptation on or off. Therefore, one non-commercial game is adapted and one is designed and developed in order to be able to control this manipulation. Moreover, purpose-built games allow for more freedom with regards to the type and the level of adaptation. In this thesis, two types of adaptation are deployed: an unconventional adaptive timer that changes the countdown speed based

on players' scores, and a more commonly implemented adaptation that alters enemies' attack and health based on the player's performance. Having varied types of adaptation allows for more rigorous testing of the hypothesis using two different games.

*Information
about games*

With regards to the information players receive about games, the wording of game descriptions is chosen carefully to avoid confirmation bias and affective priming of participants. The players are provided with neutral descriptions of games, outlining the premise and describing controls, as they typically would before trying out a new game for the first time. That way, the only difference between conditions is the description, which aims to set players' expectations about the adaptive technology in the game.

1.5 Research Contributions

*Primary research
outcomes*

The scope presented in the previous section provides the basis for evaluating the work described in this thesis. The focus of this research is geared toward empirical evaluation of the effect of player awareness and knowledge about adaptive technologies in digital games on their perception of the games and immersion; providing scientific evidence and data foundations upon which future theoretical developments in the area of immersion research may be built. Hence, the primary outcomes of this research are the following:

- This research provides the empirical evidence to support the claim that players' expectations of adaptive technologies in digital games based on neutral information they know before playing the game affect their perceptions of the game, and, as a result, their immersion.
- This research provides empirical evidence showing that players' expectations of adaptive technology in the game is enough to increase their enjoyment of the game and immersion in it, i.e. players feel more immersed in a digital game when believing that it contains an adaptive feature, even if the feature is not present in the game.
- This research demonstrates that the precision of information about an adaptive feature in a digital game has varied effects on immersion of players, i.e. players feel most immersed in a game when they receive more detailed information about an adaptive feature that it contains, while being aware of this feature makes players

feels more immersed in the game than being completely unaware of its presence.

- This research shows that players' expectation of an adaptive feature in a digital game has a positive effect on immersion, regardless of whether the feature is present in the game or not.
- This research demonstrates the durability of the effect of information about an adaptive feature in a digital game on immersion during a casual engagement.

In addition to the main contributions, this thesis makes additional contributions in the following areas:

*Secondary
research outcomes*

- This work provides an analysis of and comparison between three of the most widely used questionnaires to measure player experience, identifying the similarities between and drawbacks of each tool.
- This research demonstrates that players feel more immersed in a digital game when playing in first-person perspective than when interacting with the game world in third-person perspective in a game that offers a choice between the two camera viewpoints, and this effect is not based on players' preferences with regards to these perspectives.
- This research provides the empirical evidence to support the claim that adaptive technology have a positive effect on immersion of players in single-player casual digital games. This evidence is based on the evaluation of two different types of adaptation, where a timer adaptation is a novel techniques developed specifically within the context of this work.

1.6 Ethical Statement

Research conducted for this PhD thesis is guided by the principles of ethical considerations, in line with the University of York's ethical guidelines. Each participant taking part in this research was above the legal age of consent (18 years), and was fully briefed about their rights before taking part in the studies.

*Ethical
considerations*

All experimental studies described in this thesis followed the ethical principles of 'Do No Harm', 'Anonymity and Confidentiality', and 'Informed Consent'.

DO NO HARM: No participants in any of the studies conducted during this PhD were put in any harmful situations. The experiments were designed in such way that participants would not be subjected to any physical harm, or mental discomfort, or distress. Additionally, digital games that players were engaged with did not contain blood or gore, and had generally inviting and friendly gameplay. However, if participants felt uncomfortable in any way, they were allowed to stop their participation and leave at any time, and their data could be destroyed upon request.

ANONYMITY AND CONFIDENTIALITY: Data collected in the studies was kept anonymous and confidential. Individual identity of participants was kept anonymous and, upon completion of each study, the collected data from all subjects was compiled into a spreadsheet, which was used to analyse the data. Gathered data was stored on secure password-protected systems, and the physical copies of this data is kept securely and is protected from unauthorised access.

INFORMED CONSENT: Each individual taking part in the studies was informed about the general aims of the experiments, their procedures and tasks that they were required to undertake. Each study began with a briefing session in which participants were informed about the experimental designs, and ended with a debriefing session in which they were provided with the full detail of the experimental manipulation, and were allowed to ask any outstanding questions. Each briefing session was followed by an informed consent form that participants read and signed if they agreed with the terms. The form is available in Appendix a.

The University's policies concerning the governance of ethics changed during the conduct of this thesis. The studies conducted at the earlier stages of the PhD degree did not require a University-wide clearance, as the ethical evaluation was cleared by the HCI group in the department of Computer Science, who raised any concerns if there was a potential risk of breaching any ethical procedures. These studies were, therefore, judged by the supervisor as the authority behind the ethical conduct of the thesis. The studies conducted at the later stages of this thesis were ethically cleared and signed off by the University ethics committee.

Part I

BACKGROUND

Digital Games and Player Experience

2

"[In] giving expression to life man creates a second, poetic world alongside the world of nature."

Johan Huizinga, 1970

AN overview of economic importance is one of the most common parts of introduction to a vast majority of digital game research literature, and, indisputably, the figures confirm the significance of the medium in the modern world. For the past few years the digital games industry's revenues are steadily exceeding the returns of the film industry not only in the USA, but in other parts of the world too (Entertainment Software Association (ESA), 2016). However, the economic success of the medium should not be the only criterion to judge the cultural importance of digital games. Nowadays, playing digital games is an important part of our lives, just as playing outdoors and board games were in the past centuries – regardless of what the medium is, both conventional and digital games provide us with a wide range of emotional and cognitive experiences (Grodal, 2000).

Economic importance of games

Digital games have been a popular research topic for the past several decades. However, the research is no longer limited to studying game development lifecycles, and hardware and software behind digital games – with increasing interest in learning more about usability of digital systems, researchers in the field of digital games also began taking apart experiences people have when playing games, their motivations to play, and the effects of games on players themselves.

Studying the interaction between players and games has many implications both for the digital games research community and the digital games industry. As the number of players is steadily growing (Entertainment Software Association (ESA), 2016), knowing precisely

Games Research

*Online content
influencing
gaming
experience*

what players want and expect from digital games can help game makers to produce games that people want to play. However, behind this vital fast moving industry sits great advertising and marketing resources. The success of an individual digital game often relies on its publicity. With the rapid increase in use of social media and the Web in general, players now have access to a variety of online sources that allow them to gain an insight into the game before they even get to try it. Reading articles online, watching videos of gameplay, following other players' recommendations and reviews have a great effect on players' first impression of the game. However, it is also possible that players set their expectations based on the what the game has to offer them – expecting certain features can change player's perception and even affect their behaviour in the game.

*Reviews have an
effect on players'
perceptions of
games*

However, the lack of research in this area does not allow us to make such claims. Anecdotal evidence in the form of online articles and players' discussion on gaming forums has been showing signs of the effect of information on players' experiences with digital games, which in turn feeds forward into more online reviews and discussions of digital games that did not conform to players' expectations. One of the most recent and prominent examples being the reception of *No Man's Sky*, where players' unmet expectations of the game resulted in a great disappointment^{1,2}. Keeping players satisfied is important to game developers, as bad publicity can draw their players away from the games they make. Therefore, empirical research is required in order to test this idea of information influence on players' gaming behaviour and experiences they have as a result of what they know about a digital game.

*Immersion is a
highly valued
experience in
games*

Immersion is an important positive experience that players value and seek out when interacting with games. This experience represents and describes cognitive sense of "being in the game", which leads to players directing all their attention and thoughts into the game, as opposed to the real world surroundings (Brown and Cairns, 2004). While being immersed in a game players lose track of time, and forget about their everyday concerns. Keeping players immersed is evidently important not only to the players but also to the game makers who wish to design and build successful products. Much research has gone into studying this experience, however much research has been in the

1 Customer reviews of 'No Man's Sky': <http://store.steampowered.com/app/275850>

2 'No Man's Sky and the perils of infinite promise' in The Guardian: <https://www.theguardian.com/technology/2016/sep/05/no-mans-sky-perils-infinite-promise-sean-murray-hello-games>

area of hardware and software influence on player engagement and enjoyment, but little is yet known about the effects of players' personal attitudes toward games based on the information they know about games, such as preferences and expectations.

Challenge is a highly valued experience in any digital game: matched perfectly to players' skills and abilities, challenge plays a significant part in a smooth progression and shaping a positive experience of a digital game. Adaptive technology can help tailor the gameplay to a diverse set of players. However, despite the evident benefits of such technology, little research has gone into studying how perception of adaptivity in games affect players' experiences of these games.

Therefore, the two background chapters of this thesis provide an overview of existent work relevant to the topics of this thesis. The second chapter contains a review of player experience models, tools used to measure these experiences, and the effects of various factors on the experience of playing digital games. Immersion is the core concept that this thesis aims to study, and hence it is reviewed in depth with regards to the definitions of and existing theories and models of this positive experience. Moreover, as the focus of this work is primarily on the expectations of players and their perceptions with regards to adaptive technology, an overview of psychology theories relevant to expectations, preferences, and cognitive biases is provided at the end of this chapter demonstrating how information can change one's behaviour outside and within the context of digital games.

The third chapter of this thesis contains an overview of challenge in digital games, the various methods and techniques used to adjust challenge to match players' individual skills and abilities, and the research done in order to study the effect of these technologies on player experience. This chapter provides a comprehensive overview of adaptive technologies in digital games in order to learn more about the existent work in the area and to identify any existing gaps in the literature relevant to the perception of this technology in digital games. First, we need to define what the term "digital games" means in the context of this thesis.

2.1 Digital Games

Early 1970s marked the beginning of the digital age, as computers started exponentially going down in price and steadily increasing in their computational capabilities, meaning that the technologies of com-

munication and presentation could be finally merged into a single medium (Murray, 2000). The activities originally based in the real world started gradually moving away to the digital one – technological advancements brought us interactive media as equally engaging as conventional play, if not more. However, one of the greatest impacts of this digital revolution on our everyday lives was the creation of the digital games.

New technology creates opportunities for bringing traditional games from the real world to the virtual medium, and improving them due to unlimited possibilities provided by the other reality, for example it allows players to try a new identity, to explore places that do not even exist in real life. And as technological advancement is progressing further, imagination is the only limit that game developers have.

Game Media

Many traditional games are easily transferrable from the physical world into the virtual medium. Electronic devices are capable of supporting behaviour defined by the game rules that are typically upheld by humans, and have enough memory capacity to keep track of the game state. Digital games allow for much more flexibility in the way games are designed and created. The secondary reality not only provides many players with an opportunity for escapism (Yee, 2006), but also is a perfect medium for generating aesthetically good looking interfaces, more complex maps and rules, and more elaborate storylines than the traditional games. A player is no longer limited in the time they have to spend on a game, as most modern games have an option to save the progress made such that the next time the player can return to the game at the state they left it in. Moreover, open-ended games that are not restricted to a specific goal, such as the Sims or Minecraft, allow players to use their imagination in order to define their own objectives. Modern graphics engines allow players to discover and explore new worlds, make virtual friends and get experiences that are not available in real life, such as becoming an assassin or a mage.

Gaming devices

Digital games are no longer limited to one device. Many contemporary games developed by major companies are often released for more than one platform, whether it is a console or a computer, or even a portable device, e.g. a smartphone. New technological discoveries lead to releases of more elaborate equipment: 3D screens³, virtual re-

³ 'The Best Gaming Monitors of 2016' in PCMagazine: <http://uk.pcmag.com/monitor-reviews-price-comparisons-from-pcmagcom/10164/guide/the-best-gaming-monitors-of-2016>

ality kits⁴, and motion sensing input devices⁵ are bringing the player closer to the digital reality by improving the methods of interaction with the medium, as well as keeping presentation as realistic as possible.

One of the most attractive features of digital games is its built-in AI that allows players to immerse themselves into the virtual world of a game without the need for inviting other players to join them. Complex algorithms and theories used to produce game AI in modern games often are so detailed and precise that they have to be downgraded in order to match the 'human' level (Lidén, 2003). The ability of computational devices to uphold the rules brings more flexibility to a game, as it allows the player to concentrate on the game rather than the rules, without the need for remembering them (Juul, 2010). Apart from the rules, the game AI is also responsible for the moves and actions of an opponent, upholding what is permissible and determining what these actions would lead to.

*Artificial
Intelligence*

The ability to alter the state of the game world is another reason why so many players are attracted to digital games. Interactivity is a feature specific to digital games, and cannot be found in books or films, where the viewer merely observes the consequences of a pre-defined story. No matter what game it is and how many times an individual plays it, each game round and session would be different – depending on the actions a player takes, their motor skills and hand-eye coordination, or in some games on the objects they find or skills they develop as a character, there are various ways to progress in the game, level up and increasing the difficulty of the game. Not being able to precisely predict the outcome allows players to have new and different experiences each time they are interacting with the game environment (Grodal, 2003).

Interactivity

However, apart from the general benefits of digital games over other types of digital media, there are a number of motivations identified by digital game players.

2.2 Player Motivations

Numerous posts and discussions online suggest that players have many reasons as to why they choose to start playing digital games and what

4 'The best Oculus Rift games you can buy right now' in Trusted Reviews: http://www.trustedreviews.com/best-oculus-rift-games_round-up

5 'Kinect vs. PlayStation Move vs. Wii' in PCMagazine: <http://www.pcmag.com/article2/0,2817,2372244,00.asp>

keeps them coming back to this activity. One of the key motivators is the ability of digital games to create experiences and possibilities that are often not available in the real world. These experiences are always emotional, whether it is a joyful admiration of the peaceful atmosphere inside the virtual world, adrenaline from combat with other players, or even disappointment from losing a game, which fuels a competitive player's interest. Digital games allow players to forget about their everyday problems and stresses, and concentrate all their attention on succeeding in a game world (Yee, 2006). The opportunities in the game are often similar to the ones players might experience in real life, e.g. making a successful career as a farmer, or being a lead singer or a musician in a popular band; but inside game players are not afraid to take chances. If they fail, they do it privately – merely losing a virtual life or virtual money; and, for the most part, they can start over and go through the game or a mission again in order to succeed.

Emotions

Escapism

Opportunities

Achievement A sense of achievement is another powerful motivator for digital game players. Players love measuring their success, whether it is the number of collected items, killed enemies, covered miles, or completion times. All of these allow the most competitive players to track their progress inside a game. This desire to come up with new strategies in order to progress through the game, to acquire more powerful items or characteristics for the character improvement, as well as defeating more powerful opponents (Yee, 2006) keep players interested in digital games.

Motivations to play games depend not only on personal traits and interests, but also on the game itself and what it offers to the player. Many modern digital games have enormous picturesque environments that can be explored for hours, days, and possibly months. A desire to discover new worlds, to create and participate in stories, and to customise and control the virtual character are amongst most popular motivations to play these games (Yee, 2006).

Exploration

Community Multiplayer games allow friends to spend time together not only in real life, when they play together in a virtual musical band (*Guitar Hero*) or when they have a virtual tennis match against each other (*Nintendo Wii Sports*), but also online by playing together against another team of players or even competing against each other. Many online gamers meet new people in Massively Multiplayer Online (MMO) game chats for collaboration in order to achieve a mutual goal, to chat about their shared interests, or to simply meet other players (Yee, 2006).

According to Rigby and Ryan (2011), there are three characteristics that make digital games so popular – consistency, immediacy, and density of intrinsic satisfactions they are able to provide. Immediacy in digital games refers to their ability to offer instant engagement – games instantaneously transfer players to rich worlds filled with opportunity and challenge, which may not always be available in real life full of unpredictable circumstances. Digital games are consistent in their ability to deliver engagement and need satisfaction. Unlike the reality, where many things may not go as planned, the outcomes in the digital world consistently reflect the player’s actions and expectations. Games follow specific rules and, as a result, the actions, consequences, and rewards are all linked together fairly. This means that most players working toward a goal will eventually achieve it, and, in most cases, the player gets what they deserve according to the efforts they put into playing. Density of a digital game refers to the game’s ability to entertain any kind of players, whether they have extensive experience or are new to gaming – digital games keep constant stream of entertainment from the very beginning until the end.

Immediacy

Consistency

Density

2.2.1 Player Experience of Need Satisfaction

Games’ ability to satisfy players’ needs has been the central argument behind the Player Experience of Need Satisfaction (PENS) theory, developed by Rigby and Ryan (2011). The authors argue that a true theory of motivation should focus on the factors associated with enjoyment and persistence across players and genres, and how games with differing controllability, structure, and content might appeal to basic psychological needs. They conducted a set of studies based on the idea that players of all types seek to satisfy psychological needs in the context of play, and to measure this experience they developed the PENS scale, which was elaborated from self-determination theory (SDT) – a widely researched theory of motivation that addresses both intrinsic and extrinsic motives for acting, and the relation of motivation to growth and well-being (Deci and Ryan, 2000).

*Player Experience
of Need
Satisfaction*

Enjoyment, challenge, fantasy, arousal, suspense, interest, and competition are amongst those factors that players consider most important for their experience of digital games, whether it is their motivations for playing or their subjective experience as a result of playing. The link between the reasons for playing and the experience of this act has been examined in various studies, e.g. Ryan, Rigby, and Przybylski (2006) reviewed player’s motivations for playing digital games

with an aim to predict their level of enjoyment and the effects of game play on well-being. Their theory on player motivations suggests that understanding the specific psychological needs of a player, and knowing how to satisfy them in digital games, leads to deeper satisfaction when playing and makes people want to continue playing.

Competence The PENS model suggests that digital games are most successful, engaging, and enjoyable when they are satisfying specific intrinsic needs: competence, autonomy, and relatedness (Ryan, Rigby, and Przybylski, 2006). Competence refers to an individual's need for challenge, their desire to enhance their abilities and skills, and to gain knowledge of new situations. Honing players' problem solving skills and receiving positive feedback on successful completion of a task is not only beneficial in digital games, but also is an important part of their personal and professional development.

Autonomy Autonomy refers to the players' innate desire to take actions willingly, without being controlled by circumstances or others. To satisfy the need for autonomy, a player should be provided with choices and opportunities to act according to but not bounded by rules, as well as receiving meaningful feedback reflecting their success or failure while doing the task.

Relatedness Relatedness reflects our need to be connected with others and being able to interact with them in a meaningful way. People seek to be connected with others for the intrinsic reward, to have a mutually supportive connection with others – digital games offer an opportunity to connect players and experience companionship within a virtual environment. Even games that do not support multiplayer allow the player to feel as if they matter to others, to have a sense of belonging inside the game, by creating a strong narrative and supporting it with appropriate responses from other characters within the game world.

Immersion Ryan, Rigby, and Przybylski (2006) argue that immersion is as important for the satisfaction of a player's needs as the other three factors, and authenticity of the content of the game as well as its controls improve the chances of one becoming immersed into the virtual world. The researchers use the terms presence and immersion interchangeably in the context of their model, referring to both as the sense of being transported into a game world. According to Rigby and Ryan (2011), there are three types of immersion or presence – physical, emotional, and narrative; and being able to become physically immersed in a virtual world would increase emotional and narrative immersion.

Controls Satisfying player's needs is an important task for the game designers and developers. The proposed model provides a good summary of the reasons that motivate people playing digital games, however it

does not necessarily describe the subjective experiences had by players during and after a gaming session. Moreover, it does not describe how a game designer can approach the problem of providing, e.g. more autonomy in the game; which is a major drawback.

In order to learn more about the actual experiences players have during gaming, a number of theories and concepts have been developed and researched in recent years, including engagement, immersion, flow, and presence. These are reviewed in the next section.

2.3 Player Experience Research

As digital media are becoming more present in our everyday lives, games in their new form are no longer seen as merely entertainment for young people – anyone, regardless of their age, gender, culture or personal preferences, can find a game to their taste. And due to this change in media, new models and theories are needed in order to understand the production, distribution and particularly use of digital games, and the difference that the new medium brings to our play. Digital game studies produce theoretical concepts that are often based on or are applicable to some of the traditional notions of play, yet they are adaptable to the challenges brought by the transportation of games into the digital medium (Kücklich and Fellow, 2004).

It is evident that the experience of playing digital games is subjective and differs from player to player. Nonetheless, there are certain types of experiences that remain the same for millions of players across a wide range of games: entertainment, challenge, engagement, etc. In the analytical research of this field various terms have been established to try to account for these experiences. The most widely used theories include engagement (O'Brien and Toms, 2008; Schoenau-Fog, 2011), immersion (Brown and Cairns, 2004), flow (Csikszentmihalyi, 1991), presence (Lombard and Ditton, 1997), and fun (Poels, De Kort, and Ijsselstein, 2007). However, no consensus has been reached as to which of these theories provide a more comprehensive insight into the experience of playing digital games, neither there is a commonly agreed method for evaluating this experience (Bernhaupt, Eckschlager, and Tscheligi, 2007).

This chapter provides a review of a number of different concepts used to describe player experiences, along with a brief description of the similarities between these concepts, their differences, as well as the benefits and drawbacks of each theory. Drawing from this review

and the comparison of player experience theories, this thesis therefore focuses on the most appropriate, widely used, and inclusive concept of immersion.

2.3.1 *Flow*

One of the most widely known psychological theories was proposed by Csikszentmihalyi (1991). The concept *Flow* describes an optimal state that can be evoked by high levels of engagement in an activity. Csikszentmihalyi describes flow as an experience that people have when performing an activity “so gratifying that people are willing to do it for its own sake, with little concern for what they will get out of it, even when it is difficult or dangerous”.

Requirements Flow is an extreme state and there is no shortcut for it – a person is either in flow or is not. Being in this state helps a person to become entirely absorbed into performing the activity, making it more intrinsically rewarding. The activity becomes the only thing that matters, separating the outside world from one’s awareness. While being in the flow, people become so fully absorbed in the act of performing an activity that all irrelevant thoughts and perceptions are ignored, leading to loss of self-consciousness. The ultimate state is only achieved when the skills of an individual are matched by the challenge of an intrinsically rewarding activity, however when the challenge is beyond one’s abilities, this may lead to anxiety, or boredom if the player does not feel challenged enough. Having clear goals every step on the way and immediate feedback are likely to increase the chance of being inside the state of flow. It is a state where a person feels as if they are one with the activity, being in full control, and consequently losing track of time.

Applications Flow is applicable to a wide range of activities, including music (Bakker, 2005), sports (Jackson and Csikszentmihalyi, 1999), and web browsing (Nel et al., 1999), and it is also used in the context of gaming experience. Chen (2007) believes that it is possible for game designers to match the challenges inside the game to the player’s skill set, regardless of the previous experience they had – whether the player is a novice or a professional gamer. He proposed a four-step methodology in order for a game design to provide the end-user with enjoyable and rewarding experience. For that, some of the core components of flow should be chosen; the player should be kept in the ‘Flow Zone’, which can be achieved in different ways for different players using adaptive

technology, and choices provided in the game ensure that the state of flow is never interrupted.

Although flow is often used to describe the state of involvement in playing a digital game, it is an extreme state, so according to the theory it is unlikely that some games, like *Flappy Bird* or *The Sims*, which have no obvious goals, would lead to an enjoyable experience – but they do. Similarly, not all modern digital games are able to adapt to the player’s tactics, so it is not always possible to precisely match the challenges inside the game to player’s skill set, yet still people play and enjoy these digital games. This means that a player may not to be in the state of flow but they can still find this activity enjoyable, intrinsically rewarding, and be willing to continue playing a game.

Limitations

It is evident that experience from playing a digital game is different at each stage of involvement – casual players do not get as involved with the game as professional players do, similarly short games like Tetris provide different experience to games that require investment of time and effort, such as *World of Warcraft*. A player cannot be slightly in the state of flow while being engaged in game play, and because this theory does not account for other stages of involvement, and is too focused on a specific experience, it is not a suitable concept for describing the whole player experience.

GameFlow

In order to apply the concept of flow to digital games, Sweetser and Wyeth (2005) developed *GameFlow* – a concise model of enjoyment in digital games, following the same structure and idea as the flow concept. They proposed eight core components that a game should have in order to lead players toward the flow experience. Some of them are the same as the elements of flow, e.g. a game must provide enough challenge for the player to maintain high level of concentration while playing it; at the same time the player skills should be closely matched by the level of challenges inside the virtual environment. The game should also have clear goals and sufficient feedback so that the player is able to trace their progress toward the goal, while feeling in control at all times.

Similarities with flow

According to Sweetser and Wyeth (2005), if a game has these six flow elements, the player should become immersed in the game – becoming less self-aware and aware of their surroundings, losing track of time, and feeling emotionally and cognitively involved with the game. Although it is not clear as to why immersion – a state in which player feels deeply involved with a game – was amongst other seven ele-

Elements of GameFlow

ments, which in the context of the model are characteristics of a digital game and not its player.

Finally, social interaction is another core component that, according to the researchers, leads to the complete enjoyment while playing a game. They argue that digital games should support cooperation and competition between players, providing opportunities for them to socialise both inside and outside the game. While many multi-player digital games are certainly popular amongst their players, and can often be highly addictive (Kuss, Louws, and Wiers, 2012), it is not necessary that playing against game AI is not an enjoyable experience. It is evident that not all digital games support social interaction between players, and many single-player games lead to positive experiences without the need for another player. Modern game AI is often capable of providing sufficient challenge and unpredictable outcomes for any type of player.

Limitations

Overall, the model provides a set of guidelines for game developers to follow in order to make a successful product, rather than describing an actual experience had by a player during gaming sessions. Moreover, because the components of GameFlow follow the same structure as flow, the model has the same drawbacks as its predecessor. According to the researchers, it is possible to identify the quality of a digital game using these guidelines, and depending on whether the the rating of the game is high or low it is possible to distinguish whether it will succeed or fail. The main drawback of these guidelines is that they are game-oriented and not player-oriented, therefore they do not describe the experience had while playing the ‘successful’ digital game and how it differed from the experience of the ‘failed’ one.

2.3.2 *Presence*

Another frequently used term to describe an experience of playing digital games is *presence* – the sensation of being inside a virtual environment and feeling surrounded by the stimuli (Lombard and Ditton, 1997). Although this term is often used interchangeably with immersion, it is important to differentiate between these two concepts. Presence is a specific state that can only be achieved when a mediated environment looks and feels appropriate to a place where the player can feel present in, while games without a virtual reality cannot provide the player with this sense.

Definition

Presence is a term that is most commonly associated with virtual reality (VR) – an artificial environment used to simulate physical pres-

ence in realistic looking or imaginary world perceived through sensory stimuli, such as visuals and sounds. Such environment allows an individual to move around, explore, discover and use items within the virtual world, and even combat or collaborate with other players.

According to Lombard and Ditton (1997), a sense of presence occurs as a result of a combination of all or some of these six factors: the social richness of interaction, the ability of a user to accomplish significant actions within the environment, the sense that the environment and other actors also have a social impact on what happens in the environment, realism of the virtual environment, the sense of being “transported” into a new reality, and the psychological and sensory immersiveness of the interface. First three factors are generally described as “social presence” – the sense of being with someone, being able to interact with the space and each other, as well as working together on the same goal, contributes to the heightened sense of presence. Similarly, the other three factors are described as “spatial presence” – the feeling of being integrated into a mediated environment (Wirth et al., 2007).

Requirements

The sense of being present inside digital environment not only depends on one’s perception of reality, but also on the technology used by the player to perceive and interact with the virtual world, e.g. a VR set is more successful at abstracting the player from the real world, and therefore is more likely to create an illusion of being present in a second reality. Similarly, using headphones instead of speakers to play game audio is more likely to increase presence (Sanders Jr, 2002).

Presence is believed to be one of the most important factors in terms of improving player experience. Ravaja et al. (2006) suggest that digital games that provide their players with a strong sense of presence generally illicit higher overall enjoyment. It seems that many contemporary digital game makers share the same views as they release new products with high quality realistic graphics and sounds, and focusing on more natural forms of interaction when designing new consoles and controllers.

Although this concept is suitable for digital games with highly realistic environments, it is arguable that games which do not lead to the sense of presence are less enjoyed and loved by their players. Many digital games provide their players with positive experience without the need for transferring them into another reality, e.g. playing abstract puzzle games or even any two-dimensional digital games often leads to real world dissociation without the player feeling as if they are one of the Tetris blocks.

Limitations

2.3.3 Engagement

One of the most widely used terms to describe a player's involvement with a digital game is *engagement*. This positive experience is a result of being involved in a fun and motivating task (Mayes and Cotton, 2001).

While this term is frequently used outside the domain of digital games for describing a degree of involvement with an activity, it is also widely recognised and frequently used not only by digital game players to describe a positive experience of playing games, but also by player experience researchers and game developers. Engagement draws us in to an activity, which attracts and holds our attention (Chapman, 1997). It can arise as a result of successful "need satisfaction", as proposed by Rigby and Ryan (2011), and is influenced by user's first impression of a digital application and the enjoyment one derives from using it (O'Brien and Toms, 2008).

Process The process of becoming engaged in a gaming activity then begins with people becoming motivated to play either through personal or game-related motives. Then, the player begins working toward an objective that is either set up by the game or defined by the player. This objective allows one to perform certain activities in the game in order to make progress toward their goal and experience accomplishment as a result of successful performance. Players feel engaged in these activities as long as the objective is not reached, and experience affect as a result of accomplishment. Similarly, players can experience a range of emotions if the objective is not met. Moreover, players can re-engage with the game after accomplishing the task by setting up new objectives or by returning to work toward accomplishing the existent objective later (Schoenau-Fog, 2011). According to Schoenau-Fog (2011), engagement is initiated by one's individual motivation to begin playing, and is often driven by continuation desire, leading to perseverance, determination, and tenacity.

Objectives

Activities

Accomplishments

Affect

Similarly, O'Brien and Toms (2008) argue that the process of engagement comprises of four distinct stages: point of engagement, period of sustained engagement, disengagement, and reengagement. This experience with technology, in this case digital games, is characterised by such factors as challenge, aesthetic and sensory appeal, feedback, novelty, interactivity, perceived control and time, awareness, motivation, interest, and affect. The point of engagement is initiated by the aesthetic appeal or novel presentation the game, players' interests and motivations, information available about the game, and their ability

Point of engagement

and desire to be involved in the interaction and invest time into this activity. Engagement is sustained when players are able to maintain their attention and interest in the game, and is characterised by positive emotions. Players should receive timely and appropriate feedback from the game, appropriate challenge and control inherent in the interaction in order to keep them interested. They also want to lose their time perception and self-awareness while being engaged in game playing. Players can disengage for many reasons, which can be internal to the game – technical issues and non-stimulating content, and personal reasons, such as tiredness, work, other plans. Depending on the outcome of the disengagement, player might never return to the game, or reengage with it later on if they had positive past experiences, and they perceive novelty in the following gaming sessions (O'Brien and Toms, 2008).

*Period of
sustained
engagement*

Disengagement

Reengagement

Engagement is one of the most broadly used terms to describe the experience of playing a digital game, e.g. Brockmyer et al. (2009) and Turner (2010), but at the same time it has also been incorporated into other theories, such as flow (Chen, 2007), presence (Lombard and Ditton, 1997), and immersion (Brown and Cairns, 2004). For example, Lombard and Ditton (1997) consider engagement as an aspect of the “psychological immersion” component of “presence as immersion”, which occurs when a user becomes “involved, absorbed, engaged and engrossed” in the virtual world of digital games.

O'Brien and Toms (2008) suggest that certain attributes of engagement resemble the ones of flow's: focused attention, feedback, control, interactivity, and intrinsic motivation. However, intrinsic motivation required to enter the state of flow is not compulsory in order to become engaged in an activity: a player can do so non-voluntarily. Flow also requires sustained focus over longer period of time and loss of awareness of the real world; while engagement should still occur when multitasking.

*Contrasting
engagement and
flow*

Just like while being immersed or while being in flow, engaged users are actively involved, motivated, and perceive themselves to be in control over the interaction. However, there are other characteristics of these gaming experience theories that are unlikely to be found in engagement. While attention is required in order for a player to become engaged in a gaming activity, the game does not have to become their only focus. Moreover, players do not lose their awareness of time or their surroundings, like they do when being immersed in a game. Engagement also is not dependent on the specific goals of an activity. Players may become involved in gaming without any specific purpose

or desirable outcome in order to have an engaging experience. The activity does not need to be meaningful, like in the case of flow, as long as the activity has an impression on the player – it does not have to have more meaning than that the experience was enjoyable and challenging (O'Brien and Toms, 2008).

One could also argue that engagement is a prerequisite for experiencing fun, enjoyment, pleasure, immersion, and flow, as players need to become engaged before these other concepts can be experienced (Schoenau-Fog, 2011). For example, Brown and Cairns (2004) explored the experience of immersion in more detail using the grounded theory approach, during which the researchers found that immersion is a graded experience, which begins with engagement as the first stage, gradually progressing onto engrossment and, eventually, leading to total immersion. To get engaged a player needs to invest time, effort, and attention while playing, and must be interested in the game by overcoming barriers of player preference and learning of the controls in order to become engaged.

2.3.4 Immersion

Immersion is another widely acknowledged term used to describe the experience of being involved in digital game playing. This term has been commonly recognised as an experience that leads to enjoyment and entertainment when reading a book (Ryan, 1999), watching a film (Weibel and Wissmath, 2011), or playing a digital game (Brown and Cairns, 2004).

In digital games in particular, immersion has consistently proved itself to be an important element of the experience players seek from digital games. Unlike engagement, which can be achieved as a result of positive experience of most digital games, immersion can be viewed as a more involved experience that begins with a simple engagement but can then extend to a state of engrossment, eventually leading to total immersion (Brown and Cairns, 2004).

A multitude of theories have been developed and researched describing immersion from a variety of perspectives. These are described in more detail in the following section. Immersion, in the context of this research, describes an experience of playing a digital game from a number of different perspectives, making it more suitable than other theories previously discussed. The main drawback of these theories was their limitations toward either game factors or player factors, and none of them described player experience in terms of both. The broad

nature of the term immersion allows this freedom of definition. It is not only possible to analytically establish how certain features in the game affect the player's immersion level, but also to account for the human aspects of the concept. While immersion research has been more oriented toward the influence of game factors on experience of playing a digital game, the human aspects of the problem have not received much attention, despite their evident importance in terms of influencing the experience of playing a digital game. The following section provides an overview of the current state of research in the area of immersive player experience, as well as reviewing some psychological and physical factors that affect immersion while playing digital games.

2.4 Immersion in Digital Games

Immersion is a complex concept, and unlike most of the other theories discussed earlier, does not have a precise definition. There have been many attempts to define and describe this concept, specifically in the context of digital games, which has resulted in the emergence of various theories.

Immersion is a relatively broad concept that can be applied not only to digital games, but also to books and films (Ermi and Mäyrä, 2005). However, the nature of immersion created by these kinds of media differs from the experience people have when playing games. The immersive experience created by the stories that we either read or watch on a screen can be classified as narrative immersion – people get immersed when following a story. Games provide their players not only with a narrative (although it is arguable whether every game has one), but with another important component that differentiates games from books and films – interactivity. Because games are interactive, experience of participating in the actual game play differs from what people experience when watching another person playing through a game. Although both activities are immersive, experience through observation is different to the immersion state occurring when actively participating in the activity.

This section provides a comprehensive review of various definitions of immersion in digital games, outlining specific features of this concept in the context of games differentiating it from other possible immersive experiences. Moreover, several different theories on immersion are discussed, together with the distinctions and similarities of these, and the identified research gaps.

2.4.1 Immersion Definition

Traditional games have played an important role in our culture and society for many centuries, providing players with positive experiences and entertainment. People often feel so engaged in the act of playing that they forget about their concerns and worries, immersing themselves into a new world, forgetting about time and reality (Brown and Cairns, 2004). As modern digital games allow for the development of highly sophisticated interfaces and virtual environments, more opportunities exist for players to try on new identities and develop new skills – something that is not always available to the players in real life. This experience of feeling highly involved with a medium is defined as immersion (Jennett et al., 2008).

Immersion as an act of being submerged into water

The concept of immersion in games has existed for as long as people have played them, but due to its broad nature, there have been many attempts to define this experience. Originally, immersion was described as an act of being submerged into a liquid – one of the very first definitions was given by Murray (2000), who compared this experience to the original meaning:

“Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus... in a participatory medium, immersion implies learning to swim, to do the things that the new environment makes possible... the enjoyment of immersion as a participatory activity.”

This definition is relevant in the context of any medium, and it describes a state that can be achieved while performing any highly engaging activity.

Observational and participatory immersion

For centuries books and theatre have provided people with immersion in stories told either in text or via acting, but invention of new media brought us a totally different experience, which differs between an ‘observational’ immersion as in watching other players during a gaming session, and ‘participatory’ immersion – when a person is actively engaged in the act of playing and interacting with a mediated environment. In the context of digital games there have been a number of definitions proposed to describe the term immersion – Morris

and Rollings (2000) define it as the “sense of actually being in the game world”, it is a state in which “the technology of the presentation [...] disappears” (Brooks, 2003). Real world dissociation is also the key theme in many other definitions, e.g. Pine and Gilmore (1999) define it as a dimension that describes the link between the environment and the player. Immersion in this case takes place when a player becomes physically and virtually absorbed in the mediated environment. Similarly, immersion is defined by Dovey and Kennedy (2006) as “the experience of losing a sense of embodiment in the present whilst concentrating on a mediated environment”, and in the case of digital games, players “lose track of immediate physical surroundings”. While it is also defined in terms of the feeling of being a part of a virtual environment (Wirth et al., 2007), immersion also allows the player to retain some awareness of their surroundings while playing a digital game (Baños et al., 2004; Witmer and Singer, 1998).

The difference between immersion and presence is not always clear

Players lose themselves in the game, which not only leads to reduced awareness of their surroundings, but also makes them forget about time and their everyday concerns (Jennett et al., 2008). Sweetser and Wyeth (2005) describe immersion as “deep but effortless involvement in the game”, and Seah and Cairns (2008) state that immersion leads to extended playing sessions because a player loses track of time. In their study, Brown and Cairns (2004) interviewed a number of gamers, and found that players invest time and effort when playing games and expect appropriate rewards for this investment. These players feel so engaged with a game that their self-awareness decreases and they become less aware of their surroundings. They also mentioned feeling “emotionally drained” when they stop playing, which suggests that people become emotionally involved in the game. According to Brooks (2003), in the state of complete immersion player’s “personal concerns and issues that may have been weighting heavily on one’s mind before the story experience, have also disappeared”.

Reduced awareness of time and surroundings

Reduced self-awareness

Immersion is a result of positive experience, described as “going into an environment different from one’s usual environment by physical means or by use of one’s imagination.” (Garneau, 2001). The player enjoys living a different life, forgetting about their own problems and stresses from the real world (Huiberts, 2010). While escapism is a strong motivation for many people to play digital games, it is not the only reason that leads to immersive experience. Apart from afore mentioned feelings of being surrounded by the stimuli, and feeling deeply absorbed in an activity, immersion is also associated with identification with the situation or a character inside a game (Taylor, 2002).

Definition of immersion

Overall, the reviews demonstrates that immersion is a broad concept, the definitions show a common resemblance. Based in the consensus of these definitions, immersion is defined as a state of strong involvement that a player experiences while playing a digital game, in which they become completely focused on this activity, which leads to a feeling of being decreased awareness of one's surroundings, distorted sense of time, and reduced awareness of one's self.

2.4.2 Models of Immersion

Immersion, unlike other player experience theories, was not a concept defined solely by a single researcher or a group of researchers. Widely used in gaming communities, the term immersion was brought to attention by many digital game researchers who understood its importance for digital game players. This subsection provides a discussion of several major theories that attempt to classify immersion, together with a brief overview of the similarities and differences between each theory.

Graded Experience

Engagement

The absence of a clear definition and the uncertainty in understanding of immersion was a motivation for a theory developed by Brown and Cairns (2004) using the grounded theory. They interviewed gamers in order to explain the concept based on real world experiences, which lead to deriving different levels of immersion in digital games, corresponding to the players' sense of engagement and involvement in the game. The first stage of immersion is engagement. In order to enter this level, the players have to simply invest time and effort to play the game, and whether the player wants to concentrate their attention on the play depends on the game itself – sufficient feedback and responsive controls should support their game play. Moreover, the player should be rewarded according to their effort invested in playing. When all the requirements are met, a player feels engaged and wants to continue playing.

Engrossment

Further involvement with the game brings the players to the next level – engrossment. At this stage players devote a lot of their attention to the game, becoming more emotionally involved in the game play. This then leads to reduced awareness of their surroundings and decreases their self-awareness. This stage is achieved when players feel that a game is well constructed – visual presentation, storyline and in-

interesting objectives should be combined in such a way that they can directly affect player's emotional state. At this point the players are focused on the game more than previously and want to keep playing until they reach the highest level of immersion.

This third and highest level is called total immersion – a complete involvement with the game. The player feels submerged into the game environment and feels that nothing else is as important as playing. It occurs when the player can feel the atmosphere inside the game world and gets emotionally involved in the story, empathising with the characters inside the game. At this stage players get so deeply absorbed in the activity, that they become cut off from reality, making the game the only thing that matters to them. While total immersion is harder to achieve because it requires high level of concentration and absolute focus on the game, which may be more applicable to experienced gamers investing much time and effort in playing digital games, it is likely that casual players would typically achieve only first two stages.

Total immersion

It is evident that players become gradually immersed in playing digital games, and depending on the game itself, as well as the amount of effort and time invested in playing it, players achieve different levels of immersion in every gaming session.

Sensory, Challenge-based, and Imaginative Immersion

An alternative approach to explaining immersion was done by grouping immersive experience into categories depending on specific aspects of a game that may vary depending on the game itself or the individual differences between players. Ermi and Mäyrä (2005) proposed a gameplay experience model, the SCI-model, which suggests that there are three types of immersion: sensory, challenge-based, and imaginative. According to this categorisation, sensory immersion is related to audiovisual presentation style and quality; challenge-based immersion occurs when the level of challenge matches player's abilities; and imaginative immersion is described as being absorbed into the world of fantasy and identifying with the characters within this world.

*Sensory
immersion*

*Challenge-based
immersion*

*Imaginative
immersion*

In this model, challenge-based immersion is an essential element that is unique to games, as gameplay requires active participation from the player. However, depending on the individual characteristics of a digital game these three types can be combined and mixed together, e.g. Tetris would be an example of sensory and challenge-based immersion combined, text-based digital games provide their players with

a narrative and challenge but are limited in the sensory domain, while most modern digital games are a combination of all three experiences. One of the main benefits of the model is its ability to describe player experience in any digital game based on the different mechanisms that differentiate it from others.

The SCI-model allows to distinguish between experiences when playing different kinds of digital games, which is important considering that feeling immersed in Tetris is rather different from what players experience in, for example, *World of Warcraft*. Despite making a clear differentiation between types of immersion based on game factors, the theory does not account for the differences between players, or the effects of emotional or cognitive involvement in the game on immersion. Moreover, it does not explain how this experience differs at various points in the game play.

Tactical, Strategic, and Narrative Immersion

Tactical immersion

Alternatively, Adams (2004) suggested a different approach to classification of immersion, identifying three distinct kinds – tactical, strategic and narrative immersion. Tactical immersion refers to a moment by moment act of playing a digital game. It is typically found in games that produce challenges simple enough to be quickly solved, without challenging the player to be concerned about the larger strategy of the game, or its story. In order for a player to achieve this state of immersion, the game should have responsive controls, consistent gameplay and flawless user interface.

Strategic immersion

Strategic immersion refers to the player's involvement with the digital game while developing a strategy in order to find an optimal path to victory from a vast number of possibilities. This state of immersion is achieved when the player is provided with appropriate mental challenges in a digital game with a logically structured and systematic gameplay.

Narrative immersion

Finally, narrative immersion refers to a state of deep involvement with the storyline. The player becomes emotionally connected to the character and wants to continue playing in order to see the outcome of the story in the digital game. Narrative immersion can be achieved not only in games by also while reading a book or watching a film, in which the reader, the viewer or the gamer care more about flawless storytelling – meaningful dialogues, interesting characters and feasible plots, rather than the game AI or audiovisual presentation, flaws of which may be overlooked if the story is consistent.

Overall, the model proposed by Adams is similar to the SCI model, where tactical immersion is analogous to sensory immersion, strategic immersion is analogous to challenge-based, and narrative immersion shares similar ideas with the imaginative immersion. However, unlike the SCI model, Adams' theory suggests that a player can only prefer one type of immersion at a time, and shares a similar idea to the graded theory, where each kind of immersion can only be achieved after overcoming certain barriers.

Dimensions of Narrative Immersion

Qin, Patrick Rau, and Salvendy (2009) developed a questionnaire to measure player's immersion in the narrative of digital games, identifying seven dimensions of immersion based on their analysis of previous research in the field. These dimensions correspond to different stages of playing a digital game – according to the researchers, player's curiosity, as well as the balance between challenges and skills are the prerequisites for narrative immersion. In this context, a player should be interested in exploring a game's narrative, and their skill set should be matched by the difficulty level of the game as closely as possible. While playing a game, the player's perception and cognition are influenced by their ability to concentrate on the game narrative for a long period of time, their ability to exercise control over the game narrative and comprehension of the structure and content of the story. Finally, player's post-game experience is affected by their ability to empathise with the imaginary world and their familiarity with the game story.

Curiosity
Skills and challenge

Concentration
Control
Comprehension
Empathy
Familiarity

The main drawback of this theory is its emphasis on narratives in digital games, which makes it not applicable to games that are lacking a traditional form of storytelling. It is evident that some of these dimensions are narrative specific such as curiosity, comprehension, empathy and familiarity, and correspond to the imaginative immersion in the SCI-model; while other dimensions are analogous to the traditional characteristics of immersion – control, challenge and skills, and concentration, which generally correspond to the sensory and challenge-based immersion.

Diegetic and Intra-diegetic Immersion

A different approach to defining immersion through the analysis of different points of view within different digital games, as well as within a single digital game was used by Taylor (2002). In her thesis, she defined two types of immersion in digital games – diegetic immer-

Diegetic immersion

*Intra-diegetic
immersion*

sion, created when the player is interested in the game play, and intra-diegetic or situated immersion, which refers to the feeling of being inside a virtual environment “*situated through both a character’s perspective and an embodied point of view*”, empathising with the storyline and enjoying the strategy of the game. A similar classification of immersion into two kinds was proposed by McMahan (2003), who refers to the terms as diegetic and non-diegetic. When the player is in the state of diegetic immersion, they become unaware of separate elements and their relation within the game. Intra-diegetic immersion allows the player to become absorbed in the virtual environment as an experiential space, creating an illusion that the player is within the game world. In this classification the intra-diegetic type includes both a spatial and a narrative aspect.

According to Taylor, these two kinds of immersion are not mutually exclusive, and depending on the game attributes, a player may experience either exclusively diegetic immersion or some kind of blend of both immersions. However, in order for the intra-diegetic immersion to occur, the player must first become diegetically immersed in the game. For that, the digital game should have consistent game world containing user-friendly interfaces, consistent audiovisual data and interesting game narrative and theme choices. These requirements are analogous to the three types of immersion previously discussed in the other immersion models.

Components of Immersion

*Emotional and
cognitive
involvement
Real world
dissociation
Control and
challenge*

A study investigating quantitative measurement of immersion in digital games was conducted by Jennett et al. (2008). They developed a questionnaire which was validated using three different experiments, and was extensively used in many studies after that. The questionnaire was also a part of validation of the concept suggesting that immersion can be considered as a combination of five components: emotional involvement with the game, players’ cognitive involvement, their real world dissociation, perceived control inside the game, and perceived challenge.

Unlike the SCI-model, and the models proposed by Adams, Taylor, and Qin et al, that were mainly focused on the components of the game, this theory takes into account the player as a factor that affects immersion as well – the first three factors are based on the individual differences between players, and the other two factors are related to the game itself. This notion of immersion overlaps with the definition

used in the GameFlow theory (Sweetser and Wyeth, 2005), and shares the use of graded experience proposed by Brown and Cairns (2004).

This classification and the previously reviewed theories share common ground. Emotional involvement in a digital game seems to share the idea of imaginative immersion of the SCI-model, while cognitive involvement of the player, as well as the control and challenge in the game are analogous to the idea of challenge-based immersion. However, sensory immersion implies that a player experiences the game as if they were inside the virtual world – a notion similar to presence, while real world dissociation does not necessarily imply that the player would feel the same way. Although these two terms have opposite meanings, they still share the idea of the player feeling less aware of their surroundings as they engage in the game play.

Incorporation

As an alternative to explaining immersion as a graded experience or as an experience that consists of different elements, immersion is also viewed as a subset of a larger concept. In an attempt to define such concept, Calleja, 2011 proposed a notion of incorporation – a gaming experience which occurs when a player is able to incorporate the game environment into their consciousness, while at the same time being assimilated in the environment as an avatar. In this concept, immersion is viewed as a component of incorporation, and it is synonymous with the concept of presence.

Incorporation has six components: kinaesthetic, spatial, narrative, ludic, shared and affective involvements. Kinaesthetic involvement deals with control and movement; spatial involvement is concerned with familiarising one's self with the spacial domain of the game; shared involvement covers collaborative and competitive behaviour of human and AI agents within the environment; narrative involvement describes the story created during game play and player's interaction with it; affective involvement includes the emotional participation in the game play; and ludic involvement deals with the player's decision-making processes used to achieve goals that are assigned to them either by the game or the player him- or herself. Player's immersion arises from limiting their attention on one or more of these kinds of involvement.

Each of these components is considered from two different viewpoints. The aspects of the game that attract the player outside gaming sessions are referred to as micro-involvement, which include those aspects that lead to this attraction in the first place, and factors that keep

*Kinaesthetic
involvement
Spatial
involvement
Shared
involvement
Narrative
involvement
Affective
involvement
Ludic
involvement*

*Micro-
involvement*

players coming back to the game. While macro-involvement is concerned with the aspects that keep players engaged in game play.

Work by Thon (2008) and Bjork and Holopainen (2004) published several years earlier share similar ideas with Calleja's incorporation theory. In his attempt to define immersion as a multidimensional experience, Thon established four kinds of immersion – spatial immersion, i.e. player's perception of the paces within the game; ludic immersion, which occurs when players abilities are matched by the level of challenge inside the game like in Flow; narrative immersion, i.e. the player's perception of the development of the game story and its characters; and social immersion, which occurs when the game provides the player with the social space. These categories match four of those proposed by Calleja. Similarly, Bjork and Holopainen defined five types of immersion – emotional, cognitive, psychological, sensory-motoric, and spatial immersion. The first three types of immersion correspond to the affective involvement defined by Calleja, however it is possible that they partially include characteristics of ludic and narrative involvements too. Kinaesthetic involvement is described by these researchers similarly to sensory-motoric immersion, and spatial immersion is analogous in both theories.

Incorporation, like other theories based on the fact that immersion depends on the factors inside the game, does not account for external influences, such as the quality of the audiovisual presentation, brightness of the lights inside the player's room, or an individual perception and interpretation of the game. Despite the large number of existing models of immersion, a model that covers all aspects simply does not exist – both physical and psychological influence on immersion. Player experience research has been mainly focused on game factors, but the human aspects have not been reviewed in as much depth, which is why a general model of immersion has not been yet completed. A more comprehensive model would not only describe how a game can keep the player immersed, but also review how players' attention and perception of the game, as well as their planning and attitude, affect their gaming experience.

Immersion Conditions

In contrast to the previously discussed theories, McMahan (2003) does not define immersion in terms of levels or components, instead she provides three conditions that create a sense of immersion in a digital game. This theory views immersion as a state that occurs when the game and the player are in a perfect balance. Firstly, the player must

be able to see the impact of their actions on the game environment in order to keep track of their progress during the game. In order to match this condition, a game should provide its player with sensible controls and appropriate feedback.

Controls and feedback

Secondly, the conventions of the virtual world must be consistent, even if they do not match those of the real world. Digital games do not need to have realistic graphics and high quality picture and sound effects in order to immerse the player in the game world, but consistency in audiovisual presentation and gameplay is important to the player. Whether the main character is an elf or a super-hero, the positive experience of playing these digital games comes from believable storyline, consistent gameplay without the need for realistic physics or the player constantly being reminded that what they see on the screen does not happen in real life.

Consistent game world

Finally, the player's expectations of the game or its environment must match the environment's conventions fairly closely. While the first two conditions described by McMahan (2003) are more related to the game attributes, their requirement is the person factor. While a digital game should be unpredictable in order for the player to be interested in perceiving the outcome of their actions, there should not be randomness in the way the game behaves – rules guide players but do not bound them. Matching players' expectations is an important task for any game designer and developer. According to Douglas and Hargadon (2001) players develop schemas based on the generic concepts and knowledge in order to guide their expectations. Therefore, immersion occurs as a result of players being absorbed in the world of familiar schema – when all their expectations are met.

Matching player's expectations

2.5 Measuring Player Experience

In order to be able to study these experiences in practice and be able to collect data about certain concepts, many tools and methods exist based on the theoretical concepts described previously. Generally, the experience one has during playing a digital game can be measured more objectively, using physiological data about the player, or subjectively, using quantitative interviews and questionnaires.

Physiological measuring tools typically require players to wear special equipment attached to their bodies, and can record data about changes in their heart beat (electrocardiography), electrical activity of their brains (electroencephalography), electrical activity of muscle tis-

Physiological measures

sues (electromyography), and electrical characteristics of skin (electrodermal activity). Despite the evident benefits of the data produced using these methods, this approach is considered problematic for measuring player experience (Mekler et al., 2014). Firstly, being connected to sensors while playing a digital game is far from a realistic set-up. Secondly, interpreting such data without collecting additional subjective data either during the game play or afterwards, and then mapping it onto the physiological data, can be challenging and might lead to false conclusions.

Qualitative methods Subjective methods, including interviews and focus groups, allow researchers to gain more insight into the reasons for the players' behaviour and their experiences of playing digital games. However, such methods can lack standardisation and comparability.

Quantitative methods Questionnaires, on the other hand, are useful standardised research instruments that allow quantification of the subjective experience under consideration, while being relatively easy to deploy (Adams and Cox, 2008). These psychometric instruments have many benefits over other methods. Like the more objective measures, the use of questionnaires ensures consistency and uniformity of collected data, because the same specific aspects are considered by all participants in all studies. Questionnaires can be used in online surveys to collect large amounts of data from diverse population, which can be done cost-effectively.

Advantages of questionnaires

Disadvantages of questionnaires There are, however, a few drawbacks of using questionnaires to measure player experience. Some of the challenges researchers face when looking for the most appropriate questionnaire include the ability to persuade participants to treat the questionnaires seriously, and the scale upon which participants answer them. Moreover, it is important to consider the wording of questions, so it does not reduce the face validity of the questionnaires (Adams and Cox, 2008).

PX questionnaires Player experience is a multi-faceted experience. Theories, and their corresponding questionnaires, aim to address each unique concept in great detail. While some questionnaires measure generic experiences, such as engagement (Brockmyer et al., 2009) and immersion (Jennett et al., 2008) in games, which take into account most aspects of gaming, others focus more on a specific facet of experience, e.g. narrative immersion or social presence (De Kort, IJsselsteijn, and Poels, 2007; Qin, Patrick Rau, and Salvendy, 2009).

The variety of questionnaires allows researchers to focus on a specific aspect of games. On the other hand though, the various questionnaires show considerable conceptual, and in some cases actual, over-

lap, while supposedly measuring apparently different experiences. This leads to a confusion as to whether they in fact do the same job. The plurality of questionnaires also reduces the ability to compare the outcomes of player experience studies. This section therefore provides an overview of existing questionnaires used to measure the experience of playing digital games, together with a discussion of their validities and availability to the public.

2.5.1 *Questionnaires Measuring Player Experience*

Many player experience theories use their own questionnaires to quantify the experience one is having when playing digital games. While the theories aim to focus on a specific aspect of player experience unique to each concept, the overlap between the theories is evident. Moreover, questionnaires are developed to address each nuanced experience, resulting in a large number of tools that potentially measure the same or similar experiences.

Engagement is amongst some of the most widely used concepts to broadly describe the experience players have when interacting with digital games. It is, however, only one dimension of player experience, and can be related to a number of other PX theories, including immersion (Brown and Cairns, 2004) and motivation (Rigby and Ryan, 2011). Several models and theories have been developed in the past few years to describe this experience (Brockmyer et al., 2009; Ijsselsteijn, Poels, and Kort, 2008; Mayes and Cotton, 2001; Schoenau-Fog, 2011); many of which have their own versions of questionnaires to measure engagement.

Ijsselsteijn, Poels, and Kort (2008) proposed the Game Experience Questionnaire (GExpQ/GEQ), which was based on findings by Poels, De Kort, and Ijsselsteijn (2007), who investigated the feelings and experiences players have when playing digital games by focusing on different stages of gaming: on what occasions players typically start gaming, their experience during game play and post-play. This questionnaire was designed to quantify player experience through dimensions of immersion, flow, competence, positive and negative effect, tension, challenge, and social presence using 33 questionnaire items. However, this questionnaire has not been published and therefore is not readily available to researchers who might wish to use it in their research. Moreover, because the questionnaire has not been released, it is not possible to evaluate the validity of this instrument.

*Game Experience
Questionnaire
(GExpQ)*

*Game
Engagement
Questionnaire
(GEngQ)*

Brockmyer et al. (2009) developed another questionnaire to measure engagement – Game Engagement Questionnaire (GEQ). In order to distinguish between the two scales, this one is referred to as GEngQ. Unlike GExpQ, this questionnaire was designed to quantify the subjective experience of deep engagement of violent digital game players, which comprise immersion, presence, flow, and absorption, where these terms were used in the order of increasing levels of engagement from the lowest, immersion, to the highest, absorption. Overall, the questionnaire consists of 19 items measuring all of the four constructs. According to the authors, “*the term ‘engagement’ will be used as a generic indicator of game involvement*”. The questionnaire items are available publicly (Brockmyer et al., 2009), and the scale as a whole has been empirically validated. The authors report good reliability statistics.

*Engagement
Questionnaire
(EQ)*

Another engagement questionnaire was developed by Mayes and Cotton (2001) – the Engagement Questionnaire (EQ), with a goal to develop a tool that can be applied to range of genres and digital game players. The questionnaire was designed to quantify engagement using 46 items split into five factors: interest, authenticity, curiosity, involvement, and fidelity. However, the questionnaire has not been published and has not been empirically validated.

*SCI Immersion
questionnaire*

Immersion, amongst other player experience concepts, is a closely related concept to engagement, and is often used interchangeably to describe players’ involvement with a digital game. As described in the previous section, immersive experience was studied by Ermi and Mäyrä (2005), who developed a questionnaire to measure this experience. Based on the SCI-model, the researchers developed a 18-item scale that they tested on 13 different games, demonstrating good internal validity for each of the three factors. The three factors also seem to vary meaningfully among the games. However, the questionnaire items were never published, making it difficult, if not impossible, for other researchers to evaluate the reliability of such scale.

*Immersive
Experience
Questionnaire
(IEQ)*

Several years later, Jennett et al. (2008) also researched players’ immersive experience, which lead to the development of the Immersive Experience Questionnaire (IEQ). It is aimed at measuring the levels of immersion experienced by players, and was intended to work as a uni-dimensional scale, however factor analysis demonstrated that there might be five underlying concepts that affect this experience: cognitive involvement, emotional involvement, real-world dissociation, challenge, and controls. The scale was published in Jennett et al. (2008) and is readily available to researchers. Moreover, the IEQ was statistically validated, and has been used extensively across a diverse array of dif-

ferent use cases and game genres, for example Cox et al. (2012) and Nordin et al. (2014).

In addition to the two immersive experience scales, the Immersive Tendency Questionnaire (ITQ), developed by Witmer and Singer (1998), aims to measure one's tendency to get immersed in a virtual environment. This can be useful in order to observe certain mediating effects between the experimental manipulation and the experience of presence players might have as a result of it. The ITQ contains three subscales: involvement, focus, and propensity to play and enjoy video games, which were statistically validated by the authors, and the scale as a whole was presumed valid.

*Immersive
Tendency
Questionnaire
(ITQ)*

Rigby and Ryan (2011) argue that engagement is motivated by players' abilities to satisfy fundamental psychological needs for competence, autonomy (freedom of choice based on personal interests) and relatedness (interaction with other players in the game). The questionnaire based on the Player Experience of Need Satisfaction (PENS) theory addresses these three concepts, together with two additional components: immersion/presence and intuitive controls, resulting in 5 distinct scales. The PENS questionnaire has been statistically validated (Ryan, Rigby, and Przybylski, 2006), and extensively used a number of studies, for example Birk and Mandryk (2013), Gerling et al. (2014), and Johnson and Gardner (2010). However, the scale is copyrighted and therefore is not readily available to researchers. However, it can be obtained under an agreement by contacting the authors.

*PENS
questionnaire*

A few questionnaires are, however, more commonly used to measure player experience than others. The IEQ, GEQ, and PENS scales are some of the more prominent examples of questionnaires used to explore player experience in games user research nowadays. However, despite the fact that the three questionnaires were developed with intentions to measure three distinct experiences, it appears that there is much overlap between the concepts that they measure, as well as the items within the questionnaires.

Moreover, just like the theories these questionnaires are aimed to quantify, the scales have much overlap between their components and items. For example, Table 1 provides a summary of the some of the most widely known and used questionnaires and their components. There is some evident overlap between the components of each questionnaire, while some similarities in the concepts are less obvious as they are named or grouped differently in different scales. For example, immersion is a component of both the PENS and the GEQ questionnaires, while the IEQ measures immersive experience as a whole. The

*Conceptual
overlap of
questionnaires*

Questionnaire	Components
Immersive Experience Questionnaire (IEQ) (Jennett et al., 2008)	Cognitive Involvement, Emotional Involvement, Real World Dissociation, Challenge, Control
Game Engagement Questionnaire (GEQ/GEEngQ) (Brockmyer et al., 2009)	Absorption, Flow, Presence, Immersion
Player Experience of Need Satisfaction Questionnaire (PENS) (Rigby and Ryan, 2007)	Competence, Autonomy, Relatedness, Controls, Presence/Immersion
Game Experience Questionnaire (GEQ/GEExpQ) (IJsselstein, Poels, and Kort, 2008)	Competence, Tension, Flow, Negative Affect, Positive Affect, Challenge, Sensory and Imaginative Immersion
Play Experience Scale (PES) (Pavlas et al., 2012)	Autotelic experience, Freedom, Focus, Absence of extrinsic motivation
Presence-Involvement-Flow Framework (PIFF) (Takatalo et al., 2010)	Interaction, Physical presence, Attention, Role engagement, Co-presence, Arousal, Interest, Importance, Challenge, Competence, Playfulness, Control, Valence, Impressiveness, Enjoyment
Presence Questionnaire (Witmer and Singer, 1998)	Sensory, Distraction, Realism, Control

Table 1: Questionnaires measuring gaming experiences and their respective components.

PENS also considers intuitive controls as a separate sub-scale in addition to immersion, while the IEQ suggests that controls contribute to the immersive experience that one might have when interacting with a digital game. Furthermore, one of the more frequently occurring components is challenge, which suggests that this factor plays an important role in shaping a gaming experience.

However, it is also evident that despite the general overlap in the concepts, the questionnaires do vary in certain ways from each other. There are factors that are unique to specific experiences. For example, 'realism' is a component of the Presence Questionnaire, which implies that it contributes toward the experience of presence, while it might not be considered as vital to the experience of immersion or engagement.

Yet, each scale aims to measure a unique experience

Overall, player experience questionnaires acknowledge many factors that contribute toward a positive experience of playing digital games. The commonly used concepts include the feeling of dissociation from the real world, loss of time perception, high concentration on the gaming activity, emotional investment in play, and the importance of skills, challenge, and the balance between the two. Nonetheless, it is not entirely clear which tool is most suitable to measure immersion, and what scale produces the most reliable and valid data. A large amount of questionnaires measuring seemingly similar experiences without a clear distinction between the scale purposes poses a challenge to researchers, who want to use the most suitable tool for their experiments. Moreover, not being able to access some of these questionnaires limits the choice only to the tools that are readily available.

Common trends

2.6 Influence on Immersion

The existing models of immersion have demonstrated that player's level of involvement with digital games often depends on the hardware and software of the game. Depending on the screen size and the quality of imagery, presence of music and the choice of soundtrack in a digital game, it is possible to vary a person's level of engagement, immersion, and enjoyment during the act of playing. The following section provides a review of some of the recent research conducted in order to establish what game features and hardware influence player immersion.

2.6.1 *Environmental and Hardware Influence*

Digital game platforms come in different shapes and forms – from small handheld portable devices to personal computers and various home consoles. Nowadays, many modern digital games are available on more than one platform at once, and therefore can be enjoyed to a different extent depending on the hardware used. Players purchase expensive graphics and sound cards for their computers to improve their enjoyment of playing games: large high definition displays, surround sound headphones, headsets and speakers, next generation controllers. These products have the potential to enhance the positive experience of gaming. However, it is still possible to get immersed in the virtual world without such high tech equipment.

*Surroundings
and rituals*

In their study, Brown and Cairns (2004) found that gamers tend to have special rituals before they begin their playing session – making a cup of coffee, bringing food, dimming the lights and turning up the volume of their speakers. These small rituals often make much difference in terms of enjoyment of a digital game, and affect the immersion level of a player.

Monitor size

The size of the screen players use to view the gaming action is also an important factor in terms of their experience. van den Hoogen, IJsselsteijn, and de Kort (2009) investigated the relation between the quality of visual and auditory presentation and immersion of digital game players. Their findings support the idea that sensory presentation is important to digital game players – monitor size correlates positively with presence experienced by the player, as larger screens of touch screen devices improve the level immersion (Thompson, Nordin, and Cairns, 2012).

Virtual reality

Modern technology is capable of bringing the virtual world closer to reality, making players experience it as if they were actually inside it. Although VR simulation have existed in various forms for several decades, a recent commercially available VR head-mounted display, Oculus Rift⁶, has a potential to revolutionise gaming industry as contemporary digital game makers are trying to adapt this new technology into next generation games and consoles⁷. Work done by Halley-Prinable (2013) demonstrated that a VR headset, such as Oculus Rift,

⁶ Oculus Rift, <http://www.oculusvr.com/>

⁷ 'Project Morpheus: Experiencing PS4's Virtual Reality Prototype' in Playstation.blog: <http://blog.us.playstation.com/2014/03/21/project-morpheus-experiencing-ps4s-virtual-reality-prototype/>

provides objectively more immersive experience to players than a typical computer monitor.

Moreover, digital game industry is currently looking into developing more natural controllers in order to improve player's experience of gaming. Several studies compared some of the most popular digital game controllers – the results of the study run by Cairns et al. (2014) for mobile devices support the hypothesis that natural mapping is a key for improving player experience, and in particular their immersion. Birk and Mandryk (2013) also found that traditional controllers, such as GamePad, increase neuroticism, anxiety, and instability, and decrease the chances of experiencing empathy, according to the self-determination theory (Ryan and Deci, 2000), self-discrepancy theory (Higgins, 1987) and PENS (Rigby and Ryan, 2011). While Microsoft Kinect was more preferred for enhancing agreeableness – it was found to be optimal for friendly play environment and not as suitable for games that focus on personal advantage and conflict. Skalski, Tamborini, and Westerman (2002) suggest that controllers with natural mapping require less training than regular controllers, as they provide users with more complete mental models for how to perform more realistic actions. The simplicity of natural controllers makes them more suitable for novice and casual players than the controllers used by 'hardcore' gamers such as keyboard that has a much steeper learning curve.

Controllers

2.6.2 Games Influence on Player Experience

As the quality of speakers and monitor can influence player's experience, equally the choice of music, sounds, and imagery inside the game can affect people's enjoyment while playing. Researchers have proven that addition of music makes players underestimate the experienced duration of playing a digital game, and increase or decrease immersion inside the virtual world depending on whether the player enjoys the chosen music (Sanders and Cairns, 2010).

Music

Narration in digital games is often supported by the camera point of view (POV), whether it is parallel projection, top-down perspective or side-scrolling in 2D games, or first or third person perspective, or fixed view for 3D digital games, and sometimes even a mixture of some of these. It is widely believed that when the player views the game world through the eyes of the main character, they are more immersed in the game, rather than when they observe the character from the third person perspective (Rouse III, 1999), which could be due to the fact

Visual perspective

that players perceive the character as a separate person to themselves when playing in third person perspective, but in the first-person POV they project their own identity onto the character (Waggoner, 2009).

Avatar Similarly, this can also happen when choosing the avatar or the look of the character. Players tend to feel more attached to the character that looks like them (Gee, 2000), because it makes the 'distance' between the player and the virtual world smaller, and the player feels like they are in the game themselves. However, when they are playing a character who has very little in common with the player, the avatar is perceived as the separate character from the person who controls it, and the player feels as if the story is something they are not a part of but a puppeteer who directs their avatar. A player is more likely to identify themselves with a character that is the most attractive to them visually and depending on their role (Hefner, Klimmt, and Vorderer, 2007).

Photorealism The quality of imagery inside the game can also affect player's enjoyment and engagement level with the game. However, it is not necessary that a recent photorealistic 3D digital game would provide its players with more positive experience than a 2D digital game from a decade ago. Total photorealism is not an essential requirement for the viewer to enjoy the visuals or even to immerse themselves into the act of playing (Masuch and Röber, 2004). No matter how sophisticated the graphics are, the main factors that keep players interested in digital games is their interactivity, its challenging nature, the sense of achievement players get when playing and unpredictability of the outcomes of the game.

Suspense Digital games are more enjoyable if they facilitate high levels of suspense than those game that are more predictable (Klimmt et al., 2009). If a game is too predictable the player may get bored, but a digital game that is too random may cause frustration. Therefore, there should be unpredictability for creating challenge, but games should be predictable in order to support active coping (Grodal, 2003).

Achievement Moreover, the sense of achievement is an important factor that motivates players (Ryan, Rigby, and Przybylski, 2006). Without rewards and achievements a game loses its competitiveness, especially when a person is playing alone: if there is no way to track the progress, the player may get bored and leave the game.

Social interaction Social factor is believed to have an impact on the experience of playing a digital game. Playing against a human was shown to be more enjoyable (Gajadhar, de Kort, and IJsselsteijn, 2008) and immersive (Cairns et al., 2013) than playing against game AI, but there appears

to be no difference in the player's experience when playing against a human opponent who is located online or whether both of them are present in the same room (Cairns et al., 2013).

Challenge, amongst other factors, is perceived as one of the most important factors that a digital game should possess in order to keep players interested and satisfied (Adams, 2014). It has been reviewed and used by digital game researchers in many theories stating that appropriately balanced challenge contributes to a positive gaming experience.

Challenge

This section demonstrates some of the factors that affect player experience in general, and immersion in particular. Studying the effects of different settings and factors within and outside digital games on player experience is vital in order to explore the nature of gaming experiences, such as immersion, in more detail, and to refine the existing model of this experience. In addition to the physical dimensions of digital games, there are factors that also affect the experience of playing games, which include players' personal attitudes and perceptions of digital games based on their previous experiences and preferences, and influenced by opinions and reviews of other players. The following section discusses some of the existent, though limited, research done in order to understand how player experience is affected by these factors, which are going to be referred to as 'player factors' in the context of this thesis.

2.7 Player Predispositions

Whether or not a game can keep a player glued to the controls depends not only on the characteristics of a digital game, but also on the player's individual skills and expectations. According to Kücklich and Fellow, 2004, *"whether the game is playable depends as much on the player's former playing experience, taste and willingness to adapt to a new play environment as on the game's controls, graphics, audio and genre"*. Kücklich and Fellow also argue that *"play is not just a mode of interaction the user is subjected to, but also an attitude that she brings to the medium in the form of notions and expectations about the technology [...]"*

Players' individual differences and their perception and interpretation of information about digital games contribute greatly to the shaping of their gaming experiences. Understanding players' needs, therefore, is an important task for game designers and developers who aim to create products that keep their consumers satisfied.

However, little research has been done with regards to the human aspects of player experience. Immersion theories, reviewed in previous sections, demonstrate that some of the main factors that researchers focus on when studying experiences of playing games are mostly based around game characteristics. The research of human aspects of games is not a novel field, however with emerging demand for creating adaptable technology that changes the game behaviour according on its players' actions, understanding the needs of the players is as vital as learning about the effects of game factors on gaming experience.

2.7.1 *Expectations in Digital Games*

This section provides a discussion of expectations in relation to immersion in digital games, factors that affect these expectations, and theories on how players construct their expectations based on their personal characteristics. Moreover, it provides an overview of different factors that can affect one's perception of digital games, and their gaming experience as a result of this.

Players choose games based on the information available to them

Players form their attitudes toward a game based their general knowledge of the world and based on the information they know about the game. Game previews released to advertise games provide players with a suitable indication of the graphical detail and sound effects one might expect from the actual game, and players find these previews particularly useful when choosing a game that feels just right (O'Brien and Toms, 2008). They also consult other people, both their friends and online reviewers, to select a product that best suits their needs. Players then become engaged in gaming if something resonates with their interests, whether it is the aesthetic appeal of the visuals or a novel story or concept. These elements capture players' attention and interest and move them toward engagement.

Subjective information

When selecting a brand new game, players often rely on their previous experiences and preferences to direct them toward games that look and sound most appealing. Research done by Livingston, Nacke, and Mandryk (2011) shows that players' enjoyment of a digital game changes depending on the tone of the review they read about this game. In their studies, players who read negatively phrased reviews rated the game considerably lower than the players who read positively phrased text, and the biasing effect was stronger when being exposed to a negative text than a positive one, compared to the baseline of players who did not read any reviews at all. The researchers

also found that the reviews written by critics and by other game players affect players' perception of the game in a similar manner.

Apart from the subjective information that players read before trying a game out for the first time, there is more objective information that can also affect their expectations. Reading game descriptions and watching trailers that advertise clever AI, exciting narrative, and procedurally generated content can set players' expectations high. These expectations, however, have to be met by the game conventions, otherwise players might never get immersed in the game (McMahan, 2003), or even worse – give up on playing it and never return. For example, dynamic difficulty balancing implemented in multiplayer digital games is typically perceived as a beneficial feature that aims to provide a better balancing of players based on their skills. However, being aware of its existence may bias players' perception of the feature and consequently lead to less satisfactory experience of gaming (Hunicke, 2005).

Objective information

However, this might not always be the case. When being highly engaged in the act of playing, a player can subconsciously compensate for certain inconsistencies inside a digital game – a phenomenon known as 'suspension of disbelief' (Vorderer, Klimmt, and Ritterfeld, 2004). This term describes a state when a player willingly decides to ignore inconsistent information presented by the medium in order to have a positive experience. In the context of digital games, the term means more than just coping with inconsistent storyline and fantastic plot – interactive nature of games also can affect a person's judgement of incoherent behaviour, low level of realism, or even the fact that the player is interacting with the game world through a controller without natural mapping to their actions. Players often choose to ignore the fact that their characters do not have the same basic requirements as humans – travelling through enormous worlds for virtual days or fighting off enemies without the need for a nap or a drink; their health often regenerates all by itself and their weapons can have no lifetime with unlimited number of ammunition in the inventory.

Suspension of disbelief

It is entirely possible that a player can get so immersed in the game that particular inconsistencies are overlooked in order to keep the balance of experience. A study by Cheng and Cairns (2005) demonstrated that players can get so immersed in the game that they do not notice significant changes to the physics of the game.

A recent but anecdotal evidence has also demonstrated how players can experience game features without them being implemented in a

Placebo effect in games

game⁸. According to an interview with Jeffrey Lin, the lead game designer of social systems at Riot Games, *League of Legends* (LoL) players' experiences were affected by a supposedly nerfed (made less effective or desirable) performance of a Champion in the game, while the nerf was not implemented in the patch to the game. The sole knowledge that it was there made the player change their game play. This suggests that the information players know about the game not only before they try it for the first time, but also during their engagement, can affect their experience.

*Benevolent
deception*

Deception though, whether intentional or unintentional, is typically perceived as having negative connotations. Nonetheless, it can be used to improve one's experience of a product, in which case it is known as a term 'benevolent deception' (Adar, Tan, and Teevan, 2013). The researchers describe this phenomenon as a tool used by product designers to mask some features, which do not affect the users' perceived productivity, which, in turn, keeps them satisfied. Some of the prominent examples where this concept has been implemented include the 'placebo' traffic lights buttons, which do not affect the speed of the traffic light changing its colours, but the users of the button are misled into believing they do, which makes them feel in control and satisfied as a result of pressing the button. Similarly, during busy times, Netflix switches the personalised recommendation system off and display a generic star-rated system for their users, who are not aware of the change (Adar, Tan, and Teevan, 2013). This kind of deceit can be used to benefit either the game developers or game players, or both, depending on the nature of the deceit. For example, in the case of an unimplemented nerf gun in *League of Legends*, the deceit was unintentional and affected only the players.

Preferences

Additionally, previous experiences of games and players' personal traits and general knowledge often lead to the formation of preferences toward certain genres, games, and their features. In psychology, preferences refer to an individual's attitude toward a set of objects (Lichtenstein and Slovic, 2006), and can help a player choose games from a multitude of digital games available on a market. However, they can also limit players in their choices and could break their engagement when not met O'Brien and Toms (2008).

It is evident that even before playing a digital game, people already have an idea of what they are expecting to experience, which can affect their objective judgement of this particular game. It is also possible that

⁸ Jeffrey Lin's interview about the 'placebo effect' in LoL: <https://www.rockpapershotgun.com/2015/12/14/league-of-legends-jeffrey-lin-interview/>

in a sequel, players already have an established expectations based on the previous versions of the game, and therefore may miss new possibilities of play provided in the newer version of the same game (Lindley and Sennersten, 2006).

Overall, it is evident that players' can be subjected to numerous effects depending on the different information they are exposed to before and during game play. However, the literature on the effects of information on player experience is scarce and often lacks empirical evidence, particularly with regards to the effects of information intrinsic to digital games, such as adaptive technologies, on players' immersion.

2.8 Summary

Many different concepts and theories have been developed in order to describe a positive experience of playing digital games. Each theory has its own merits, and aims to describe nuanced experiences from various viewpoints. However, it is evident that a comprehensive model of player experience has not yet been developed. Nonetheless, immersion is a broad and all-inclusive experience that amongst other concepts is often used and valued by game researchers, developers, and players to describe their positive involvement in digital game playing.

However, the existing models of immersion are limited in the way that they are mainly focused on the influence of game factors on this player experience, and often ignoring the fact that immersion is dependent on how the player perceives such technology as well. The hypothesis, drawn from the work of McMahan (2003) and Kücklich and Fellow (2004), is that player's expectations play a major role in shaping the experience of playing a digital game – if these expectations are matched by the conventions of the game world, the player feels immersed, while unmet expectations can distract the player and decrease their level of immersion.

The overview of the games user research unveiled the importance of studying the effects of player factors on gaming experiences, and the lack of progress in this part of the field compared to the effect of game factors on player experience. Players' expectations and perceptions of games can change their experiences when playing with the game, as seen in this literature section. However the influence studied so far typically depends on one's exposure to subjective opinions in the form of magazine articles, game ratings, and reviews. While anecdotal

dotal evidence suggests that players' perceptions of the game and their experience of playing it can be affected by the information they know about the game itself, i.e. neutral information about game features.

A prominent example of a game feature that players often perceive as potentially beneficial to their game play is the ability of a digital game to adapt to their behaviour and performance. The next chapter, therefore, describes adaptive technologies used in contemporary digital games, their benefits and drawbacks, and discusses the potential influence of players' perception of such technologies on their gaming experiences.

Adaptive Technologies in Digital Games

3

Challenge is a widely studied factor in digital games that is believed to play a crucial role in making games playable and enjoyable (Vorderer, Hartmann, and Klimmt, 2003). However, digital games that are not too challenging for players with varied levels of skill, experience, and motivation, while at the same time are not too easy, are hard to design. Challenge is one of the key attributes of player experience, as seen in the previous chapter. It is not only a key component of flow, but it also plays an important role in leading players toward an immersive experience, according to Ermi and Mäyrä (2005) and Jennett et al. (2008). Learning more about the relationship between challenge and player experience, therefore, can inform the design of digital games and, as a result, enhance gaming experiences of their players.

3.1 Challenge in Digital Games

In games user research, gameplay is defined as a series of actions performed by the player or game actors and their associated feedback or outcomes (Vorderer, Hartmann, and Klimmt, 2003). Along the way toward the goal, a player encounters obstacles, which they have to overcome in order to make progress in the game – these obstacles can be broadly described as challenges (Adams, 2014).

Adams (2014) breaks challenge into ten categories, which are commonly used in contemporary digital games. These include: physical coordination, formal logic, pattern recognition, time pressure, memory and knowledge, exploration, conflict, economic challenges, conceptual reasoning, and creation/construction.

Physical coordination challenges are amongst some of the most widely used methods of testing a player's ability, most commonly in the form of hand-eye coordination. Typically, these challenges involve rapid inputs of the controls (speed challenges), or quick reaction to events (time challenges). Platformer games, shooters, and fast puzzle games

like *Tetris* are amongst some of the prominent examples of games with this kind of challenges. Moreover, accuracy and precision are often tested in action, action-adventure games, sports games, and vehicle simulators, as well as in RPGs that include combat elements.

Time pressure Games also often feature time pressure challenges, which tend to encourage direct, brute-force solutions. Similarly, games that involve any form of racing allow players to compete either with one another or with the game AI in order to achieve a goal in shorter time than the opponent.

Formal logic However, physical challenges are not the only challenges digital games offer to their players – the cognitive abilities of players are also often tested in a number of different ways. Logic challenges keep players interested by providing the basis for strategic thinking in turn-based games and other games in which the player can make precise deductions from reliable data. Mathematical challenges can be found in games that rely on chance, or games in which the player does not have reliable data and so must reason from probabilities.

Memory and knowledge Another way to engage players mentally is to include factual knowledge challenges, like in trivia or quiz games. Similarly, a player's ability to recall things that they have seen or heard in the game can be tested using memory challenges. These are often met in games with stronger narrative, like adventure games and RPGs.

Conceptual reasoning Extrinsic knowledge is required for conceptual thinking and lateral thinking puzzles. In conceptual reasoning puzzles the player uses their reasoning power and knowledge of the puzzle's subject matter to arrive at a solution to a problem. While lateral thinking puzzles rely on the terms of the puzzle being made clear to the player so that the most obvious solution does not appear to be possible and the player need to find an alternative solution instead.

Pattern recognition Pattern recognition challenges test the player's ability to spot visible or audible patterns, or patterns of change and behaviour. A prominent example is visual match-3 games, such as *Bejewelled* and *Candy Crush Saga*.

Exploration Many contemporary games come with large-scale game worlds, which provide players with long game play by adding various challenges along the way. Exploration is not a challenge per se, however certain goals and tasks can make exploration more exciting and challenging for the player. These often involve setting objectives in the game for the player to locate hidden objects, obstructing the path to the goal with locked doors, setting traps, or even turning the journey into a maze or illogical spaces.

Both digital and traditional games, like chess, also involve conflict. As games vary in speed, the scale of actions, the complexity of the victory conditions, the conflict challenges can be broken down into strategy, tactics, logistics, and other components. These challenges are mostly applicable to strategy games, which involve planning, anticipating the opponent's moves, and knowing and minimising personal weaknesses. Additionally, these challenges are often found in survival and stealth games, and games that rely on defending one's vulnerable items or units. *Conflict*

Finally, economic challenges can be broadly applied to most games, which contain some variant of economy – accumulating health points and collecting ammunition. However, a more prominent example would be construction and management simulators that require efficient management of a complex economy in order to reach a winning condition. These challenges consist of accumulating resources, achieving balance, and caring for living things, like in *Tamagochi*. *Economic challenges*

According to both Ermi and Mäyrä (2005) and Jennett et al. (2008), immersion occurs as a result of well balanced challenge. Ermi and Mäyrä (2005) categorise immersion into three types, where, according to the researchers, challenge-based immersion consists of two dimensions: the challenge of 'pace' and 'cognitive challenge'. The two types were investigated with regards to the effect on immersion by Cox et al. (2012), who demonstrated that an increased physical demand of the game required from its players does not lead to an increased level of immersion. Adding time pressure can make games more physically and cognitively challenging, which in turn makes players feel more immersed. *Immersion occurs as a result of well balanced challenge*

Cox et al. (2012) also found that players feel more immersed in the game when the balance between the challenge and their expertise level is matched fairly closely. Evidently, matching the challenge in the game to the skills of its players is a difficult task for game designers. Game developers make important decisions about the difficulty in the game and how this difficulty is achieved through different elements inside it. Typically, digital games have progressive difficulty from level to level, which increases from the start toward the completion stage. But the way it is done is largely dependent on the choices the designer makes (Adams, 2014). Linehan et al. (2014) studied four successful video games to explore how the games teach players skills. Their findings demonstrated that, in these games, main skills are introduced separately through puzzles that require players' performance to be little more than the basic skill. After a new skill is introduced, an oppor- *Physical and cognitive challenges affect immersion differently*

tunity is offered to the player to practice that skill and to integrate it with previously learned skills. Puzzles increase in complexity up from the point at which the current skill is introduced until a new skill is introduced.

Difficulty curves

As the player's skill level increases during the game, the challenges the player is faced with should become more involved as well. The changes in the difficulty level of a digital game during game play usually can be viewed as a function of distance travelled within the game, and is called a difficulty curve (Aponte, Levieux, and Natkin, 2009). These curves can differ rather drastically between different games and game types. Nagle, Wolf, and Riener (2016) lists some of the most prominent examples of difficulty curves, which are used in contemporary digital games. One of the more traditional methods for increasing difficulty is to start at a low difficulty level and then increase it over time or distance in the game. This can be done continuously (e.g. *Tetris* or *Portal*), discretely (e.g. *Super Mario Bros*), or with addition of randomness (e.g. *Half life* or *Grand Theft Auto III*). Additionally, a digital game can have a linearly increasing difficulty with plateau after a point, like in the cases of *League of Legends* or *WoW*, and linearly increasing difficulty interspersed with rest periods of low difficulty – in games like *Doom* or *Quake* (Nagle, Wolf, and Riener, 2016).

Naturally, players learn and adapt to the game as they play. Some players learn faster than others and often players tend to excel in different aspects of the game – each player plays and progresses in their own unique way. Therefore, having a difficulty that rises as one progresses through the game regardless of their learning curve could hinder one's experience of the game. Certain players would find the game boring if it becomes too easy for them, and other players can get stuck while trying to advance in the game (Newheiser, 2009). So to account for the variation on players' skills and abilities, various methods and techniques exist that allow players with any level of expertise to enjoy the game.

3.2 Adaptive and Adaptable Technologies in Games

Adaptable systems

Typically, difficulty can be determined either statically or dynamically (Qin, Rau, and Salvendy, 2010). In a static design, adaptable systems allow players to adjust game settings by explicitly choosing from a number of options according to their preferences (Bontcheva, 2002), for example choosing a difficulty level or, in some cases, personalising

gameplay even further by choosing visual perspectives or character avatars and skills. When offering multiple difficulty modes, the player can set the game difficulty to account for two things a game designer cannot control: their personal previous experience with similar types of games, and their native talent (Adams, 2014). This makes games more accessible to a broader range of players, as they can explicitly tailor the game difficulty to their individual preferences. Switching between difficulty modes also allows players to experience the game on harder difficulty if they beat the game on an easier mode. However, providing too many choices could be overwhelming for players, which might eventually lead to frustration. Moreover, adaptable systems still rely on static difficulty adjustment throughout the game, which means that the experience players have might not perfectly suit their individual talents.

An alternative solution is dynamic difficulty adjustment (DDA) or Dynamic Game Balancing (DGB), which adapts the gameplay according to the player's abilities. According to Kuang (2012), *"the main idea of DDA is to have facilities in the game available to gauge the player's performance and skill, and adjust the difficulty accordingly during gameplay to provide the most consistent (and hopefully most fun) experience for the player."* Broadly, DDA techniques are often referred to as adaptive systems, adaptive AI, adaptive algorithms, adaptive features, adaptive technology, or, simply, adaptations, which all imply the same meaning. In the context of this thesis, these terms are, therefore, used interchangeably.

*Dynamic
difficulty
adjustment*

Mulwa et al. (2010) defines adaptivity as the ability of a system to identify users' preferences or characteristics and customise the system accordingly, which, in the context of digital games, means that the player influences the adaptation process implicitly, as opposed to explicitly making choices, as they would do when using an adaptable system. These adaptive methods can handle the drawbacks of adaptable systems, such as handling the variation in players' previous experiences and their native talents. Moreover, as not all genres are suited for discrete difficulty modes, adaptive technology can be a more suitable alternative. These systems can be used to moderate the challenge levels for each person, help players avoid getting stuck, adapt gameplay more to an individual's preference or taste, or even detect players using or abusing an oversight in the game design to their advantage (Charles et al., 2005).

Adaptive systems

Players' performance in the game is used to adapt digital games to one's game play, and it can be evaluated and measured using different techniques depending on the game styles and types. To measure one's

performance, game designers usually consider level design characteristics (Bartle, 2004), amount of resources or enemies (Hunicke, 2005), and the amount of win and loss states (Poole, 2004).

*Implementations
of adaptive
behaviour in
games*

Adaptive technologies can be incorporated into digital games using various approaches (Charles et al., 2005). One way to adapt a game is through the player's character: the actions that the player takes have implications, for example, if the character levels up – their weapons and attacks become more powerful. Another widely used technique alters non-player characters' (NPCs) behaviour and characteristics: depending on the players' performance in the game, the enemies' health and strength changes, they may become less or more aware of the characters' presence, and even vary in terms of items they carry on them. Finally, the game environment itself can be altered when the player's performance changes: for example, if the character levels up, the enemies they encounter change and become more varied in their quantities, the character might also find specific items and locations, which might not have been accessible beforehand.

Both multiplayer and single-player games use adaptive algorithms to adjust the difficulty in the game to balance the challenge based on the players' skill. However, the techniques used to adjust gameplay differ between games based on whether the player is competing against an AI or another player.

In multiplayer games, adaptation typically involves balancing challenge in the game in such a way that all human players have an equal opportunity to win (Adams, 2008). However, this difference in the abilities and experience between players can lead to substantial differences in their performances, hindering their gaming experiences. Usually, to balance this difference between players, games have player balancing, which can be broadly classified into four main types: matchmaking, asymmetric roles, difficulty adjustments, and assists (Cechanowicz et al., 2014). Matchmaking uses complex systems that identify groups of players with similar skill levels; asymmetric roles provide players with an opportunity to pick a role in the game that best suits their abilities; assists adjust a player's ability to perform basic actions in the game by simplifying the input required to correctly perform an action; and finally, difficulty adjustment balances the difficulty in the game based on the players' performance. Difficulty adjustment is also commonly used in single-player games, where these algorithms help players with different skill sets to make progress in the game in a less competitive environment, like in multiplayer games.

*Matchmaking
Asymmetric roles*

Assists

*Difficulty
adjustment*

According to the multiplayer dynamic difficulty adjustment (MDDA) framework, defined by Baldwin, Johnson, and Wyeth (2016), adaptive features in the game vary based on seven parameters, each of which have two or three different attributes. The decision to use an adaptation can be determined either before the game match commences or in real-time during the match, and can be automated by the game system or chosen by the players. The effect of adaptation can also be intended either for a single player or the entire team. Moreover, the adaptation can rely on certain level of skill from low-performing players to improve on their performance or adapt gameplay regardless of it. The player can turn the adaptation on themselves or it is done for them, while it can be used once, multiple times, or continuously over a certain timeframe. The adaptation can be visible to the player or the other players, or can be hidden. Many of these characteristics are also applicable to single-player games.

Determination
Automation
Recipient
Skill dependency
User action
Duration
Visibility

Overall, adaptive technologies in digital games allow for the more balanced gameplay that is supposedly beneficial for one's gaming experience. In the most extreme case of player experience, a perfect match of skills and challenge is a major constituent of flow (Csikszentmihalyi, 1991). However, recent work in the area of games user research has provided empirical evidence that suggests that adaptive features in games also have a positive effect on the players' experiences in shooting games (Bateman et al., 2011; Vicencio-Moreira, Mandryk, and Gutwin, 2015), MOBA games (Silva, Nascimento Silva, and Chaimowicz, 2017), racing games (Cechanowicz et al., 2014), and casual games (Smeddinck et al., 2016): resulting in higher levels of enjoyment and fun (Newheiser, 2009), experiences of autonomy (Klarkowski et al., 2016; Smeddinck et al., 2016), and competence (Vicencio-Moreira, Mandryk, and Gutwin, 2015). Though the effect of adaptive technologies on more generic player experiences, such as immersion and engagement, has not been well studied.

Adaptive technologies are beneficial for gaming experiences

Despite the evident benefits of adaptive technologies, digital games using algorithms in order to adapt to each player's individual behaviour are not so common. Traditional approaches, such as collecting requirements before and during game development process, seem to be more trusted by game developers. Alpha and beta testing of the game by its potential players, adding appropriate patching, and publishing software development kits (SDKs) for players to modify the game after its release are the most common player-centred approaches currently used by the industry (Charles et al., 2005).

Adaptive techniques are not very common

Designing a game based on the requirements of a limited group of potential players, however, can lead to the lack of accessibility of the end product to a wider market. A less risky solution to the problem involves a dynamic modification of a video game to individual players by using player modelling techniques (Houlette, 2004) and adaptive game technologies (Charles and Black, 2004). By reducing the dependency on collecting data about player requirements and the player demographics, digital game companies could instead focus on variations in learning and playing styles, correlate these with personality profiles to avoid problems created by stereotyping players on the basis of age and gender (Kerr, 2003).

3.3 Perception of Adaptive Technology in Digital Games

Generally, adaptivity is perceived as a beneficial feature in digital games, which makes games challenging, engaging, and fun, which can also increase the game's replayability (Ibáñez and Delgado-Mata, 2011; Sweetser and Wyeth, 2005). Such an approach allows for more interesting gameplay, with a wider range of possibilities for exploring the game world, different outcomes of a battle with every game session, making the experience unique for each player and varying it slightly every time the game is played again from the start. When a player feels that the game is responsive to them as an individual, they may feel more immersed in the game world, and experience a heightened sense of enjoyment when playing the game (Gajadhar, de Kort, and IJsselsteijn, 2008).

Adaptive technology can increase the game's replayability

Adaptive technologies are often invisible in the game design – as the game AI adapts to the player's individual approach, the player feels moderately challenged, and as a result feels increasingly immersed in the game. However, if the players become aware of another player having an assistance from the adaptive technology, it can be perceived as an unfair advantage by more experienced players, like in the case of *Mario Kart* (Newheiser, 2009). Particularly, in a situation when the player does not need to improve on their skills to improve their performance, because it is done for them. Similarly, scaling the level of difficulty in the game based on one's progress can deprive the player from their sense of achievement (Bostan and Ögüt, 2009). However, according to the interviews conducted by (Baldwin, Johnson, and Wyeth, 2016), this kind of perceived unfairness is more prominent in competitive games, where the player competes against strangers. Depping et

Perception of fairness of adaptive technologies

al. (2016) had similar conclusions about players overlooking the ‘unfair advantage’ of weaker players when being in a less competitive environment.

Effective adaptive adjustments to the gameplay can be done without hindering the perceptions of fairness of the players. The balancing technique developed by Vicencio-Moreira, Mandryk, and Gutwin (2015) has been shown to improve the performance of the weaker players, which resulted in greater enjoyment of the game for players with any level of experience. Similarly, the target assistance developed by Bateman et al. (2011) was also perceived as a fair balancing technique, despite players’ options being less favourable when learning about other players being assisted in the game. Nonetheless, both groups felt that this kind of assistance could benefit the overall group play experience.

Overall though, perception of adaptability varies between players – while in some cases players might interpret certain patterns in the game as the adaptive algorithms making adjustments to their gameplay, in other situations players might focus more on the task in hand and overlook the effects of adaptivity. Hunicke (2005) found that players’ perceptions of adaptability does not always correlate with the actuality of the difficulty adjustment: in his study some participants perceived adjustments, which were not present in the game, while other players missed the adaptation when being assisted in making progress in the game.

*What’s in
players’ heads
matters*

Unlike the multiplayer games, where, in most cases, players compete with other human opponents, single-player games offer a different kind of competitive play. As the player works their way toward a goal, they are mostly in the race with themselves and the game AI. Therefore, in such settings, adaptive technology has a potential to assist players with varied experience levels in making progress through the game in an enjoyable manner.

*Perception of
adaptivity can
vary between
multiplayer and
single-player
games*

However, despite the obvious benefits of this technique, there is little empirical evidence to support the idea that adaptive technologies in games have an effect on player experience (Karpinskyj, Zambetta, and Cavedon, 2014). Research into the effect of game balancing in multiplayer games on player experience has become more prominent in recent years, identifying the perception of unfairness as one of the main issues when it comes to the implementation of such features in games that are played by several players at once (Hunicke, 2005). While single-player games could benefit from having such systems helping players enjoying the games – they can prevent players from

getting stuck, and allow anyone with any level of skill and previous experience to enjoy the game equally. Unfortunately, no research has been done to explore players' perceptions of these features. Gathering more empirical data could help game user researchers understand this phenomenon in more detail and learn about how player experience is affected when playing with such features while being aware of them and when adaptation is hidden away.

3.4 Summary

The recent rise in popularity of adaptable and adaptive technologies in digital games, has led to an increased interest in studying the effects of these systems on gaming experiences. Having such features in games is often perceived as beneficial to one's gameplay, yet it is not yet known if these features affect players' immersion, or, more importantly, whether one's perception of these technologies have an effect on their experience of playing the game with such system.

Therefore, this thesis aims to gain further insight into how players' perceptions of adaptive technology affects immersion. This is done by challenging the player's expectations of a digital game through the information of varying levels of accuracy and precision about adaptive features in games and measuring immersion using a questionnaire. The next chapter then describes the method, which is used in this thesis to choose the most suitable tool for measuring immersion.

Part II

MEASURING GAMING EXPERIENCE

Study I: Measuring Player Experience

4

To begin answering the outlined research questions, one of the first steps to take is to find the most appropriate tool to measure immersive experience of players.

Currently, there are over a dozen of questionnaires used to measure a specific experience people have when playing digital games, as discussed in Chapter 2. However, some of these scales are not always available to the researchers, some are not validated, but more confusingly, the different questionnaires seem to have largely similar purpose. Overall, it appears that some of the most frequently used questionnaires have a similar structure, questions phrased in a similar manner, and they aim to measure experiences that are not entirely separate in their nature. Therefore, this chapter describes the work done to compare three of the widely used questionnaires measuring immersion in order to make an informed decision about choosing the most suitable tool for this research.

The work described in this chapter is based on a joint work with Dr Aliimran Nordin (a Research Fellow at the Institute of Visual Informatics, the National University of Malaysia), and has been published in Denisova, Nordin, and Cairns (2016). Nordin was responsible for obtaining the PENS questionnaire from the authors, and he assisted in participants recruitment. My contributions are the compilation of the questionnaire items, creation of the online form, collection of responses, data analysis, and write-up.

4.1 Measuring Immersion

Immersion is widely used and acknowledged term used to describe positive experience of playing digital games. In order to study this experience in more detail, researchers deploy questionnaires, which allow to directly measure the reported experiences of players. This approach in games research, however, is challenging for new researchers

Choosing a suitable questionnaire is a challenge

because of the proliferation of questionnaires available. The problem is knowing which questionnaires are measuring what aspect of experience.

Immersion questionnaires, just like the concept itself, vary depending on the framing of the concept they aim to measure: they either measure the whole experience or quantify this experience as a part of a broader concept. For example, some of the widely known immersion questionnaires are the Immersive Experience Questionnaire (IEQ) by Jennett et al. (2008) and the immersion questionnaire by Ermi and Mäyrä (2005). Alternatively, immersion is sometimes perceived as a part of an engaging experience, like in the Game Engagement questionnaire (GEngQ) by (Brockmyer et al., 2009), or as a part of the Player Experience of Need Satisfaction (PENS) (Ryan, Rigby, and Przybylski, 2006).

Overall, having a variety of questionnaires focusing on different aspects of games can be beneficial for researchers, allowing them to explore different facets of player experience. While, at the same time, the various questionnaires show considerable conceptual, and in some cases actual, overlap, while supposedly measuring apparently different experiences. This leads to a confusion as to whether they in fact do the same job. The plurality of questionnaires also reduces the ability to compare the outcomes of player experience studies.

Therefore, this study aims to evaluate whether questionnaires with a similar goal to measure immersion in digital games produce consistent and correlated results. This empirical work also helps to determine which aspects of these existent questionnaires work well when measuring the intended experience, and which do not. This information is then used to choose the most suitable tool to measure immersive experience in the following chapters of this thesis.

4.2 Choosing from Existing Questionnaires

Such a large number of existing questionnaires poses a challenge for new researchers, who may not necessarily be familiar with every specific detail of each theory. Choosing one is therefore often based on their availability, as many of these questionnaires are not readily available to the researchers, e.g. the immersion questionnaire by (Ermi and Mäyrä, 2005). So eventually only the easily accessible questionnaires tend to be used for measuring player experience. There is also a question of reliability. To obtain reliable results it is imperative that the

*Conceptual
overlap of
questionnaires*

*Plurality makes it
difficult to
compare results
across studies*

*Availability of
questionnaires*

data is gathered using a reliable questionnaire. However, some of the available questionnaires are not statistically validated, and as a result cannot be presumed trustworthy. *Reliability of questionnaires*

The aim of this thesis is to explore the effects of players' perceptions of adaptive technology on immersion. Therefore, three questionnaires that aim to measure immersion were chosen. They do so by measuring this experience either as a component of another player experience, like in the case of the GEngQ and the PENS, or as a whole experience, as the IEQ does. These tools were chosen based on their dominant use in gaming research, their availability, and their conceptual overlap.

The GEQ (GEngQ) (Brockmyer et al., 2009) and the IEQ (Jennett et al., 2008) are both available publicly and are set up in a similar fashion to evaluate player experience. The GEQ consists of 19 positively worded questions answered on a 7-point Likert scale. The questionnaire is formulated in such a way that the engagement is a unidimensional experience, which ranges up from immersion to flow. *GEngQ*

The IEQ uses 5-point Likert scale questions to measure player experience, but is specifically focused on the notion of immersion when playing games. It uses a combination of positively and negatively worded statements, adding an additional layer of accuracy. The overall score is composed of a summary of the results from the positive questions, and the inverted results of the negative. The development of the IEQ also suggested that there are five factors underlying immersion, but in practice, immersion is treated as a unidimensional concept with the factors framing the interpretation of the results. *IEQ*

Another questionnaire frequently used to quantify the experience of playing digital games is the PENS. The questionnaire contains 21 items, where it reviews the experience in terms of 5 components, such as competence, autonomy, relatedness, immersion/presence, and intuitive controls. All but one are measured using 3-item scales (apart from immersion, which is a 9-item scale), ranked on a 7-point Likert scale. *PENS*

An item-by-item analysis shows some similarities between all three of these questionnaires. Therefore, it is reasonable to expect some correlation between the results obtained using them. However, all three are also described as measuring differing concepts, with the PENS in particular addressing five ostensibly unrelated aspects of player experience. The questions are then to what extent these questionnaires do in fact measure different concepts, and which of these scales is the most suitable tool to measure immersion in this research.

4.3 Experimental Method

The aim of the study was to compare three of the most widely used questionnaires measuring player immersion: the IEQ, the GEQ and the PENS. For this, the items from each scale were combined into an online survey, which was distributed in a number of online gaming forums in order to gather responses from a variety of digital game players.

For this, we collected data online, and did a correlation analysis of the questionnaires, their items, and a reliability analysis of each scale. Moreover, because the PENS is not a unidimensional scale, we also performed a principal component analysis (PCA) on the items in the questionnaire.

4.3.1 *Participants*

Overall, the study gained 287 respondents, and after the initial screening of the data 17 responses were removed from players who either did not provide their age, leaving 270 responses that were deemed as valid. Responses received were from 30 women, 232 men, 1 person who identified as other gender, and 3 people who did not report their gender. The average age of participants was 26.42 years ($SD = 6.66$, min/max : 18/63). Participants were from a total of 32 countries, where majority of them were native English speakers. They had varied levels of previous experience of playing digital games, averaging 17.5 years of gaming ($SD = 6.63$).

Participants were invited to complete the survey, in which they had to reflect on their most recent experiences of playing a digital game, which they entered before taking the survey. Overall, over 100 titles were entered, with some of the most popular games shown in Figure 1. Other titles listed were from a variety of genres, including role-playing games (RPGs), action games and action-adventure games of various kinds, simulations, strategy games, and racing games. To incentivise the participants we offered them to be entered into a prize draw raffle to win Steam or Amazon vouchers worth £20, depending on their preference.

4.3.2 *Materials*

The questions from the IEQ, the GEQ, and the PENS questionnaires were merged to produce a single unified questionnaire that was deliv-

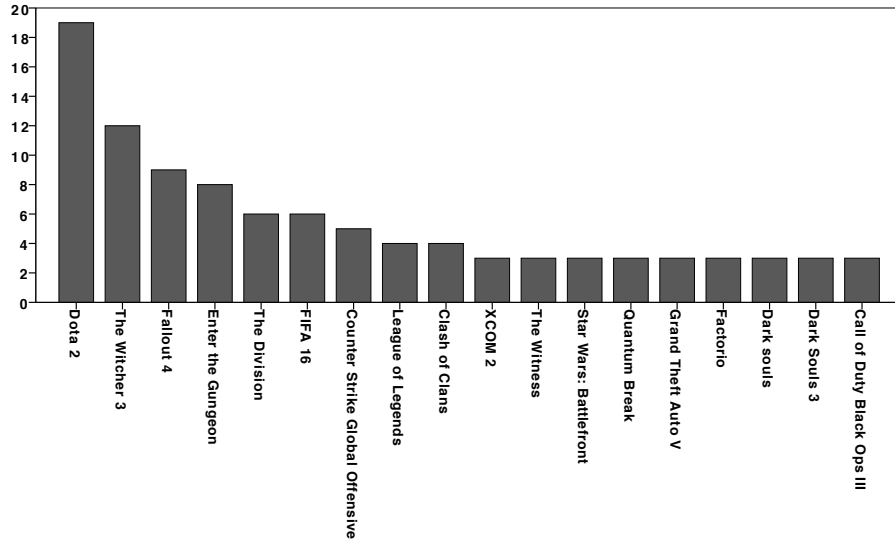


Figure 1: Most popular titles of the most recently played games by the survey respondents.

ered through Google Forms. Because each questionnaire had different question formats that might confuse participants, the items from all three were presented as standard Likert-type statements in the present tense (as in the GEQ). For example, a question in the original version of the IEQ: “To what extent did you find the game easy?” was rephrased to: “I find the game easy” to match the conventions of the other two questionnaires. This approach resulted in one of the IEQ items (IEQ5) matching the wording of a GEQ item (GEQ1): “I lose track of time”. In order to avoid a duplication in the final questionnaire, only one of these items was kept.

A full set of questions used in this study, together with the original questions from the GEQ and the IEQ can be found in Appendix b. The PENS items are omitted due to the copyright agreement imposed by the authors of the scale.

All items had a 7-point Likert scale anchored at the ends with Strongly Disagree and Strongly Agree. The order of the questions was randomised in Google forms for each participant in order to avoid order-effects.

At the end of the questionnaire, there was an open-ended field for comments. This was not extensively used but where appropriate, these responses are considered in the Discussion section.

4.3.3 Procedure

A link to the survey was distributed on various online gaming forums, including several communities on Reddit, Steam, Twitter, and Facebook games groups, with the aim to gather responses from a diverse audience of digital game players. The survey was available to self-selecting respondents for 4 days, during which 287 unique responses were gathered.

Each participant was briefed about the aim of the study, their rights, and on the usage of the data in accordance with the ethical clearance provided on the study (Appendix a). After this they were asked to reflect back on their most recent experience of playing a digital game, and to choose answers that best reflected their experience.

The statistical analysis was performed using SPSS. Scale reliability was performed to ensure internal consistency for each questionnaire using Cronbach's α , together with a principal component analysis (PCA) for the PENS performed in order to deduce whether the items fell into the five scales that the questionnaire originally had. Additionally, item-total correlations were considered to identify items with weaker coherence to the overall scales they belonged to. Correlations between scales and their components were all done using Pearson's product correlations.

4.4 Results

4.4.1 Scale Reliability

A questionnaire's reliability is a quantitative assessment of its internal consistency. The most common way to estimate the reliability of these types of scales is through Cronbach's α (Nunnally, 1978). Coefficient α can range from 0 (no reliability) to 1 (perfect reliability), where good reliability for research or evaluation is considered to be around .70 or higher (Everitt, 1996; Kline, 2000; Nunnally, 1978).

All three questionnaires yield good levels of reliability

The collected data was used to perform reliability analysis on the IEQ, the GEQ, and each of the PENS scales: Competence, Autonomy, Relatedness, Immersion, and Controls. Internal consistency measures of reliability (Cronbach's α) for each of the scales are summarised in Table 2.

Scales	Items	Cronbach's α	MSA
Immersive Experience Questionnaire (IEQ)	31	0.91	.908
Game Engagement Questionnaire (GEQ)	19	0.85	.824
Autonomy (PENS)	3	0.78	.698
Competence (PENS)	3	0.74	.674
Relatedness (PENS)	3	0.62	.534
Immersion (PENS)	9	0.88	.896
Controls (PENS)	3	0.80	.710

Table 2: Reliability analyses of the questionnaires: the IEQ, GEQ, and PENS.

Relatedness scale in the PENS had a lower internal consistency than the other scales, which can be considerably improved to 0.81 if one of the items is removed (PENS₉).

Additionally, internal consistency of the PENS as a single scale was evaluated, yielding Cronbach's α of 0.90.

4.4.2 *Principle Component Analysis*

The PENS was not designed to be a uni-dimensional scale, and we recognise that high alpha is not a valid indicator of unidimensionality. Therefore, in order to validate the scale, we performed the Principal Component Analysis on the 21 items.

PCA is a common method used to validate questionnaires by establishing the overall relationships between the scale items, and finding out how these items group into sub-scales of the questionnaire. The PENS questionnaire is split into 5 components: Competence, Autonomy, Relatedness, Immersion, and Controls. Using the collected data from a variety of different games and genres, we now can validate the scale components using this method with oblique rotation (direct oblimin), following typical practices (Kline, 2000). The correlations between the extracted components will help us to evaluate the overall coherence of the questionnaire.

Analysis of the Measure of Sampling Adequacy (MSA) suggested that the weak Relatedness item seen previously (PENS₉) was not suitable for PCA, due to its low correlation with the overall scale and the Relatedness component on its own. We, therefore, removed it from further analysis, resulting in high levels of sampling adequacy: MSA = .897.

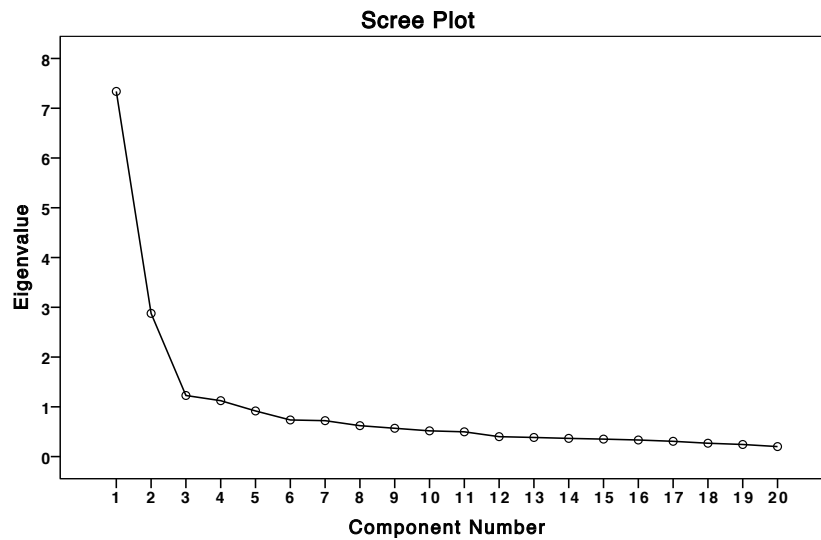


Figure 2: Scree plot from all items in the PENS questionnaire.

An initial analysis was run to obtain eigenvalues for each factor in the data. “The number of positive eigenvalues determines the number of dimensions needed to represent a set of scores without any loss of information” (Rietveld and Van Hout, 1993). Five factors had eigenvalues over Kaiser’s criterion of 1 (Field, 2009) and in combination explained 65.85% of the variance.

Additionally, the number of relevant factors was determined by looking at the factors before the breaking point on the scree plot (Field, 2009). The scree plot (Figure 2) was ambiguous and showed inflexions that would justify retaining between 2 and 5 factors.

We used the structure matrix to analyse the factors. While it is widely debated in the statistics literature whether to use the pattern matrix or structure matrix, we followed the conclusions of Everitt (1996), who state that for an oblique rotation the factor structure matrix should be used for factor identification and interpretation.

After comparing each of the 2, 3, 4, and 5-factor solutions, we retained the 2-factor solution as it does not co-load between factors, and the correlations between the factors appear to be weak. The chosen 2 factors also account for more than 50% variance. The 3, 4, and 5 factor solutions are available in Appendix c.

Structure matrix
suggests 2-factor
solution for
PENS

The structure matrix also suggested two clear factors, the first composed of Immersion and Relatedness (Cronbach’s $\alpha = 0.90$) and the second of Autonomy, Competence, and Control (Cronbach’s $\alpha = 0.84$).

PENS Components	PENS Items	Factor 1	Factor 2
Competence	PENS1	.100	.735
	PENS2	.346	.662
	PENS3	.220	.652
Autonomy	PENS4	.496	.482
	PENS5	.446	.660
	PENS6	.416	.567
Relatedness	PENS7	.722	.389
	PENS8	.747	.278
Immersion	PENS10	.704	.376
	PENS11	.758	.300
	PENS12	.787	.241
	PENS13	.505	-.138
	PENS14	.735	.312
	PENS15	.716	.166
	PENS16	.769	.352
	PENS17	.435	.604
	PENS18	.816	.184
Controls	PENS19	.134	.647
	PENS20	.187	.723
	PENS21	.157	.774

Table 3: 2-Factor solution using the PCA on the PENS items. Loadings over .4 are highlighted.

Table 30 shows the factor loadings after rotation. The correlation between factors was $r = .306$.

The 3-factor solution accounted for more variance, however two out of the three factors were similar to the ones in the 2-factor solution, with the third component, with only a few items, largely crossloading with two other factors. The component correlation matrix also suggested that the third factor is negatively correlated with the other two. Similarly, the PENS items were co-loading on different factors in the 4-factor and 5-factor solutions, and the component correlation matrices for both solutions showed strong correlations between factors. Interestingly, in the 5-factor solution, the items were grouped in a similar manner to the five original PENS factors. However, the split was not clear, as many items also co-loaded on one or more other components.

Therefore, the 2-factor solution was chosen as a more suitable solution for interpreting the data.

This suggests that across the wide range of games considered by the participants, PENS does not automatically divide into five clear factors, but in this context has only two factors. It would be worth more substantially exploring the PENS to gain more insight into why the conceptual differences underlying the scales are not seen in the PENS scores here.

4.4.3 Scale Correlations

All three questionnaires correlate with one another

Overall, there were high positive correlations between the pairs of the IEQ, the GEQ and the PENS Immersion scales, as shown in the Table 5. The results obtained using the IEQ and the GEQ scales were highly correlated: $r = .804$. Similarly, the IEQ and the GEQ were also positively significantly correlated with the results from the PENS Immersion/Presence: $r = .705$ and $r = .666$, respectively.

Given the high statistical reliability of the overall PENS scale, this was also treated as a single scale and compared to the other questionnaires and showed correlations of $r = .813$ and $r = .692$ with the IEQ and the GEQ, respectively. Interestingly, even the total scores of the items of the PENS scale that are not part of the Immersion component also correlated with the IEQ and GEQ, $r = .750$ and $r = .569$ respectively.

	IEQ	GEQ	PENS (Total)	PENS				
				Competence	Autonomy	Relatedness	Immersion	Controls
	M = 141.56	M = 67.90	M = 94.84	M = 15.40	M = 15.60	M = 11.61	M = 36.61	M = 15.62
	SD = 22.71	SD = 16.61	SD = 20.46	SD = 3.46	SD = 3.83	SD = 4.30	SD = 11.86	SD = 3.85
IEQ	-							
GEQ	.804**	-						
PENS (Total)	.813**	.692**	-					
Competence	.573**	.405**	.592**	-				
Autonomy	.595**	.428**	.697**	.443**	-			
Relatedness	.461**	.421**	.683**	.237**	.333**	-		
Immersion	.705**	.666**	.902**	.323**	.500**	.586**	-	
Controls	.524**	.369**	.546**	.547**	.399**	.163**	.270**	-

Table 4: Pearson r correlations of questionnaire scores (N = 270, **p < 0.01).

	IEQ				
	Cognitive Involvement	Emotional Involvement	Real World Dissociation	Challenge	Control
	M = 48.59 SD = 9.15	M = 26.51 SD = 7.15	M = 24.75 SD = 6.77	M = 17.71 SD = 3.38	M = 24.00 SD = 4.33
Physical Imm (PENS)	.385**	.671**	.405**	.165**	.503**
Emotional Imm (PENS)	.306**	.687**	.330**	.279**	.313**
Narrative Imm (PENS)	.558**	.777**	.322**	.298**	.514**

Table 5: Pearson r correlations of the IEQ and the PENS Immersion (Imm) sub-scales scores (N = 270, **p < 0.01).

PENS Immersion sub-scales correlate with IEQ Immersion components

The PENS Immersion scale can also be broken down to three components: physical, emotional, and narrative immersion (Ryan, Rigby, and Przybylski, 2006). When comparing each sub-scale to each of the components of Immersion, as measured by the IEQ, the PENS physical immersion (presence) correlated highly with the IEQ emotional involvement ($r=.671$), so did the PENS emotional immersion ($r=.687$). The PENS narrative immersion also correlated highly with emotional immersion, as measured by the IEQ ($r=.777$), as well as two other components: cognitive involvement ($r=.558$) and control ($r=.514$).

4.4.4 Item Correlations

Questionnaire items correlate strongly

An item by item correlation analysis showed that over 30 pairs of questions strongly correlate ($r > .60$), and almost 300 pairs of items that correlate moderately ($r > .40$) not only between the questionnaires, but also within each scale. The GEQ and the IEQ have a few items that correlate, and each questionnaire also contains the item: "I lose track of time" (GEQ1 and IEQ5). Moreover, GEQ18: "I really get into the game" correlated with almost every single item in all three questionnaires. The IEQ and the PENS, in particular, have many items that have strong correlations with other items within these questionnaires, as seen in the Table 6.

Questionnaire Items		r
GEQ6: If someone talks to me, I don't hear them.	GEQ10: I don't answer when someone talks to me.	r = .731
GEQ5: The game feels real.	PENS12: When moving through the game world I feel as if I am actually there.	r = .669
GEQ18: I really get into the game.	IEQ1: The game has my full attention.	r = .650
GEQ18: I really get into the game.	IEQ2: I feel focused on the game.	r = .702
GEQ18: I really get into the game.	IEQ3: I put effort into playing the game.	r = .656
GEQ18: I really get into the game.	IEQ19: I feel motivated when playing the game.	r = .634
GEQ18: I really get into the game.	IEQ29: I enjoy playing the game.	r = .620
IEQ1: The game has my full attention.	IEQ2: I feel focused on the game.	r = .615
IEQ2: I feel focused on the game.	IEQ3: I put effort into playing the game.	r = .626
IEQ2: I feel focused on the game.	IEQ19: I feel motivated when playing the game.	r = .651
IEQ2: I feel focused on the game.	IEQ29: I enjoy playing the game.	r = .626
IEQ3: I put effort into playing the game.	IEQ4: I am trying my best.	r = .746
IEQ8: I am very much aware of myself in my surroundings.	IEQ9: I notice the events taking place around me.	r = .612
IEQ19: I feel motivated when playing the game.	PENS17: When I accomplish something in the game I experience genuine pride.	r = .625
IEQ22: I perform well in the game.	PENS1: I feel competent at the game.	r = .610
IEQ23: I feel emotionally attached to the game.	PENS7: I find the relationships I form in this game fulfilling.	r = .624
IEQ23: I feel emotionally attached to the game.	PENS14: The game is emotionally engaging.	r = .665
IEQ23: I feel emotionally attached to the game.	PENS15: I experience feelings as deeply in the game as I do in real life.	r = .663
IEQ29: I enjoy playing the game.	PENS5: The game lets you do interesting things.	r = .624
IEQ29: I enjoy playing the game.	IEQ31: I would like to play the game again.	r = .694
PENS7: I find the relationships I form in this game fulfilling.	PENS8: I find the relationships I form in this game important.	r = .689
PENS10: When playing the game, I feel transported to another time and place.	PENS11: Exploring the game world feels like taking an actual trip to a new place.	r = .667
PENS10: When playing the game, I feel transported to another time and place.	PENS12: When moving through the game world I feel as if I am actually there.	r = .639
PENS10: When playing the game, I feel transported to another time and place.	PENS16: When playing the game I feel as if I am part of the story.	r = .643
PENS11: Exploring the game world feels like taking an actual trip to a new place.	PENS12: When moving through the game world I feel as if I am actually there.	r = .675
PENS11: Exploring the game world feels like taking an actual trip to a new place.	PENS16: When playing the game I feel as if I am part of the story.	r = .637
PENS12: When moving through the game world I feel as if I am actually there.	PENS16: When playing the game I feel as if I am part of the story.	r = .613
PENS12: When moving through the game world I feel as if I am actually there.	PENS18: I react to events and characters in the game as if they were real.	r = .631
PENS15: I experience feelings as deeply in the game as I do in real life.	PENS18: I react to events and characters in the game as if they were real.	r = .601
PENS19: Learning the game controls is easy.	PENS21: When I want to do something in the game, it is easy to remember the corresponding control.	r = .600

Table 6: Correlations between the pairs of the items from the GEQ, the IEQ, and the PENS questionnaires (all correlations are sig. $p < .001$).

Although the questionnaires produced coherent results, and there were many strong correlations between many items, some items did not correlate as well or at all with any of the other questions. An item by item correlation analysis highlighted eight items, which had low to no correlations with other items ($r < 0.4$). These include:

GEQ4: *"I feel scared"*

GEQ9: *"I feel spaced out"*

GEQ14: *"I lose track of where I am"*

GEQ16: *"Playing makes me feel calm"*

IEQ10: *"I feel the urge to stop playing and see what is happening around me"*

IEQ18: *"There are times in the game in which I just want to give up"*

IEQ20: *"I find the game easy"*

PENS9: *"I don't feel close to other players"*

Not all items were applicable to all digital games

Some of the questions seemed out of place to some respondents. Items such as "I feel scared" (GEQ4) can be genre specific, and it does not necessarily apply to many games. Vaguely phrased questions, such as "I feel different" (GEQ3) also provided too many opportunities for interpretation, as well as the following item: "Things seem to happen automatically" (GEQ2) – all three correlating weakly with rest of the items. Although GEQ2 correlated with another similarly phrased item: "Playing seems automatic" (GEQ12), neither of these items had strong correlations with the rest of the questions.

More problematic items showed up in the comments of our participants, who mentioned their inapplicability to some of the games the people play, and general awkward phrasing in some cases. Some unreliable items also became evident during the analysis of the collected open responses from our participants. One such question asked players about their relationships with other players (PENS9). As many single-player games do not provide opportunities for this experience, this question was viewed as confusing, and players left comments such as (P13): "Some of the questions, for example the ones asking about my relationship to other player, didn't apply to a lot of the game (single player) games I prefer playing" and (P99): "The questions that you were asking seemed to target more of a triple A game audience with world building or even more aptly a MMO or MMORPG I find those games to focus far more on relationship building, immersion and blurring the lines between reality and fantasy". As a whole however, relatedness to the "others" was not always inapplicable, as many RPG

games offer players opportunities to build relationships with other characters that can be valuable to the player. This perhaps suggests why the PENS₉ item in the relatedness scale did not function as well as the other two.

Another issue mentioned in the comments was about the fact that not all games have a clear ending, as one of the IEQ items concerns players' desire to "win" the game (IEQ₂₅). For example, (P₃₆): "I feel the questionnaire isn't really apt at answering to the game I played. RimWorld isn't really a game you play to win, there is no real winning. You play to experience difficulty and try to overcome [the challenges].", and (P₁₀₆) mentioned this issue too: "There was a question about getting to the end of whatever game you are playing but that doesn't exist for CS:GO".

Similarly, not all digital games are aimed at eliciting emotional responses, and therefore some items in the IEQ and the PENS were deemed inappropriate. A League of Legends player described his experience as something more akin to a sports player during a football match (P₂₄₁): "The appeal of it isn't like Skyrim or The Witcher in the sense I want to be immersed in another world but more of the sense you get when you play a sport. I will be with a group of friends and out go "out" to play to forget about our worries and responsibilities bonding at the same time."

4.5 Discussion

Overall, the results obtained using the IEQ and the GEQ correlated strongly, which suggests that engagement and immersion are in fact addressing the same underlying aspect of player experience. Similarly, data gathered using the immersion scale of the PENS questionnaire also greatly correlated with results obtained using the other two. These findings are not surprising considering that engagement is often perceived as a part of immersive experience (Brown and Cairns, 2004), and all three scales had questions of a similar nature. The strong positive correlations between the results obtained using each suggest that, broadly, they aim to measure one underlying aspect of player experience, while there may be some minor differences in the aspects each of them home in on.

Similarly, there was a positive significant correlation between players' perception of competence and to what extent they found the controls intuitive, according to the results collected using the PENS. As

Immersion and engagement are addressing the same underlying concept

competence questions concerned players' perceived level of skill and challenge in the game, and controls questions were more relevant to the challenge players face when using the controls, it is fair to assume that there is a correlation between the two factors as they broadly address challenge, regardless of its nature. Having appropriate levels of challenge is important for the players to have a positive gaming experience, as reflected in the correlation between the competence and controls data and the IEQ results.

Autonomy, as it is measured in the PENS questionnaire, is described in terms of the amount of freedom and the interesting options the game offers their players. These questions were similar to the emotional involvement, as it is measured in the IEQ. Having interesting choices in the game also contributes to the overall experience, as it is also seen in the high correlation between autonomy and the IEQ and GEQ results. Similarly, there was a positive correlation between autonomy and relatedness. The two come hand in hand in games that offer opportunities for emotional involvement, and a storyline, in which the player can develop relationships with other players.

PENS is strongly related to a single underlying concept

Somewhat surprisingly, though the PENS questionnaire was not devised as a unidimensional scale, a reliability of .90 suggests that the all of the PENS is strongly related to a single underlying concept. Furthermore, that this correlates strongly with both the IEQ and GEQ scores suggests it too is measuring player immersion. From consideration of the questionnaire items, this is not so surprising. There is a large overlap between the themes of questions used in all questionnaires, which address such aspects as physical and mental challenge, intuitive controls, emotional involvement (including relationships with other players, the storyline and aesthetics), sense of time, and a sense of being in the game world.

While high reliability is not a strong indicator that a questionnaire follows a single dimension towards measuring immersion, the high correlations of the PENS with the IEQ and the GEQ suggest that using this questionnaire provides comparable results to the ones that are obtained using the other two scales. The PENS was not designed to measure engagement or immersion, however Rigby and Ryan (2011) say that players' need satisfaction leads to a heightened sense of engagement, which might be the case. Therefore, although the questions might have been designed to focus on the need satisfaction of players, the positive experience elicited as a result of the need satisfaction can be captured using this questionnaire, as seen in the strong correlations with the results obtained using the GEQ and the IEQ. However,

there is not enough evidence to support this claim, and more research should be done in order to gain more insight into player need satisfaction causes the experience measure by the other two questionnaires, or the PENS can in fact be used to measure engagement.

The aim of this study was to explore the differences and similarities between the questionnaires used to measure players experience in order to find the most suitable tool to measure immersion in the context of this thesis. The results demonstrate that, in their present form, the questionnaires can be used equally reliably to measure player engagement in general, and immersion in particular.

4.6 Choosing Immersion Questionnaire

Overall, the analysis of the collected data suggests that although there is much correlation between the three widely used questionnaires, there is potential for improvement. As different game genres elicit different aspects of gaming experience, the questionnaires in their present form are not fully applicable to all kinds of digital games. As things currently stand, all three seem to function as appropriate measures of player immersion in a game.

A refined questionnaire based on these three would be beneficial. Such a tool would allow us to evaluate players' experience in a variety of digital games without discriminating against games that do not have all such aspects. This would not only allow more robust findings, but increase the comparability of studies in different contexts. Moreover, additional research is needed to unveil the individual differences in games based on the theme, content, and styles of play, in order to build the most suitable questionnaire for a variety of genres and types of games. However, the proposed research is outside the scope of this thesis.

The aim of this thesis is, however, to study the effect of information about adaptivity on immersive experiences of players. Therefore, it is crucial that the most appropriate tool is chosen for this purpose. Out of the three questionnaires compared in this study, the IEQ was the only questionnaire that was explicitly designed to gather quantitative data about players' perceived level of immersion, while the other two questionnaires contain immersion only as a factor of a more general experience – engagement or the player experience of need satisfaction. Evidently, results gathered using a questionnaire specifically designed

*IEQ is explicitly
designed to
measure
immersion*

for the purpose of measuring the immersion would provide more comprehensive and focused insight into this experience.

Generally, the IEQ allows to measure a multi-faceted immersive experience of players, which can be split into five factors: cognitive and emotional involvement, real world dissociation, challenge and control. Broadly, these components of immersion can apply to almost any digital game. Immersion, as measured by the PENS, also can be split into physical, emotional, and narrative components. Considering that digital games do not always provide an opportunity to experience presence (physical immersion) or even narrative immersion (for example, it is arguable that games like *Flappy bird* or *Tetris* even have a narrative). Similarly, some items of the GEQ were thought to be non-applicable to the games the participants had recently played. Therefore, considering the applicability of all questionnaires for a broad range of digital games, the IEQ was considered the most suitable, particularly for single-player games.

IEQ is applicable to a wide range of games

IEQ is well-established and extensively validated in many studies

Considering that all three questionnaires produced similar results when measuring immersion, the most suitable questionnaire should be chosen based on the questionnaire's validity. All three questionnaires are valid tools for measuring gaming experiences and they are equally well-established in the field. However, as the PENS is not readily available to researchers, it makes it challenging to acquire in comparison to the other two scales. The GEQ is a well-known questionnaire, however, it is seldom used in experimental studies: a review of 300 citations in March 2017 has revealed that only 11% of the publications use the questionnaire to measure engagement. While the IEQ has been extensively validated through the use in numerous experiments, almost twice as many of 300 reviewed sources citing Jennett et al. (2008) use the IEQ as an experimental measure. Some of the few examples include Cairns et al. (2014), Nordin (2014), and Thompson, Nordin, and Cairns (2012).

Therefore, considering the questionnaires' validity and reliability, applicability to a wide range of digital games, and general focus on certain aspects of player experience, the IEQ was chosen as a tool for measuring immersive experience of players in the scope of this thesis.

Part III

EXPECTATIONS IN DIGITAL GAMES

THIS part of the thesis demonstrates the work done in order to gain an insight into the effect of players' expectations of a digital game based on the information that they know about the game on player immersion. The goal of this research is to gather data in order to explore how immersion changes when players experience a digital game depending on their preferences formed during previous gaming sessions and when being exposed to specific information about the game prior to their first encounter with it.

The effect of players' preferences is studied in the context of visual perspectives in a digital game that provides a choice between the two, which allows for an initial evaluation of how players' perceptions and experiences of the game is influenced by the match or mismatch between the point of view in the game and their preferred perspective. This exploratory research allows to gain further insight into how previous experiences in the form of preferences affect immersion.

Additionally, players' perceptions of a digital game are evaluated using information specific to the game, which players are exposed to before trying the game out for the first time. The aim is then to explore how first impressions of players based on this information alter their perceptions of the game, and to gather data in order to learn more about the extent to which these perceptions affect immersion. This is done through setting players' expectations of the game having adaptive technology, while the game does not possess such quality. In one of the two studies conducted to explore this relationship, participants play two gaming sessions with the same settings and content – in one of the sessions players are told that the game has adaptive AI, and another session does not have it. Another study is *ceteris paribus* a between-subject version of the former study.

All three studies aim to gather data in order to gain more insight into the main research question:

Do players' perceptions of a digital game based on the information they know about its adaptive features influence their immersion?

This work provides initial insight into the effects of preferences of players and their deceptive expectations of adaptive features on immersion. The results suggest that player preferences in the context of visual perspectives do not have an effect on immersion. However, this is tentative, as preferences are formed during previous experiences of players, and therefore can be difficult to control in experimental environment. On the other hand, both studies aimed at exploring how the mere expectations of adaptive technologies in games affects im-

mersion suggest that players' perceptions of the game can, in fact, be altered based solely on their beliefs that the feature is present, while it is not. These studies also demonstrate that immersion is affected by players' knowledge about the adaptation even if it is not present in the game.

Study II: Preferences in Visual Perspectives

5

PLAYERS form preferences with regards to specific games and genres based on their previous experiences and their general views. These attitudes allow them to choose games quickly, however they also limit players in their choices.

As digital games are becoming more complex due to the increase in the capabilities of modern technology, players are faced with many choices inside the games too: whether it is the choice of difficulty, avatar, story mode, or camera viewpoint – some games have so many possibilities for replay that some of us might never be able to experience all available choices.

Preferences, therefore, help choosing amongst all possible options in such adaptable systems, i.e. the systems that offer options that players can choose from, and it is possible that people who play a game in a setting that does not match their preferences might feel less immersed, because their expectations are not matched by the conventions of the game world. Players might also find it distracting and potentially more difficult to play a game in a mode that does not conform to their preferences. However, these are more speculative thoughts, as little research has gone into studying the effects of preferences on player experience. As players form their attitudes outside a controlled environment, such variable can be difficult to control, as variation between players' personal traits can affect their preferences. Nonetheless, in the study described in this section we challenge this as we aim to explore whether players' preferences, based on their previous experiences, have an effect on immersion when playing a digital game that offers players a choice between two camera viewpoints.

5.1 Visual Perspectives

Various software and hardware factors affect players experience, as seen in the Chapter 2. One of the more popular factors studied by

Visual presentation affects gaming experience

games researchers is visual presentation. Ranging from the size and quality of the screen on which players view the results of their actions in a game (Thompson, Nordin, and Cairns, 2012) to the realism of the avatar (Seyama and Nagayama, 2007), visual aesthetics has a large impact on the experience players have during their game play.

There are many ways to present the game world to the player: it might be presented in 2D or 3D, viewed from a top-down perspective, from the point of view of the character, or behind the avatar's shoulder. As machines had become more advanced in their computational abilities, the predominance of individual computer graphics techniques have evolved too, allowing for the development of more realistic digital games. Trying to enhance their customers' experience, digital games companies offer a wide range of genres, complexities, and formats for the diverse tastes of their players. With the advent of 3D graphics, digital games could expand beyond the typical sprite-based 2D graphics used in earlier games, to picture a more realistic and lifelike view of a game world. Previously, perspective projection was used in some earlier games to present a 3D environment from fixed thought somewhat limited perspective.

First-person and third-person perspectives

Two of the main 3D perspectives frequently used in modern digital games are first-person and third-person POV. Most games however offer only one of these choices, which is typically decided by the game makers based on the computational requirements, as well as the atmosphere they want to depict.

First-person perspective allows the player to view the game through the eyes of the playable character; and as a result, hands and sometimes feet are the only parts of the character that are often seen. This allows the player to observe the world around them up close, giving a greater view of the scenery. This perspective is believed to provide the most immersive feel for the game player (Taylor, 2002).

First-person POV is believed to be more immersive than the third-person POV

Alternatively, in a third-person POV the camera is positioned in such a way that the player is distanced from their character, offering a sensation that they are playing their own role rather than that of the character in the game. This helps the player to get close to the action from the perspective of the main character, without giving the player the sense that they actually are the character. Although such camera positioning gives a wider field of view of the surrounding area, it makes it hard for the avatar to accurately gauge its focus of interest (Salamin, Thalmann, and Vexo, 2008). Character's visual focus point is particularly important in games where the player needs to know exactly where they are aiming, and be able to finely adjust the aim. This perspective

is particularly suitable for games where the player might be following more than one character through the story (Taylor, 2002).

Some contemporary digital games are offering an option to choose between first-person and third-person POV to compensate for the drawbacks of each of the viewpoints. Often, third-person perspective is used for exploration and interaction, and first-person point of view is useful when projective accuracy is required (Taylor, 2002). However, this preference has been the subject of discussion on social networks, and gaming forums for years; the first-person and third-person perspectives are often argued about, whether either of them makes a player feel more immersed in a game than the other one.

This question was addressed in the article by Rouse III (1999). He argues that the distance between the player and the character can be a crucial factor when it comes to estimating immersion. Third-person POV distances the player from the game world and the character they are playing. Hence, the sense of immersion appears to be significantly weaker. According to Gard (2000), one of the creators of *Tomb Raider*, one of the greatest appeals of digital games is that they allow the player to feel in control, and to see the consequences of their own actions instead of the actions chosen by the protagonist. Immersing the player in the game world as much as possible is essential to this 'ownership' of choices made in the game world (Rouse III, 1999). The third-person perspective makes the gap between the player and the game world more noticeable, hence the decisions made by the player become less of their own, and more about directing another character to make the right choices. In the latter option, it becomes evident that no matter what choices the player makes, it would appear that they are controlling the actions of someone other than themselves. Hence the player naturally loses their 'ownership role' in the whole process. Third-person perspective allows game designers to give the player a much stronger, distinct character.

Identifying with the avatar, however, is not the only purpose of different visual perspectives. The controls used to navigate through the world in first-person perspective can be rather different from the ones used in the third-person point of view, and the field of view of the player can make a difference to one's performance in the game. Anecdotal evidence suggests that the first-person point of view is preferred by more experienced players, as it requires more precision when acting in the game. However, no empirical evaluation exists to support or refute this claim.

*First-person
POV is often
preferred by more
experienced
players*

It is evident that each perspective has its own benefits and drawbacks, and therefore players who are provided with such choice in a digital game are likely to pick one of the POVs based on their previous experience of similar games and their preferences formed during playing the game with this choice. Choosing a visual perspective is a form of adaptable technology, and therefore can be used to explore the effect of players' perceptions of such technology and their personal preferences with regards to these choices on immersion. An additional goal of the study described in this chapter is to test whether first-person is more immersive than the third-person perspective, as suggested in theoretical literature by Taylor (2002) and Rouse III (1999).

5.2 Experimental Method

A 2 x 2 between-participants design study was conducted in order to test whether players' preferences affect their immersion in a digital game based on the visual perspective that they are playing in. The player perspectives and their preferences in terms of the POV are the two independent variables, and immersion, as measured by the IEQ, is the dependent variable in the context of this study.

The main hypothesis of the study was that the participants playing the game in the visual perspective that does not match their preferred one would feel less immersed in the game, than the participants viewing the game world in their preferred POV. An additional hypothesis tested in this experiment was that the first-person perspective provides players with more immersion than its third-person counterpart. To ensure that players had preferences in the perspectives, only participants with previous experience of playing Skyrim were recruited.

5.2.1 *Participants*

Overall, 40 participants with varying levels of gaming experience took part in the experiment. The sample included 7 women and 33 men, with an age range between 18 and 41 years, and a mean age of 23.5 (SD = 4.97).

Over a half of the participants (22 out of 40) said that they play digital games several times a week, and rated the number of hours usually spent in a single session as over one hour in most cases. Amongst the other 18 participants, who played digital games less frequently (once a week, once a month, or less), there were those who said that they

spent over an hour in a single session, while the other half stated that they normally played digital games for shorter periods of time.

The participants who played digital games often had RPGs, first-person shooters (FPS), real-time strategies (RTS), and massively multi-player (MMO) games amongst their favourite genres. However, for the people who were less involved in gaming, puzzles and mobile games were in the list of their preferred games.

Majority of the participants (26) had previously played digital games on a PlayStation 3 (PS3), and hence were familiar with the controller. Moreover, 23 people claimed that they had played the chosen game on their PCs, but none of them had any experience of playing the game on a PS3.

5.2.2 *Materials*

The experiment was set in the Home Lab in the Department of Computer Science – a place analogous to a typical living room. The intention was to create the surroundings similar to the environment the players would typically use when playing digital games. The game used in the experiment was *Skyrim*¹, an RPG with an option to switch between first-person and third-person POV. The option for changing between these perspectives was originally set to be the ‘Select’ button on the controller, which could be easily accessed by the players. Therefore, to ensure that the player does not press the button by accident or on purpose, the function was disabled manually.

Another important factor to account for was the level of experience in digital gaming for each of the participants. Due to the availability of the game on both PC and PS3, the choice was mainly based on the controller types. PC games are more commonly played by experienced gamers, and novice players could find it overwhelming when trying to memorise a number of keys used to navigate the character around the virtual world and particularly in combat. On the other hand, a PS3 controller was suitable for players with different levels of gaming experience. The game itself is moderately challenging; however, it was decided that the level of difficulty should be adjusted depending on whether the volunteer had had some previous experience of playing the game to match their expected level of challenge.

Choosing the platform and controllers

¹ The Elder Scrolls V: Skyrim: <http://www.elderscrolls.com/skyrim/>

Following the main storyline of the game, the objective set for the participants was to complete (at least partially) a quest called 'The Golden Claw Quest' – one of the very first missions in the game. The quest was easy enough for a novice player to complete on time, but it was also one of the missions not many experienced players could remember due to its early appearance in the digital game. The objective was to enter a dungeon, where the player had to find an object (the golden claw), and then follow the instructions to discover a secret of the place. This object was deliberately chosen to be located at the opposite end of the dungeon, to ensure that player would travel through all the rooms to find the object. These rooms and corridors required the player to fight off monsters, search for better armour or weapons, and solve a puzzle in order to proceed further. This set-up provided enough variety to offer the possibility of immersion.

Before the start of the quest each participant had a small tutorial, when they had a chance to familiarise themselves with the controls and ask any questions they might have. As a part of the tutorial, participants were asked to climb the stairs and fight off three enemies before entering the dungeon. This would provide them with enough training to get used to the controllers.

The game has a variety of weapons and ways to attack and defend oneself, each of which can lead to different experience depending on the chosen perspective. For example, when using a bow, it is easier to aim at a target while being in first-person perspective, however melee weapons and magic are suitable in both, similar to the findings in the study by Salamin, Thalmann, and Vexo (2008). This was taken into account in the beginning of the quest – each player was equipped with a sword and a shield, which were the most powerful items at that point in the game. Although the players were not limited in their choice of weapons, they were advised to stay with the pre-set equipment.

5.2.3 Procedure

The participants were split into two independent groups randomly: 20 people played the game in first-person POV (Figure 3), and the other half played in third-person perspective (Figure 4). No participants were forced to take part in the research, and an informed consent form (Appendix a) was provided for each of them to read and sign before the start of the experiment.

Each participant had the same experiment explanation (Appendix f) and the same set of instructions of how to navigate the game with the



Figure 3: The Elder Scrolls V: Skyrim in First-Person Perspective

PS3 controller if they have never used it before, or never played the game on the console. Participants were asked to fill in a questionnaire at the end of the game. The experiment facilitator also left the room during the interactive component to avoid instigating any pressure to perform within a certain time.



Figure 4: The Elder Scrolls V: Skyrim in Third-Person Perspective

The same small quest was set up for each person, estimated as 15-20 minutes to complete depending on the level of expertise of participants. Regardless of how far from completion a participant was, they were interrupted after 15 minutes of playing the game.

Once the participant was interrupted, they were asked to fill in both questionnaires, upon completion of which each participant was debriefed, and asked about their preferred perspective in Skyrim.

5.3 Results

The hypothesis stated that there would be a difference between the players' levels of immersion when playing either in first-person or third-person perspectives, and this difference will be affected by the personal preferences in terms of the POV players typically choose when playing this or similar games.

The quantitative experimental measures were analysed using one-way

ANOVA to determine whether the main effects of perspectives and preferences on immersion, and the interaction effect between these independent and pseudo-independent variables were significant. Pairwise comparisons were made using Tukey HSD.

5.3.1 Perspectives

*First-person
POV is more
immersive*

Overall, the hypothesis that people who play the game in first-person perspective on average have higher levels of immersion than those who watch their character from behind was supported by the results obtained in the study. The difference between these two groups of players was significant: $F(1, 36) = 10.22$, $p = .003$, $\eta_p^2 = .221$. However, there was no significant effect of players' preferences on immersion: $F(1, 36) = 2.87$, $p = .099$, $\eta_p^2 = .074$. Neither there was a statistically significant interaction between perspectives and preferences on immersion: $F(1, 36) = 3.78$, $p = .060$, $\eta_p^2 = .095$ (Figure 5).

*No interaction
effect between
preferences and
perspectives on
immersion*

Though preferences were not explicitly controlled, each group of participants had an almost equal split of people who preferred one of these perspectives over another. Out of 20 participants playing in first-person perspective there were 9 who preferred this POV, and 7 who preferred first-person POV in third-person POV condition.

The summary of immersion scores for different groups of players, and all five immersion components are shown in Table 7. Addition-

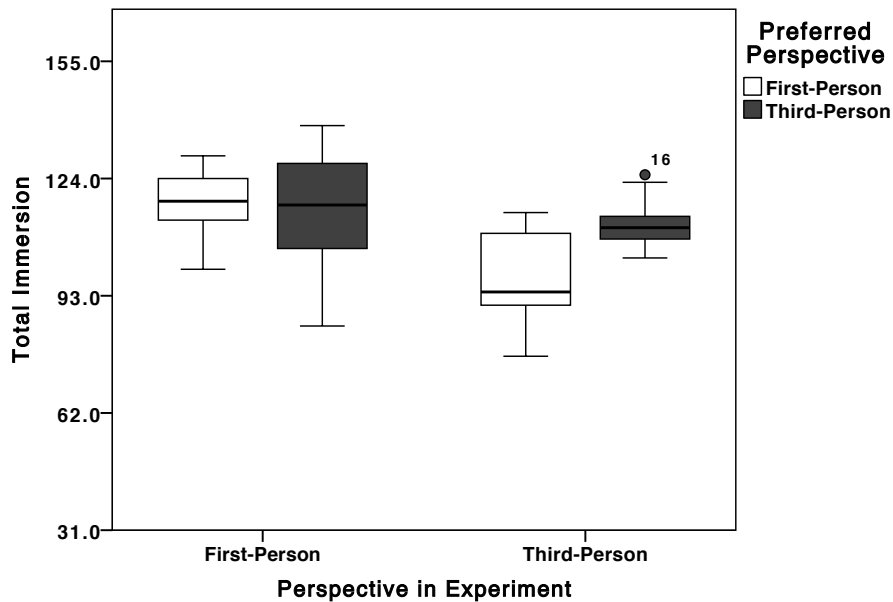


Figure 5: Total immersion of participants played in first-person and third-person perspectives, and based on their perspective preferences.

ally, the effect of perspectives, preferences in terms of camera viewpoint, and the interaction effect of the two on players' immersion are summarised in Table 8.

There was a significant main effect of perspectives on immersion, but also on players' real world dissociation, their cognitive involvement with the game, and particularly on their perception of challenge. However, the effect of preferences and the interaction effect were not significant for all immersion components apart from players' perceived level of challenge. First-person POV was found to be the most challenging out of the two modes. Particularly, first-person perspective players who typically prefer third-person POV found this perspective more challenging in comparison to the other three groups of participants, where players who prefer first-person POV and played in third-person perspective found that perspective was not as challenging, according to the immersion scores.

5.3.2 Previous Experience

In case previous experience of the game was important, immersion was tested against differing levels of experience. It was hypothesised

	Played in 1st Person		Played in 3rd Person	
	Prefers 1st Person	Prefers 3rd Person	Prefers 1st Person	Prefers 3rd Person
Total Immersion	117.78 (9.63)	116.82 (16.14)	98.00 (14.00)	112.00 (6.63)
Cognitive Involvement	37.56 (2.40)	38.09 (5.56)	31.86 (6.18)	34.69 (4.13)
Emotional Involvement	20.78 (3.99)	20.36 (5.78)	17.43 (5.44)	21.00 (3.03)
Real World Dissociation	25.78 (2.86)	25.36 (3.35)	21.71 (3.040)	24.46 (2.22)
Challenge	14.44 (1.01)	14.91 (1.22)	10.71 (2.56)	14.00 (1.15)
Control	19.22 (2.82)	18.09 (3.53)	16.29 (2.43)	17.85 (2.23)

Table 7: Mean (SD) of immersion and its components when playing in first-person and third-person POVs, depending on the preferences of the player.

	Effect of Perspectives			Effect of Preferences			Interaction Effect		
	F _{1,36}	p	η_p^2	F _{1,36}	p	η_p^2	F _{1,36}	p	η_p^2
Total Immersion	10.22	.003**	.221	2.87	.099	.074	3.78	.060	.095
Cognitive Involvement	8.96	.005**	.199	1.23	.275	.033	.57	.454	.016
Emotional Involvement	.84	.366	.023	1.14	.294	.031	1.81	.187	.048
Real World Dissociation	7.19	.011*	.166	1.59	.216	.042	2.91	.096	.075
Challenge	23.38	.000***	.394	15.28	.000***	.298	8.65	.006**	.194
Control	3.05	.089	.078	.06	.815	.002	2.18	.148	.057

Table 8: The main effects of perspectives and preferences in perspectives, and the interaction effect of the two on immersion and its components. ***p < 0.001, **p < 0.01, *p < 0.05

that the people who had previously played Skyrim on PS3 would be more familiar with the controls, and, therefore, feel more immersed. However, there was no significant difference in the total immersion scores between those players who have previously used the controller and players who have never played this game on the console ($F(1, 38) = .04, p = .835, \eta_p^2 = .001$).

Moreover, people who had played PS3 games before ($M_{Yes} = 18.12, SD = 2.76$) did not find the controllers much more intuitive while playing Skyrim than those who had no previous experience with the controllers ($M_{No} = 17.64, SD = 3.10$): $F(1, 38) = .24, p = .624, \eta_p^2 = .006$. Neither there was any significant difference in the levels of real world dissociation between these two groups of players ($M_{Yes} = 24.58, SD = 3.58; M_{No} = 24.43, SD = 1.95$); $F(1, 38) = .02, p = .887, \eta_p^2 = .001$.

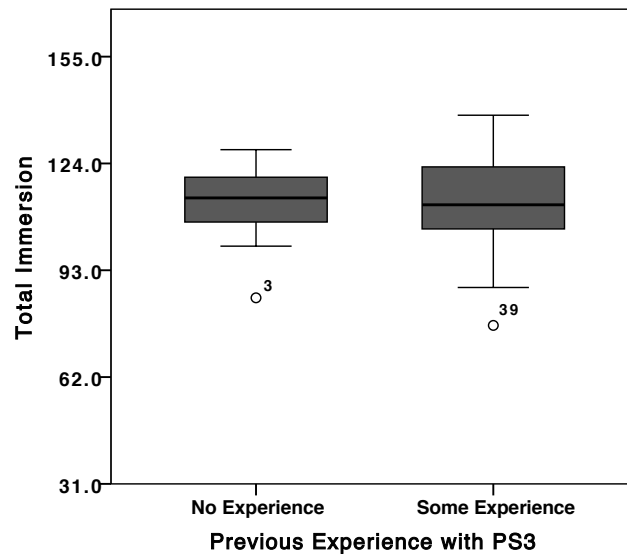


Figure 6: Total immersion in first-person and third-person perspectives based on players' previous experience of playing PS3 games.

5.4 Discussion

Following the theoretical background discussed previously, the results of this study have demonstrated that playing in first-person perspective makes players more immersed than experiencing the same RPG in third-person POV, where the perspectives can be switched using an adaptable viewpoint system.

Overall, immersion can be broken down into five components (Jennett et al., 2008). Some of these components had a positive correlation with the overall results – such as the real world dissociation, cognitive involvement and challenge; while the other two did not differ much between the two groups of participants.

According to Rouse III (1999) and Taylor (2002), when playing an RPG in first-person perspective, the player would feel as if they are a part of the story and the virtual environment; projecting their thoughts and actions onto their character, and taking ownership of them – therefore, reducing the distance between the game world and themselves. On the other hand, playing in third-person perspective offers less immersive experience due to the fact that the player feels more distanced from the virtual environment as they watch their character perform actions and make decisions from the viewpoint of somebody who controls the avatar, rather than through the eyes of the avatar.

*First-person
POV makes
players less aware
of their
surroundings*

In this study, people playing in first-person perspective also felt less aware of their surroundings than those who watched their character from point of view behind the character. It seems that the players project themselves into their new identity, thereby immersing deeper into the game world and reducing their self-awareness.

*Cognitive
involvement
based perspectives*

Similarly, cognitive involvement and perceived levels of challenge differed significantly between the two groups of players. When interacting with the game world through the eyes of the character, the player has higher concentration and is more focused on the task, which leads to the increase in these two immersion components. In fact, players' perceived level of challenge varied between groups of players in a similar manner to the overall immersion, which suggests that this experience contributed the most to the difference between immersion scores.

*Emotional
involvement
based on
perspectives*

There was no significant difference between the groups of players with regards to the levels of emotional involvement in the game. It is possible that if players spent more time playing the game in first-person, they would get more immersed than those who play this game from the third-person viewpoint, due to the fact that the players would perceive the storyline as if they were a part of it, rather than being merely observers of the events that are happening to a game character, as suggested in the literature (Waggoner, 2009). Moreover, the game does not have a character distinct from the player – each person creates their own story and their own individual looking characters with personally chosen skills and equipment. So when playing the game from the beginning until the end, the players are expected to feel more emotionally involved with their character and their story in first-person perspective. However, the short time given for players to complete one quest was not enough to get emotionally involved with the storyline, and thus no difference was observed between these two groups of players.

*Perceived control
in both
perspectives*

Moreover, the controls in both viewpoints are the same, and regardless of the player's favourite perspective it is possible to control the character well and to complete the game without switching to another camera POV. Each of these perspectives has its own benefits and drawbacks. As a result, there was no significant difference between the level of control players experienced while playing in either mode.

It is widely believed that first-person perspective is often chosen by more experienced gamers², particularly in shooting games³, as it requires more skill and better reflexes. While third-person POV is easier to navigate, and as a result is more suited for people who are less advanced in playing digital games. This explains why people who are more experienced in playing in first-person perspective felt moderately challenged and involved cognitively with the game, while those players who preferred the other viewpoint had higher scores in both immersion components. This also explains why the lowest scores were obtained by players who played in third-person POV, but normally prefer first-person perspective.

Choosing a perspective based on gaming experience

Players who worked toward completing the Skyrim quest in their least preferred perspective, however, did feel less immersed than those players whose preferences were matched by the set-up of the experiment. Though this difference was not significant. Interestingly, participants who played in first-person perspective felt more immersed in the game environment even if they would typically play the game with the camera positioned behind their character.

As players' preferences are typically constructed rather than revealed during the process of choice (Hardman and Hardman, 2009), and because players were not able to compare and contrast the two perspectives during this study, it is somewhat unsurprising that the effect of preferences on their immersive experience was not significant. Participants took the perspective for granted, and were more focused on their task in hand – getting the golden claw. Therefore, it is possible that although players might have experienced some distraction or increased perceived challenge when playing in their least preferred perspective, their immersion was not significantly affected by this.

Preferences are formed during the process of choice

The results obtained in this study demonstrate the effect of preferences and perspectives on immersion during a specific quest in a role-playing game. It is possible that the results would differ depending on the weapons players used in the game: participants in this experiment were provided with one or two-handed weapons, and did not use bows. More research is needed to explore this effect during different tasks in a game. It is also possible that during longer game play participants would identify more with the character and get more

² First Person Vs Third Person Perspective on Unity Forum: <https://forum.unity3d.com/threads/first-person-vs-third-person-perspective.57023/>

³ What Are the Differences Between First-Person Shooter and Third-Person Shooter Games? on Ebay: <http://www.ebay.com/gds/What-Are-the-Differences-Between-First-Person-Shooter-and-Third-Person-Shooter-Games-/10000000177589743/g.html>

familiar with the storyline, which could change their experience. However, visual perspectives are not the focus of this thesis, and therefore the suggested studies are outside the scope of this research.

Player preferences are a pseudo-independent variable, and therefore controlling this variable in a laboratory settings can be challenging. Players constructs their preferences during the process of thinking about choice (Lichtenstein and Slovic, 2006), and can differ based on different circumstances, like in the case of using different weapons. Therefore, further research focuses more on the manipulations that can be controlled in order to avoid any bias and confounds imposed by players' individual differences.

5.5 Conclusions

The aim of this study was to explore the effect of player preferences on their immersion, which was studied with regards to the visual perspectives in a digital game that offers a choice between first-person and third-person POVs. Interestingly, though there was a positive effect of playing in preferred perspectives on immersion, this effect was not significant.

The acquisition of preferences is not a controlled manipulation, and preferences do not necessarily reflect what the player feels at the time of playing the game, but are a rather retrospective view of their previous experiences (Lichtenstein and Slovic, 2006). Moreover, preferences differ between players based on many factors, such as personal traits and the amount of previous experience. Therefore, in order to investigate the effect of players' expectations on their gaming experiences, a more controlled variable is needed. This can be done through setting the expectations of a player based on a neutral information which they read before playing a game for the first time. This way, all players are exposed to the same content, which reduced the chances of one's experience of the game being affected by factors outside the manipulation, as all players experience the game for the first time. The next section, therefore, describes two studies, which were conducted in order to investigate whether information intrinsic to the game has an effect on immersion.

Studies III & IV: Information Accuracy about Adaptation and Immersion

6

"We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology."

Carl Sagan, 1990

IN order to understand how players' perceptions of adaptive technology in digital games affects their gaming experiences, further studies are designed, in which players are exposed to neutrally phrased content about a digital game that they play for the first time, which suggests to the players that the game they are playing adapts its content based on their behaviour and performance.

As previously discussed in Chapter 3, adaptive technology in single-player games can be perceived as a beneficial feature that improves one's experience of playing the game. However, little research has gone into studying how players' perception of this feature affects their immersive experience. Therefore, to study this effect, players are provided with information that suggests that the game they are about to play contains an adaptive AI matching their behaviour in the game, while this not being the case. This way the effect of the mere perception based on the information-infused expectations of this feature on immersion can be studied without being exposed to this technology. This effect is akin to the phenomenon also known as the placebo effect.

6.1 Expectations and the Placebo Effect

Numerous studies and experiments have provided supporting evidence showing that the placebo effect is a powerful tool in not only

Placebo effect is shown to be effective in improving performance

curing diseases and medical conditions (Fuente-Fernández et al., 2001), but it also can be successful in improving one's performance, e.g. helping elite cyclists to go faster by affecting their expectations (Sonetti et al., 2001).

The research into studying this phenomenon has produced various definitions emphasising different aspects of this schema, as well as several potential explanations of what causes this effect. Defined as the physiological or psychological response to an inert substance or procedure (Stewart-Williams, 2004), there are several theoretical approaches into describing the causes of the placebo effect. Some main concepts include a classical conditioning, and an expectance view (Geers et al., 2005).

Classical conditioning approach

According to the classical conditioning approach, it is possible to change an organism's state or behaviour by exposing it to a contingency between an unconditioned stimulus, such as active medications, and the conditioned stimuli – the methods or techniques used to manage treatments, resulting in the placebo effect as the conditioned response (Wickramasekera, 1985).

Expectations-based approach

An approach based on people's expectations states that the placebo effect is driven by anticipation that a given medication will result in a particular outcome – a higher performance when undertaking a task or an activity, or an improved medical treatment (Kirsch, 1999; Stewart-Williams and Podd, 2004). That is, expecting the suggested reaction is said to lead to the generation of that reaction (Geers et al., 2005).

Altering expectations could increase productivity and results

Expectations are powerful enough to motivate patients to improve their own medical conditions, or to motivate healthy people to increase their productivity and results. Hence, it is reasonable to suggest that the anticipation of a certain effect in digital games can lead a player to this effect. If an individual plays a video game that is suggested to have a feature that may potentially improve their performance or the overall experience of the game, the player would expect it to happen. Believing in this will cause the player to subconsciously work towards achieving better results, or think that they enjoy the game more than if they were not aware of this feature.

6.1.1 "Scientific" Explanation

The placebo effect is more than just a pill – these 'drugs' are given in particular ways, they vary in shapes and forms, and they are consumed with expectations. All of these have an impact on a person's beliefs about their own health, and as a result, on an outcome.

The presentation matters largely for the patients taking these pills. In a set of experiments, Blackwell, Bloomfield, and Buncher (1972) discovered that the colour of a pill, as well as the number of the pills taken, have an effect on the outcome – two pills were found more effective than one, and pink sugar pills were better at maintaining concentration than the blue ones, while green tablets are better at treating anxiety (Schapira et al., 1970), and the yellow colour is more suited for anti-depressant pills (Craen et al., 2000). Moreover, salt water injections have been shown to be more effective than pills for postoperative pain, for headaches and for blood pressure (Craen et al., 2000; Gracely, Dubner, and McGrath, 1979; Grenfell, Briggs, and Holland, 1961). Patients believe that it is a more dramatic intervention, and as a result should have a more serious effect. Expensive packaging, complicated explanations, and elaborate rituals are also very important for the effect to take place – it is more likely that a patient will get better when receiving a pill or an injection from a person in a lab coat, or have a placebo surgery (Gino, 2008; Kaptchuk et al., 2006).

The stimuli presentation can influence the effectiveness of the placebo effect

The presentation is necessary for convincing the players that a particular feature in a game will improve their performance. To increase the chance of having an effect on the player's perception, it is important that the player is given a credible explanation as to why this feature works and what it does. Some recent studies have proven that descriptions that use technical language are considered to be better, because they look more 'scientific'. Any information containing technical terms that are not often used in everyday conversations, may interfere with people's abilities to critically consider the underlying logic of this explanation (Weisberg et al., 2008). Similarly, people tend to rate longer explanations as more similar to experts' explanations (Kikas, 2003). And finally, non-experts are more easily convinced that the 'scientific' information they are reading is true and provides them with a good explanation of a topic, while people with more expertise may be more sceptical about the validity of the provided description, and would not be allured by the technical presentation (Weisberg et al., 2008).

A credible explanation of the feature could potentially improve players' perceptions of it

6.1.2 Adaptive Technologies

Based on this discussion, it is proposed that it is possible to alter the player's experience by suggesting that the game they are playing contains a feature which can improve their performance – this feature being adaptive AI. Believing in the ability of the feature to improve the

Adaptive AI is invisible in the game design and thus could be perceived and experienced when not being present in the game

player's performance can also lead to the higher level of immersion in the game world.

Adaptive technologies are invisible in the game design – as the game AI adapts to the player's individual approach, the player feels moderately challenged, and as a result feels increasingly immersed in the game. However, if the game does not have this feature, and it is only suggested to the player that the gameplay will be adapting to their behaviour, it is expected that the results with the 'placebic' feature would be similar to those with the actual adaptable AI in place.

Combined together, the will to believe in a more enjoyable experience of a game and the appropriately presented technical explanation of the feature may result in the placebo effect. That is, the player will assume that their good performance in the game comes from the adaptive AI modifying the gameplay according to the player's skills, while the results will be attained from them working towards achieving this experience without the help of the described feature.

In the context of digital games, the placebo effect can take place when a player is instructed using a highly technical language that they will be playing a game with adaptive AI, while the given game has no such feature. It is hypothesised that the players who are 'provided' with the feature will perform better and feel more immersed in the game, than those players who are given the game 'without adaptive AI'.

Two experiments were designed and conducted in order to test whether players' immersion changes in any way when they interact with a digital game without adaptive AI, while being informed that it contains the adaptation. This set up allows to gain initial insight into whether the expectations of this feature affects players' perceptions of the game, and their gaming experiences as a result of this.

6.2 Study III: Placebo Effect when Comparing Two Gaming Sessions

This study was designed to explore whether people experience an adaptive AI in the game when playing two sessions, i.e. whether they carry on some kind of expectations. The aim of this experiment is to explore how players' perceptions of the game changes when being told that the game contains adaptive features and to determine the effectiveness of the placebo effect in relation to the player performance and experience. That is, whether believing that a game has a feature, which

may potentially increase or decrease the challenge and improve player experience, would lead to the player experiencing these in real life and affect their overall experience of the gaming session.

6.3 Experimental Method

A within-subject study was designed to explore how players' perceptions of adaptive technology in digital games affects their immersion. Each participant played a game twice: in one session they were told that the game contained adaptive AI and the other session did not contain this feature. The study was counter-balanced, to avoid the order effect of the stimuli exposure. Immersion was the dependent variable and was measured using the IEQ.

Each player received a set of instructions before the start of the game, which contained the description of the experiment procedure and a brief explanation of the adaptive AI purpose for those participants who were not familiar with the term. The information about the adaptation was general and brief to avoid confirmation bias.

6.3.1 *Participants*

Overall, 21 participants were recruited for the study – 3 female and 18 male students at the University of York. The average age of the participants was 23 (SD = 3.4), with the youngest player being 19 and the most mature one – 32 years old.

The majority of participants were regular gamers, spending more than one hour a day playing their favourite video games, and often dedicating several days a week to progress in the virtual world. Those players listed strategies and RPGs as the genres they prefer, although FPS and sports games were also amongst some of the less frequently mentioned games. There were three people who stated that they do not often play video games, but when they do – they normally spend over an hour in a single gaming session. These participants listed puzzle games, life simulations and racing games as their favourite genres.

Most participants were familiar with the concept of adaptive AI – out of 16 people who said they had heard about it before, nine also had had previous experience of playing video games that adapted to their behaviour. All participants had played games on a laptop before taking part in the study, and were familiar with the mouse and keyboard controls.

6.3.2 *Materials*

The game chosen for this experiment was an indie survival game ‘Don’t Starve’¹ (Figure 7). In the game, the player starts off with the main character, Wilson, placed in the middle of a randomly generated map with an empty inventory. The aim of the game is to collect objects in order to survive – the tasks include building new objects from the collected ones, and using them in order to protect the character from monsters that are randomly placed on the map at the start of the level, as well as the natural events, such as weather, darkness, etc. The points scored in the game depend on how many days the character can survive in this world.

The chosen game has the potential to be perceived as adaptive

Such set-up meant that, for a first-time player, the reasoning behind placements of the resources and enemies on the map might not be clear. A potential interpretation for the allocation of the numbers and positions of the objects on the map could be attributed to a sophisticated algorithm that uses the information from previous gaming sessions of participants to create a more tailored gameplay. This uncertainty in terms of the generation of the map could change the players’ perceptions of the game, which could in turn affect their experiences.

Moreover, at the time of the study, unlike most commercially available digital games, it had a potential to be less known by frequent players, which meant that the participants would form their initial opinion about the game during the experiment. Despite the fact that many participants had previously heard about the game, they had not played it prior to the experiment.

The player experience data was collected using the IEQ (Appendix e). An additional questionnaire was used to measure the player’s subjective view on the two gaming sessions – participants compared the level of enjoyment between the sessions ‘with’ and ‘without’ adaptive AI, as well as evaluating themselves their performance in each round. The questionnaire was completed with an open-ended question about what the adaptive AI did in this game according to the participants.

6.3.3 *Procedure*

Prior to the main part of the study, participants were asked about their familiarity with the chosen digital game. Only those participants with no experience of the digital game were able to participate in the study.

¹ Don’t Starve: <https://www.kleientertainment.com/games/dont-starve>



Figure 7: Don't Starve: Example of a random game session.

To begin the study players were briefed about the aim of the experiment, outlining what would be expected of them at each stage, and what data would be collected. They were also provided with a consent form (Appendix a), which the participants signed if they agreed with all the terms.

The experiment then started with a demographics questionnaire to gather the data about participants' gaming background (Appendix d). This was then followed by a short tutorial, during which participants were provided with a brief explanation of the aim, the controls and the storyline of the game they would be playing. This was then followed by their first game trial, when they played for about 5 minutes to make themselves familiar with the virtual environment. For the main part of the study, participants were playing the game two more times for 20 minutes during each session – a half of the participants played the game with adaptive AI 'switched on' first, then moving on to the game with randomly generated world; and the other half had the order of the sessions switched. All participants got a brief explanation of what adaptive AI is and does before they played the game twice. After each round they filled in the IEQ.

The idea of the experiment was to suggest to the player that each of the two rounds they would be playing differ depending on whether the experiment facilitator switches adaptive AI on (referred to as the 'adaptive AI' condition) or off (referred to as the 'standard AI' condi-

tion). The round when participants would be playing ‘with adaptive AI’ was described to them as follows. Unlike in a standard game, the world was generated based on the participant’s performance in the game – depending on how well they performed in the game, it would ‘adapt’ the generated world to match the player’s skills. Although, explanation given to the participants was deliberately vague in order to allow for the freedom of their imagination to explain what they experience. The full description can be found in Appendix g.

		II: INFORMATION		
		None	Partial	Full
I: ADAPTATION	Standard AI	✓	✓	✗
	Adaptive AI	✗	✗	✗

Table 9: Experimental conditions used in study III.

While participants were told that this is indeed the case, both game sessions did not differ in their world generating process in any way – both times the world was created randomly by default. In fact, the game did not have an option to ‘adapt’ to the player behaviour – this was only verbally suggested to the players in order to test whether knowing that the game has a certain feature would affect the overall enjoyment of the game, or even player’s performance in it.

Upon completing both sessions, participants filled in the final questionnaire collecting data about their experience of adaptive AI in the game. They were asked to compare the two gaming sessions by answering nine questions – there were eight Likert scale questions where people could compare their performance and enjoyment of each session to another, and in the final question participants were asked to explain what the difference was between the two rounds.

The quantitative experimental measures were analysed using repeated-measures ANOVA to determine the effect of the ‘adaptive AI’ on immersion. Additionally, a two-way mixed ANOVA was performed to test for the interaction effect between the ‘presence of the adaptation’ and the players’ familiarity with the concept prior to the study.

6.4 Results

The main hypothesis was that immersion would be higher when playing the 'Don't Starve' game 'with adaptive AI' than 'without' it. Indeed, participants felt significantly more immersed in the session that they believed was adapting to their behaviour, in comparison to the session 'without adaptive AI': $F(1, 19) = 7.88$, $p = .011$, $\eta_p^2 = .283$. Figure 8 shows the difference between the total immersion in each session.

Players felt more immersed in the session 'with adaptive AI'

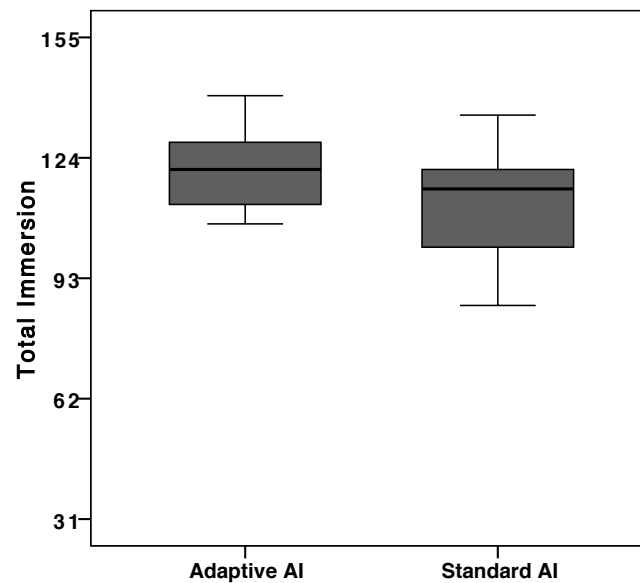


Figure 8: Total Immersion with and without adaptive AI.

	Adaptive AI	Standard AI	$F_{1,19}$	p	η_p^2
Total Immersion	119.86 (9.55)	111.90 (14.29)	7.88	.011*	.283
Cognitive Involvement	36.86 (3.04)	34.14 (5.78)	7.09	.015*	.262
Emotional Involvement	22.48 (3.23)	21.43 (3.50)	3.05	.096	.132
Real World Dissociation	26.05 (3.71)	23.95 (3.64)	5.84	.025*	.226
Challenge	13.81 (2.32)	12.76 (2.17)	2.41	.136	.108
Control	20.67 (2.24)	19.62 (2.76)	3.58	.073	.152

Table 10: Mean (SD) of immersion and its components when playing the game twice with and without adaptive AI. *p < 0.05

In terms of the five immersion components, the difference between the two sessions for each component is summarised in Table 10. Two

out of the five immersion components differed significantly between the two gaming sessions. During the 'adaptive AI' session participants felt that they were more cognitively involved with the game and felt more dissociated from the real world surroundings. There was, however, no difference in terms of players' perceived challenge between the two gaming sessions, the amount of control the participants experienced in the game, and their emotional involvement with the game during the 'adaptive AI' round.

6.4.1 Previous Experience

Players who were not familiar with the terminology prior to the experiment were more likely to feel immersed as a result of it

Participants' familiarity with the concept of adaptive AI prior to the experiment had an effect on their experience of the two sessions. People who had never come across this term before the experiment were more likely to believe in suggestions used in the experiment. A two-way mixed ANOVA confirmed that the difference in players' immersion levels between the two sessions was greater than the difference perceived by the participants who had stated that they were familiar with the concept ($F(1, 19) = 7.50, p = .014, \eta_p^2 = .306$).

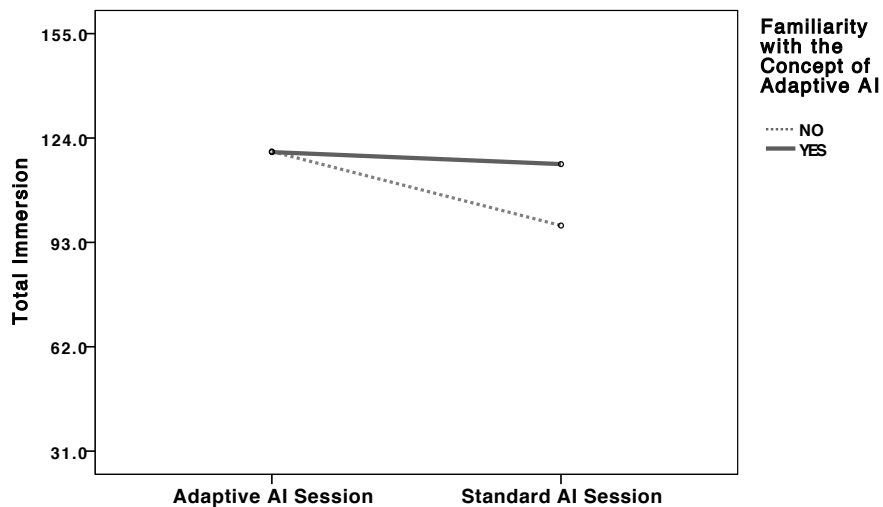


Figure 9: The effect of participants' familiarity with the concept of adaptive AI on total immersion in each session.

Playing the game twice could have potentially resulted in higher immersion scores in the second session, as people get more engaged in the process of playing and possibly learn from the mistakes they make in the first session. Although the tutorial session was aimed to

account for the training effect. However, the order of the sessions did not have a significant effect on the results ($F(1,19) = .92, p = .350, \eta_p^2 = .046$) – ‘adaptive AI’ sessions were perceived as more immersive regardless of the order of gaming rounds.

6.4.2 *Quantitative Comparison of Two Sessions*

The final questionnaire was used to collect data about participants perception of the adaptive AI in the game, and its effect on their enjoyment and performance. Ten participants answered that the game learned from and adapted to their behaviour, while five thought that the game did not adapt as such. When asked to rate the extent to which the game adapted to their behaviour as a player, participants gave it an average score of 3.2 (SD = 1.08), where 1 meant that the game did not adapt at all and 5 meant the AI was adjusting the game a lot according to the player’s actions.

Perception of adaptivity

In terms of the overall enjoyment of the game, most participants stated that the adaptive AI made a whole lot of difference. They gave it an average rating of 3.7 (SD = 1.27) out of 5, where 1 meant that the adaptive AI had no effect on their enjoyment, and major difference was rated as 5. When asked whether the gaming session with adaptive AI was more (a rating of 5) or less enjoyable (a rating of 1) than the randomly generated one, participants stated that the adaptive game made the playthrough more entertaining, giving it an average score of 3.9 (SD = 1.14).

Enjoyment as a result of adaptivity

Similarly, participants believed that the ‘presence’ of adaptive AI was having an effect on their performance in the game. They gave the adaptive session an average rating of 3.5 (SD = 1.03), where 1 meant that this feature did not affect their performance and 5 meant that their performance was largely influenced by the presence of the AI. Participants were then asked to evaluate the impact of the adaptive AI on their performance – if a player thought that their performance was improved by the presence of the feature in the game, they gave it a rating of 1, but if they felt that they performed worse in this session, they gave it a rating of 5. In this question, the average rating was 2.6 (SD = .8), meaning that participants believed that the adaptive AI positively influenced their performance.

Performance as a result of adaptivity

Eleven participants stated that the adaptive session was more challenging than the standard one (a rating of 5), while the other 10 thought the opposite (a rating of 1), which resulted in an average rating of 3.2 (SD = 1.38). Nobody said that the sessions were equally challenging.

Perceived challenge as a result of adaptivity

At the end of the questionnaire everybody provided a brief description of what adaptive AI did based on their experience and understanding. Following the end of the experiment, all participants were convinced that there was in fact an AI adapting to their play, although some stated that the quality of this adaptation could be improved. Every player was surprised to find out that both sessions had no adaptive AI to affect their playthrough. However, two people said they were sceptical of the plausibility of having this feature in the game – both had more expertise due to their study in the area of AI and a more thorough understanding the mechanics behind the game AI adaptation.

6.4.3 *Qualitative Comparison of Two Sessions*

It is evident that all participants experienced the adaptive AI in the particular session they were told to expect it in. People believed that the game was providing them with new objects in quantities they needed and in the locations they required them the most. Some participants found more useful objects: (P2): *“The adaptive AI put me into a safer environment and seemed to present me with resources as needed”*, (P12): *“I think the adaptive AI makes objects in the game appear more often when I need them. It reduces the time of exploring the map which makes the game more enjoyable”*. While some players assumed that their current inventory was affecting the objects they could locate: (P9): *“The adaptive AI seemed to be aware of the materials I needed to progress, and provided them with easy access. It also changed the number of monsters depending on how well-equipped I was”*, (P21): *“It seemed to move some of the things I collected a lot of further away, separating some of the elements of tools I built a lot.”*

Players also believed that the monsters could adjust their behaviour depending on the things they have previously done in the game, e.g. (P11): *“Avoiding insect nests seemed to result in an abundance of them in newly explored areas. The first night a spider walked into my circle of light then ran away as I approached, as a result of me not following it out of my campfire area, the tactic seemed to change and on the second night a group of 3 spiders just charged up to my character”*. Many players found the ‘adaptive’ session more challenging than the standard one, as they encountered more monsters: (P16): *“First thing I noticed is that there are far more dangers than the previous session. Second, they chased me for longer time. But in terms of their behaviours, I couldn’t tell much difference”*, and discovered fewer objects they believed they needed in the game: (P16): *“[the adaptive AI was] trying to counteract my previous behaviour in game,*

i.e. prevent me from discovering too many things at once and more scattered around the map."

However, due to the random factor that allowed for the generation of brand new worlds every time a player had a new session, it was possible to argue that one of the games was 'more adaptive' than the other. Although, technically, participants rated the same game after each round, they experienced each round differently, and not only because of the randomly created objects and places. The players believed that one of the sessions was better than the other one in some way, sometimes more challenging than the other: (P7): *"To me it seemed like the difficulty level was increasing too rapidly. Even when I was not yet able to navigate the world, this AI produced monsters that then killed me before I could finish the task at hand (building fire?). For my own gaming style, the AI acted unfavourably. It should have supported my learning of the environment. Instead, it was there to make me adapt fast or die. That is more realistic, but also much more frustrating for a novice. AI therefore seems to me like a feature suitable for advanced players"*, sometimes making the playthrough easier: (P6): *"...Seemed to be more of what you needed nearby e.g. when low on health there were more flowers around."*

It is evident that regardless of the changes made by the random factor in the game, the players explained the differences in terms of the adaptive AI, i.e. they were actively seeking explanations during game play, and this as a result affected their experience. Therefore, independently of the immersion measures, providing players with clues of what to expect changed their interpretation of the experiences.

6.5 Discussion

The results support our hypothesis that players are able to influence their gaming experience based on their perception of the adaptive technology. It is sufficient to say that there is a new technology in the game for the game to become more immersive even without the details of what the technology is or what it will do. Players use their own beliefs and knowledge to generate the experience. If they choose to believe that a game has an adaptive AI, which supposedly can make their gaming session more enjoyable and enhance their performance, they themselves will subconsciously lead to these outcomes.

Players' perceptions of adaptivity influences their immersion

As well as the quantitative differences in immersion, the comments of participants were on par with the data collected in the IEQ. Some participants perceived the 'adaptive AI' session as more challenging,

and some experienced the opposite based to their needs in the game. This difference in the perception was due to randomness in generating objects and monsters, providing different levels of difficulty for each player, which resulted in no significant difference in terms of challenge. However, it is possible to draw a line between players' performances and their understanding of what the AI did. Players who felt challenged in one session, perceived the 'adaptive AI' session as trying to help them to perform better. Conversely, under-challenged players thought that the 'adaptive AI' was trying to increase the difficulty by adding new challenges, such as generating more enemies and less food.

Cognitive involvement and real world dissociation increase when playing 'with adaptive AI'

It seems the increase is due to increased cognitive involvement and real world dissociation. This could be because players are seeing the game as providing a better experience or it may be that in trying to work out the adaptations, they are thinking harder about the game.

The level of expertise in the field also greatly affected the extent to which players are prone to experiencing the feature. People tend to interpret events according to their own knowledge and heuristics. However, if they are given an explanation that is beyond their level of expertise, they would believe in what they hear or read, as long as the explanation is plausible. The events are then interpreted according to the new information received. It is therefore possible to experience something that is not there, like in the case of adaptive AI. As a result, participants who did not have any previous experience with adaptive AI were more likely to 'experience it', than those people who had extensive knowledge of the adaptive mechanisms.

This experiment was intended to reflect a common way in which players play, namely having played other versions or having other versions to compare to. However, there is an obvious risk of desirability bias in this experiment even though players were not told what to expect from the 'adaptive AI.' This is equally present in some play-testing situations, but nonetheless is a threat to the validity of the findings of this experiment. We therefore aim to overcome this threat in the next study.

6.6 Study IV: Placebo Effect during One Gaming Session

The previous study was conducted in order to understand players' behaviour when comparing two gaming sessions, where one is supposed

edly able to adapt to their game play. However, because participants were exposed to two sessions and were asked to compare them, it is possible that players just looked for differences in the sessions and used them to describe their perception of adaptation in the game. We, therefore, conducted another study in order to test whether this was indeed the case, and to explore players' perception and experiences of a digital game with suggested feature based on a single impression.

6.7 Experimental Method

This experiment is therefore *ceteris paribus* a between-subject version of the previous one. There is one dependent variable, immersion, measured using the IEQ. The experimental manipulation is the same as before, whether participants are told that the game has adaptive AI or not.

6.7.1 Participants

Overall, 40 participants (9 women and 31 men) took part in the study. The recruited people were students at the University of York from diverse backgrounds, and with varied levels of gaming experience. The average age of the participants was 23.5 (SD = 6.32), with the age range between 18 and 43 years.

Most participants regularly played digital games, often spending over an hour in a single session, several times a week. Those players listed strategies, adventure games, RPG and FPS games as the genres they prefer; while puzzle, action and sports games were also amongst some of the less frequently mentioned ones. There were four people who stated that they do not often play games, but when they do – they normally spend an hour or more in a single gaming session playing puzzle games, sports, action and adventure games.

Out of 20 people in the experimental group, 12 stated that they were familiar with the concept of adaptive AI, but only three of those participants had knowingly played games with adaptable behaviour prior to the experiment.

6.7.2 *Materials*

The game used for this experiment was also ‘Don’t Starve’. None of the participants have previously played the game, even though some people had previously heard about it.

The gaming experience data was collected using the IEQ (Appendix e). An additional questionnaire was used to measure the game’s adaptiveness as perceived by the players – the questionnaire was deliberately phrased in a way that players in both groups could evaluate the responsiveness and the adaptiveness of the game with or without prior knowledge about the game having or not having adaptive AI, depending on the group. Additionally for the participants in the experimental group, the questionnaire was completed with an open-ended question, asking them to describe what they thought the adaptive AI did in this game based on their evaluation.

6.7.3 *Procedure*

All participants read and signed an informed consent form prior to the beginning of the experiment (Appendix a). The experiment then started with a demographics questionnaire to gather the data about participants’ gaming background. This was followed by a short tutorial, during which participants were provided with a brief explanation of the aim, the controls and the storyline of the chosen game. This was then followed by their first game trial, when they played for about 5 minutes to make themselves familiar with the virtual environment. For the main part of the study, participants played the game for 20 more minutes, starting from the beginning, without the experiment facilitator present in the room.

All participants in the experimental group received an explanation of what adaptive AI is and does before they played the game on their own (referred to as the ‘**adaptive AI**’ condition, Appendix i), while participants in the control group read a description without the AI being mentioned to them (referred to as the ‘**standard AI**’ condition, Appendix h). Each participant played the game from the very beginning, and each time the world was randomly generated with settings being at default values for both groups of participants. At the end of the gaming session they filled in the IEQ, and the questionnaire with eight 5-point Likert scale questions designed to collect data about players’ perception of the ‘adaptiveness’ of the game.

		II: INFORMATION		
		None	Partial	Full
I: ADAPTATION	Standard AI	✓	✓	✗
	Adaptive AI	✗	✗	✗

Table 11: Experimental conditions used in study IV.

The quantitative experimental measures were analysed using one-way ANOVA and Tukey post-hoc test for multiple comparisons. Additionally, the data collected about participants' perception of the adaptivity in the game at the end of the experiment was analysed using Mann-Whitney U test.

6.8 Results

The findings were on par with the results obtained in the previous study. The hypothesis that the participants playing the game 'with adaptive AI' would feel immersed in the game more than the control group was confirmed. On average, immersion scores collected in the control group were lower than the scores obtained in the experimental group, with a significant difference between them: $F(1, 38) = 6.01$, $p = .019$, $\eta_p^2 = .137$ (Figure 10). Participants who were informed about the game 'having adaptive AI' had an average score of 124.15 (SD = 6.51), whereas people who played the game without being told anything about the feature had a mean score of 116.00, with a larger variation in the results (SD = 13.37).

Again, players feel more immersed when playing 'with adaptive AI'

	Adaptive AI	Standard AI	$F_{1,38}$	p	η_p^2
Total Immersion	124.15 (6.51)	116.00 (13.37)	6.01	.019*	.137
Cognitive Involvement	38.25 (2.65)	35.75 (5.02)	3.87	.056	.092
Emotional Involvement	23.05 (2.82)	21.20 (3.46)	3.44	.071	.083
Real World Dissociation	27.55 (3.52)	24.85 (4.86)	4.05	.051	.096
Challenge	14.20 (1.74)	14.10 (2.10)	.03	.870	.001
Control	21.10 (1.74)	20.10 (2.90)	1.75	.194	.044

Table 12: Mean (SD) of immersion and its components when playing the game either in standard or adaptive condition. * $p < 0.05$

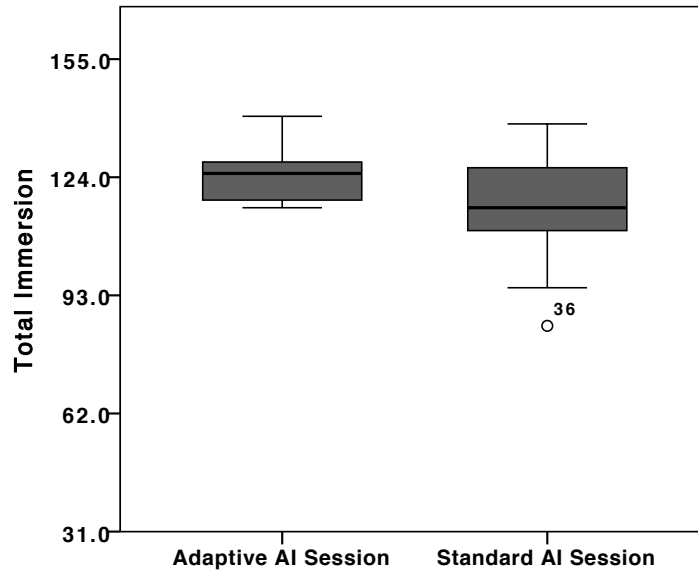


Figure 10: Total Immersion with and without adaptive AI.

Interestingly, none of the five immersion components differed significantly when compared across the three conditions (Table 12). Unlike in the previous studies, cognitive involvement of participants was not significantly different based on the information players were provided about the adaptation, neither was their dissociation from the real world.

Familiarity with the concept of adaptivity had no effect on immersion

Familiarity with the concept of adaptive AI had no significant effect on immersion scores in the experimental group: $F(1, 18) = 2.93$, $p = .066$, $\eta_p^2 = .137$; where 12 out of 20 participants had had some knowledge about adaptive AI before the experiment.

6.8.1 Quantitative Evaluation of Adaptation

A Likert scale questionnaire at the end of the session was aimed at collecting data about players' perception of the game's adaptiveness. When answering questions, each participant ranked each statement on a scale from 1 to 5 based on how much they agreed with it. Table 13 shows the questions, together with the average scores provided by each group of participants.

Overall, the results demonstrate that participants in the experimental group felt that the game was altering its behaviour based on their

Questions	Standard AI	Adaptive AI	U ₄₀	P
The game was generating content according to my behaviour in the game.	2.55 (1.32)	3.40 (.88)	128	.052
New content in the game appeared based on my decisions as a player.	2.55 (1.23)	3.45 (.76)	111	.015*
The game matched the challenge to my skills and abilities as a player.	2.50 (1.05)	3.50 (.95)	100	.006**
The behaviour of the game changed when I was doing too well or too badly.	1.90 (1.02)	3.20 (1.06)	78	.001**
The game was generating contents based on the needs of my character at that point in the game.	3.05 (.95)	3.90 (.85)	105	.009**
The game was not responding sensibly to my actions as a player.	2.15 (.88)	1.90 (.97)	167	.383

Table 13: Mean (SD) of participants' responses in standard and adaptive conditions based on their gaming experience. * $p < 0.05$, ** $p < 0.01$

decisions more than those players, who were not aware of this adaptive feature.

Additionally, players in the control group on average evaluated their performance in the game lower: $M_C = 3.15$ ($SD = .93$) than those participants, who were told about presence of adaptive AI: $M_E = 3.35$ ($SD = .86$), however this difference was not significant: $U(40) = 172$, $p = .461$.

Similarly, players in the experimental group believed that they enjoyed the game more: $M_E = 4.25$ ($SD = .64$) than the control group: $M_C = 4.60$ ($SD = .60$), however the effect was not statistically significant: $U(40) = 139$, $p = .102$.

6.8.2 Qualitative Evaluation of Adaptation

Additional qualitative data was collected in the experimental group in order to understand whether the players were able to perceive the adaptive AI, and if they did, what exactly players thought it was doing.

Generally, participants believed that the game was adapting to their behaviour in the game, however as they did not have anything to compare their experience to, the answers provided by the players were

more vague than the answers collected from participants in within-subject design study.

Positive perceptions of adaptive AI in the game

The majority of participants thought that the game was adapting to them in a positive manner. The main adaptations that they spotted were normally related to food and monster locations and quantities, based on their character's needs at a specific point in the game: (P1): *"I think it was disturbing material I needed, but not to a extent that they were easily gained. The difficulty of the environment and the animals I encountered changed the longer I played."* and (P4): *"[the game was] generating objects needed for my progress in the game based on the previous selection of tools and movements."*, *"... It also chose appropriate enemy strength for me."*

Feeling in suspense as a result of playing 'with adaptive AI'

Participants also found that the game was adapting in order to keep them in suspense, and provide new challenges and entertainments: (P3): *"Introducing the players to the environment at a high difficulty level then altering the environment depending on how well the player responded. I also think it provided materials suited to the players needs quite well."* and (P13): *"Trying to make me use the parts of the game I wasn't using, for example I was not attacking things so after a while I was attacked. It was trying to make the game more challenging by introducing more obstacles."*, or more enemies: (P17): *"More than anything, it felt like the game was adding more enemies. In some areas with lots of them there seemed to be more/better rewards to get me to fight/interact with the enemies to get them."*. Some players even thought that the game was being a little mean to them: (P17): *"I think it was avoiding me with the things I needed most - i.e. food, wood (basics) so that I could progress at a steady level whilst withholding other materials (stone) so that I did not progress too quickly."*

However, not all participants were entirely convinced that there was any adaptation happening, or if it was, it was not being particularly responsive to their game play: (P10): *"I felt the adaptive AI was very subtle..."*. Some players pointed out that playing the game only once meant that they did not have any other experiences to compare to: (P7): *"The AI could have been giving me appropriate objects and enemies, but it felt like objects were random and its possible that I just didn't meet the enemies. I have no expectations - it's a random environment so difficult to tell if it's changed."*

6.9 Discussion

The results of this study confirmed the hypothesis and were very similar to the ones obtained in the first study. The findings support the

idea that player experience, specifically immersion, is formed not only based on the features in a game but also on players' personal understanding of how the game should work regardless of whether that understanding is correct. The results demonstrate that players' expectations and experience of a digital game can be adjusted based on their knowledge of the game before playing it, which then subsequently leads to an improved experience if the player chooses to believe this information.

Interestingly, the differences in each component of immersion moved in a similar pattern to the previous study, but with sufficiently large effects to achieve significance. The only difference was that the players in the experimental group were not more cognitively involved, nor were they feeling dissociated from the real world, than the control group – conversely to the results obtained in the previous study. This is to be expected because players in this study are not acting as their own controls, this being a between-subjects design. Perhaps, being unable to compare the session to another one meant that players did not think about the adaptation as actively as the players in the previous study.

The results are on a par with the ones in within-subject study

The additional questionnaire helped to understand whether participants were able to perceive the game's 'adaptiveness'. The answers given by players in the experimental group were significantly different from the control group's responses. Knowing about adaptive AI made players believe that the game was changing its behaviour based on their performance and their decisions, and generating appropriate content for the needs of their character. It is worth noting that without the other version of the game to compare to, the comments seemed to lack the same level of confidence of the previous study. This contrasts with the control group, who perceived the game as it was, namely, placing objects and non-player characters randomly around the map.

Contrary to the results from the study where players compared two sessions, previous knowledge of adaptive AI did not have a significant effect on the perception of this feature in this study. Players with more expert knowledge in the field had similar experiences to those participants who had not heard the term before taking part in the study. Unlike in the previous study, where participants could compare two sessions, it is possible that when being exposed to the game only once, the 'experts' in the field of AI are less sceptical about the adaptation implemented in the game.

The results from both studies are, however, tentative. The game picked for this experiment was chosen based on its gameplay, which had the potential to be perceived as adaptive by its players. It is, there-

The effect could potentially be different in another game

fore, possible that a different game could have been viewed as less adaptive by the players, which could lead to the opposite effect of immersion decreasing as players realise that such feature is not present in the game.

Different information could affect players' experience differently

Moreover, despite the fact that the players were given a rather broad and generic description of adaptive AI in digital games, the traits of such technology were easily projected on the chosen game, to a certain extent. Therefore, further investigation is required to explore this effect with regards to games with adaptive features. Different adaptive technology can also be perceived less or more positively by players, so more research could provide further insight into this effect with regards to adaptive features of different nature.

6.10 Conclusions

Both studies confirmed that it is possible to implant an idea into players' minds that a digital game is capable of performing something that it is not set to do. In this particular situation players are then able to experience this feature, which is supposedly beneficial for their experience, depending on the plausibility of explanation. The players adjust their expectations of the game based on the knowledge they have about this game. This, in turn, then affects their gaming experiences.

The intention of these experiments was not to prove that, due to players' extensive imagination, digital games do not need improvement, but instead the idea was to demonstrate that the experience that comes from playing games can be a result of gamers' personal attitude and expectations.

Nonetheless, this research has allowed us to gain an initial insight into the effect of players' perceptions of adaptive technology on immersion. The results demonstrated that players' expectations set when reading the information about a digital game change their perception of the game, and as a result the experience of it. However, this is only one instance of such manipulation. More research needs to be done in order to explore how players perceive such feature when playing games that can adapt to the players. Moreover, it may be, of course, that such effects seen here wear off over time, so that over a longer timescale, the 'true' experiential outcomes are achieved, but this is currently unknown. It may be that players work out rather quickly the lack of advanced technology or it might be that they persist in their misconceptions thanks to the careful explanations that they pro-

vide themselves. It is also unclear just how much information a player needs to be susceptible to the effects seen here. Different technologies also need to be tested in order to be able to explore whether these findings hold true for other kinds of digital games.

The next part of this thesis, therefore, explores this effect in more detail using digital games with adaptive technologies to study the effect of information of different precision on immersion and the durability of this effect.

Part IV

INFORMATION ABOUT ADAPTIVE TECHNOLOGY IN DIGITAL GAMES

THE previous part of this thesis describes studies exploring the effect of expectations set by players' preferences and the neutral information about an adaptive feature in the game on immersion. The first manipulation in the form of players' preferences in the game did not have a significant effect on players' immersion, however players' awareness of the game having an adaptive feature made players feel increasingly immersed and enjoy the game more, even though the feature was not present there.

Therefore, it is paramount to explore to what extent immersion is influenced by this kind of information about adaptive features when playing a game with the features being present inside it. To do so, a digital game is required that supports such technology, while at the same time allows for the adaptive features to be turned on and off depending on the experimental settings.

Moreover, it is possible that different information and the amount of detail given to the players about the game can influence immersion in different ways. Previous studies demonstrated the effect of player awareness of the adaptation on immersion, while full details about the functionality of the adaptation were not provided to the players in order to avoid confirmation bias. The mere awareness of the adaptation that was not present in the game allowed players to experience it, and perceive the game differently. Hence, more research is needed in order to explore players' perceptions of the game that contains an adaptation, and to evaluate how this effect changes when detailed explanation of the adaptation is given to the players. Moreover, as player experience can change with time, the durability of the effect of information-infused expectations on immersion should be explored.

Hence, this part of the thesis outlines the research, which aims at gathering additional data about players' perceptions of adaptive technology in games, and the effect they have on their immersion levels. Three additional studies are presented. The games used in these studies were specifically developed for the purpose of this research and have different kinds of adaptations: a conventional adaptation that affects the strength, health, and abilities of enemies; and a more experimental feature – a timer adaptation, which changes the countdown speed of a timer depending on the player's performance.

The findings of these three studies provide the answers to the following research questions, as outlined in the beginning of this thesis:

1. Does the accuracy of information players know about adaptive features a digital game affects their immersion?

2. Does the precision of information players know about adaptive features a digital game affects their immersion?
3. Is the effect of information about adaptive features on immersion durable?

Therefore, to begin gathering information to answer these questions, a digital game was developed, in which challenge is adjusted based on the players' performance. The game and the adaptation are described in the following chapter.

Study V: Adaptive Timer

7

To continue the research into the effect of players' perceptions of adaptive features on their gaming experiences, and to evaluate how the information that players know about adaptive features affects immersion in a game with such feature or without it, a game is required, which has a functionality that allows to toggle the adaptation on and off based on the experimental condition.

Therefore, this chapter describes a digital game developed for the purpose of this research, in which a timer is adapted in order to respond to the changes in players' performance in the game. This was done to explore whether time pressure can be adapted as a challenge in the game.

A study was conducted in which players were asked to play this game: for those players who were underperforming at certain parts in the game, the rate at which the timer was counting down slowed down, and for the higher scorers the game was more challenging as it sped up the countdown rate. The results showed that having such adaptation had a significant positive effect on player immersion, while the players were not aware of this feature.

7.1 Time pressure in Digital Games

Challenge varies between digital games not only quantitatively, but also based on the nature of the challenges that the game offers. For example, physical challenges often involve skilful handling of the game controls, while mental challenge require players to come up with various strategies, tactics, manage economic systems, finding correct answers to puzzles, etc. (Adams, 2014). Time pressure can enhance these challenges or alter them in some way.

Typically, adaptive technologies alter gameplay with regards to the numbers and nature of enemies, their strengths and health, as well as the number and quality of resources available to the players at a given time. However, it can be argued that these adjustments can only work in digital games that contain specific enemies or collectable

items, while certain casual games might not necessarily allow for these changes. For example, many games like *Bejeweled* or *Tetris* rely on time pressure to keep players in suspense. However, time itself is never altered based on players' performance in the game.

Players have a poor perception of time

The goal then is to see the effect of a adaptation on the immersive experience in a single-player game. Of course, if players become aware of the adaptation, this could work against the goals of the experiment either through players resenting the adaptation and so experiencing reduced immersion, or through confirmation bias (Nickerson, 1998) and so reporting (but not experiencing) increased immersion. To avoid this, we have focused on adapting an aspect of games that research consistently demonstrates that players struggle to perceive, namely the passage of time. Nordin (2014), throughout his doctoral work, demonstrated that across a range of situations and with a range of psychological measures, players were rather poor at tracking the passage of time and were not susceptible to any in-game or contextual manipulation. We therefore used time adaptation as a way of adjusting the challenge of a game so that players would not have any awareness of the manipulation.

Adaptive the countdown rate of a timer allows to keep the gameplay the same for all players, while still varying the challenge

Adapting the countdown rate of a timer in a digital game might be an unconventional way to adjust the level of challenge in the game, as it does not fully fit the categorisation of adaptive methods in games, as described in Chapter 3. However, it does affect the outcome of players' actions indirectly, i.e. their interactions with the NPCs lead to the changes in the scores, which affect the timer countdown. Time given to the players is a part of the mechanics used in the game to create an additional sense of challenge. It is, therefore, possible that such adaptation would allow some players to experience the game exactly the same way as other players do without being aware that they play the same session for a different amount of time.

As a timer adaptation is not an explicit feature in the game, it has a potential not to interfere with the main gameplay, while having an impact on the perceived challenge indirectly. Baldwin, Johnson, and Wyeth (2014) demonstrated that if the balancing of challenge in the game based on the players' performance is too obvious, both stronger and weaker players would perceive such adaptation as unfair. Therefore, having such feature adjusting the challenge implicitly without affecting the main gameplay could be beneficial to one's gaming experience: Cox et al. (2012) showed that time pressure can enhance immersion of players.

Another reason for choosing such adaptation is simple: it does not require a complicated implementation. More sophisticated algorithms do not always have a positive effect on player experience, like in the case of Silva, Nascimento Silva, and Chaimowicz (2017). Simpler adaptations, like this one, have a potential to improve one's performance, while retaining the player's sense of agency and accomplishment (Hunicke, 2005).

7.2 Experimental Method

The aim of the designed experiment was to explore the experience of playing a game, in which the challenge is altered to match to player's skills. However, unlike the traditional methods, which modify the challenge by adapting the behaviour of non-player characters, we modified the timer in order to increase or decrease the difficulty based on players' performance and improve the experience of playing the same game for players with different levels of gaming experience. The general idea was to encourage less experienced players by subtly increasing the length of their session in order to allow for the completion of the same goal as other players, whilst providing more challenge for the people with more gaming experience by making the time 'fly by.' The hypothesis was that the people playing the game with altered time would feel more immersed in the game and generally perform consistently better than players with a standard timer.

The experiment to test this hypothesis was a between-subject design with experimental manipulation being the change in time, based on player's performance in the game. The dependent variables were players' immersion, measured using the IEQ, and players' in-game scores used as a measurement of their performance.

Overall, 42 participants (14 women and 28 men) from a range of different backgrounds and with varied levels of gaming experience took part in the study. The age range of the players was between 19 and 33 years, with a mean age of 24.05 (SD = 4.19).

7.2.1 *The Game*

In order to be able to manipulate the time based on the scores from players, a shooting game was adapted from the tutorial on Unity 4.6¹, which was then modified based for the purpose of the experiment.

The game 'Nightmares' is an isometric view shooting game, in which the player controls a little cartoon-style boy, who is dreaming of his toys turning into zombies and attacking him (Figure 11). The general idea is that every time the character gets attacked by one of the toys, the player loses a certain number of points depending on the toy, or gains points if the player manages to kill it.



Figure 11: Nightmares: a shooting game with a timer.

There were a few reasons as to why we chose this game for the experiment. First of all, having a non-commercial digital game meant that none of the players would be familiar with it, and therefore all players would have the same initial response. Secondly, being able to modify the game meant that we could add a timer, which could change depending on the score players achieved in the game. And finally, a shooting game like this one provides a fast engagement, and does not require much involvement long term. The controls are also easy enough for players to learn, regardless of their previous experience of

¹ 'Nightmares', adapted from the Unity tutorial: <https://unity3d.com/learn/tutorials/projects/survival-shooter-tutorial>

playing shooting games, games with keyboard and mouse controls, or any digital games for that matter.

The goal set for all players was to score 300 points or more within 90 seconds time limit. This number was estimated from a pilot study as a suitable score, which can be realistically obtained in 1.5 minutes. However, players were encouraged to aim for the highest score they could get. The timer and the score were displayed on the screen at all times.

Two versions of the game were developed: one had a timer with each unit of time being equal to one second, and the other game had the time unit changing based on the scores participants got throughout the game. If participants were doing better than an average player, the timer would speed up by a factor of 1.4, and when the player was doing poorly at a certain period of time in the game, the timer would slow down by the same factor. This time alteration was done four times in the game, at each point checking whether the player's performance was below or above certain requirements.

In order to estimate the potential average scores at various points in the game, 10 participants with varied levels of gaming experience were recruited for the pilot study. Their scores were recorded at five different points in the game and used together with the maximum possible scores in order to estimate the scores required to achieve a realistic number of points (in this case 300) at the end of the game.

7.2.2 Procedure

At the beginning of the study, participants were provided with an Informed Consent Form (Appendix a) to read and sign if they agreed with the outlined terms. Each participant was also given an experiment description, which briefed them about the aim and the procedure of the study (Appendix j). Then, prior to the main part of the experiment, each player was allowed to trial the game in a short pilot session in order to familiarise themselves with the controls. There were no restrictions in time and the score was not recorded, and the players were allowed to stop whenever they thought they were ready for the proper gaming session.

Participants were split into two groups: 20 players in the control group (referred to as the '**standard timer**' condition) and 22 people playing in the experimental condition (referred to as the '**adaptive timer**' condition). Depending on the condition assigned to the group, participants either played the game for 1.5 minutes or for what ap-

peared to be 1.5 minutes. During the experiment participants' scores were compared to the recorded scores from the pilot, at four points in the game – every 20 seconds. If the player had a higher score than a simple mean from the pilot, the time would be eventually reduced from 90 seconds up to 72 seconds. Alternatively, for those players, whose scores were below recorded values, the time would be extended up to 108 seconds. However, if the player was performing similarly to the average requirement to reach the goal, the timer stayed unchanged.

		II: INFORMATION		
		None	Partial	Full
I: ADAPTATION	Standard Timer	✓	✗	✗
	Adaptive Timer	✓	✗	✗

Table 14: Experimental conditions used in study V.

After that, they filled in the IEQ questionnaire (Appendix e), then the demographics questionnaire (Appendix d), and after that each participant was fully debriefed.

7.3 Results

We hypothesised that the players' scores would be more tightly positioned around the goal of 300 points when playing with adaptive timer, and that these players would feel more immersed in the game in this condition. Both statements were supported by the results. The participants who played the game without any modifications to the timer were significantly less immersed, than those participants whose timer was changing based on their performance (Table 15), as determined by one-way ANOVA ($F(1,40) = 7.41, p = .010$), with a medium effect size ($\eta_p^2 = .156$).

*Time adaptation
increased players'
immersion*

The analysis of immersion components is summarised in Table 15. The cognitive involvement and control aspects of immersion differed significantly between the two groups of players. However, there was no significant difference in players' emotional involvement in the game, their real world dissociation and perceived challenge.

Out of the 22 participants in the experimental group, 9 people had a shorter gaming session and 10 participants played for longer than 90 seconds. However, due to the time manipulation, there were 3 more players, who played for exactly 90 seconds because the timer slowed

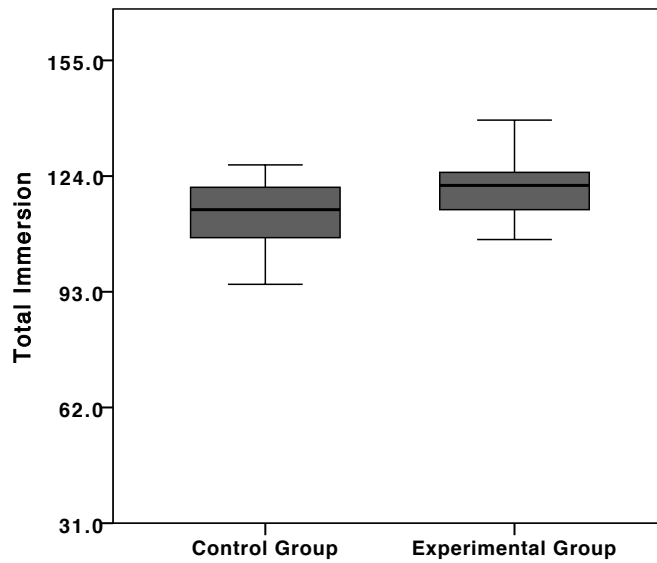


Figure 12: Total immersion with and without adaptive timer.

	Adaptive Timer	Standard Timer	$F_{1,40}$	p	η_p^2
Total Immersion	121.05 (8.11)	113.50 (9.83)	7.41	.010*	.156
Cognitive Involvement	39.64 (3.02)	37.45 (3.35)	4.96	.032*	.110
Emotional Involvement	21.55 (3.74)	19.60 (3.17)	3.28	.078	.076
Real World Dissociation	25.09 (3.60)	24.05 (4.22)	0.74	.394	.018
Challenge	14.18 (1.65)	13.50 (1.93)	1.52	.225	.037
Control	20.59 (2.56)	18.90 (2.45)	4.77	.035*	.107

Table 15: Mean (SD) of immersion and its components of players who played the game with and without the adaptive timer. * $p < 0.05$

down and sped up equal number of times at certain points in the game.

There was no significant difference between the immersion scores obtained from those participants playing shorter sessions and players with extended time: $F(1, 18) = .08$, $p = .781$. Moreover, there was no correlation between the immersion scores and the session duration (Pearson's $r(21) = -.09$, $p = .583$).

No difference in immersion when playing for longer or shorter than 90 seconds

Total Scores

Smaller variation in scores when playing with the timer adaptation

The scores in the control group had much bigger variation than the scores obtained by players in the experimental condition, as expected. The average score in the control group was 341.9 (SD = 144.34), and ranged from -106 to 474, while the experimental group obtained scores on average higher than the required 300 points – 391.5 (SD = 50.30), and ranged between 258 and 494. However, there was no significant difference between the scores of the two groups: $F(1,40) = 2.30$, $p = .138$, $\eta_p^2 = .054$.

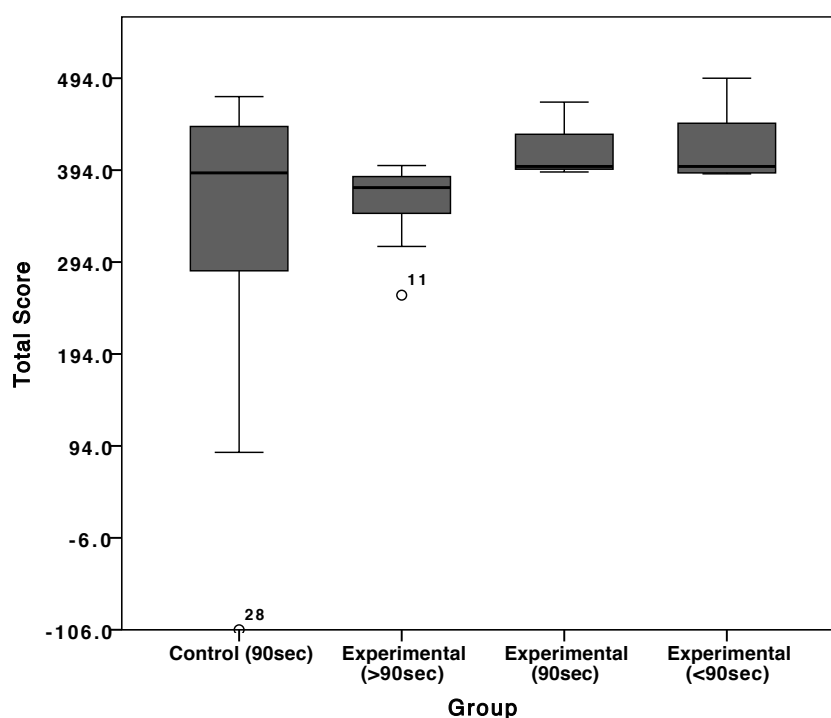


Figure 13: Total scores obtained by players with relation to the 90 seconds threshold.

The scores obtained in the experimental group also differed between those participants who played for longer than 90 seconds and participants, whose gaming time was reduced. The average scores in the group with extra time was 357.6 (SD = 43.59), while participants scored more when being under pressure – the group with reduced time managed to get 419.9 on average (SD = 37.71). There were three players who played for exactly 90 seconds in the adaptive condition, because the time increased and decreased equally during the game.

They scored between 392 and 468 points in the game, with a mean score of 419.33 (SD = 42.25).

The difference between the scores within the group of players in the 'adaptive timer' condition was significant, depending on the variation of time: $F(2, 19) = 6.24$, $p = .008$, $\eta_p^2 = .397$ (Figure 13). The difference between scores obtained in the group of players who got additional time and those who had their time shortened was significant: $p = 0.010$. However there was no significant difference between the scores of players with increased time and those whose time was exactly 90 seconds in the adaptive condition: $p = 0.083$. Similarly, scores of players with reduced time were not significantly different from the scores of the players who played for exactly 90 seconds while in the adaptive condition: $p = 1.00$.

Significantly different scores between groups of players with and without the adaptation

Players' immersion was positively correlating with their performance in the game (Pearson's $r(21) = .34$, $p = .029$).

7.4 Discussion

The results of the study demonstrated that even simple adaptation of a timer, based on player's performance, can affect their gaming experience. Although this manipulation was not as elaborate as some adaptive algorithms used in contemporary digital games, it still was able to affect player experience by matching the goal to the player's performance. Players felt more immersed in the game when the timer was changing according to their performance in the game. This may be why those in the experimental group experienced a greater sense of control, as measured with the IEQ, the game was more appropriate for their ability to assume control in the game. Further, as there was no correlation between level of immersion and time that they played, the difference in immersion could not simply be because some players got to play for longer than others.

The levels of perceived challenge did not differ between participants. Regardless of how much time players spent in the game, they were convinced they achieved their results within the required amount of time. For those who had reduced time, they were performing well, but consequently had more pressure to continue to do so. For those with increased time, they were not performing so well, but therefore got more time that allowed them to achieve the target goal. This may suggest that different mechanisms are influencing the experience

when games are adapting to players, particularly when there is a pre-specified goal against which players can monitor their progress.

Interestingly, players under time pressure and with shorter sessions achieved higher scores on average than some players in the control group, which is attributed to the fact that their performance was consistently good throughout the whole session. Players who rated themselves to have higher expertise level aimed to achieve the highest possible score, while players with less previous experience usually struggled to achieve the score of 300 and this was challenging enough for them. As might be expected, players in the control group showed larger spread in scores, particularly below the target 300, but the overall difference in scores was not significant.

Overall then, the general expectation that this particular adaptation leads to more enhanced player experience is supported by this study. Of course, this study represents only a particular type of game over a single instance of play. Different games may produce different results, and it is also not clear how knowledge of the adaptation may influence experience. It may be that over repeated play, players become aware of adaptation and therefore feel 'short changed' by the game or that it is in some way unfair. Moreover, longer or multiple gaming sessions could have influenced immersion over time. These considerations should be taken into account in further studies probing into the effect of players' perceptions of adaptivity in games on their immersive experiences.

This kind of adaptation is suitable for further studies

In its present form, this game shows an evident difference between immersion of players who play with and without the adaptive timer. Therefore, this game is an acceptable choice to be used as an adaptive game when studying the perceptions of players of adaptive technology in games with this functionality.

Study VI: Information Precision about Adaptation and Immersion

8

THE previous study showed the effectiveness of the adaptive timer implemented in 'Nightmares' in creating higher sense of immersion in players who are not aware of this feature. This makes it a suitable adaptive feature to use in the following experiment. In this study we combine the presence of adaptation and the information players know about it to further explore how players' perception of the game is affected by their knowledge about the adaptive technology in it. For this, we recruited 120 participants who were split into six groups based on two conditions: the presence of the adaptive timer or a standard timer, and the information about the timer (no information, partial information, or full information). The results suggest that players' immersion increases with the amount of detail they know about the adaptation, while they also feel more immersed when playing with the timer adjusting to their performance than playing with a standard timer. However, there is no interaction effect between the two variables on immersion.

8.1 Expectations of Adaptive Technology

In the previous study, we used a simple timer manipulation to test whether adjusting the time players spend in the game based on their performance can alter their gaming experiences. Changing the countdown speed based on the players' performance in the game was a somewhat basic adaptation, and none of the players were aware of this feature. Yet, players felt more immersed when the duration of play matched their skills more accurately than those participants who played for a fixed amount of time.

On the other hand, the two studies on the 'placebo' effect, as described in Chapter 6, also showed that players are very susceptible to the information they read about the game before they try it for the first time. Between and within subject design studies demonstrated

that being aware of an adaptive feature being present in the game can change their perception of the game and their experience, as a result of it. Participants felt more immersed when they believed that the game had adaptive AI, while the feature was not present in the game both when comparing the two gaming sessions or when only experiencing the game once. Players attributed any changes in the game play to being monitored by the AI, and felt like their experience of playing with it greatly improved their performance and enjoyment during play.

However, it is still not known how players' experience might change if the game comes with an adaptation, and the players are aware of its presence. We hypothesise that players' immersion would be higher when playing with an adaptive feature and knowing about it than when playing the game without the adaptation while being unaware of it or when being aware of the feature while not being exposed to its functionality. In the studies described in Chapter 6, the players were only told about the feature being present in the game, without the exact details about how they can benefit from it. This was done to avoid confirmation bias. Any responses that we received from players were just their own interpretations of the feature. However, as the perception of adaptation was mainly based on players' individual interpretation of it, it is not yet clear how the players' perceptions of the game could change when knowing precisely how the adaptation adjusts the difficulty, i.e. would players feel less immersed because they would be paying less attention to the feature or because they might find such feature unfair or distracting in some way?

Additionally, the previous study demonstrated that the adaptive timer implemented in the game increases players' immersion while the players were not aware of it. Therefore, a more rigorous evaluation of the effect of players' perceptions of this technology should be explored when playing a digital game with this feature, while being exposed to different levels of detail about the functionality of such timer.

To investigate how players' perceptions of a digital game changes based on the precision of information they know about the adaptive features inside it while experiencing these features, we conducted the following study.

8.2 Experimental Method

A 2 x 3 factorial between-subject design study was conducted in order to gather information about players' immersion levels and their per-

formance in a time-constrained gaming session, during which players were asked to score above 300 points in 1.5 minutes in a non-commercial shooting game – ‘Nightmares’.

Overall, players were split into six independent groups based on the experimental condition. Half of the participants had their timer adjusted based on their performance in the game, while the other half played with a standard timer displaying the amount of time left until the end of the session. One third of each of these groups were not aware of the timer adaptation, another third of the players were told that timer adjusted based on their performance but were not told what exactly this adaptation did, and the rest of the players were told how the adaptation changed their gameplay based on their performance in the game.

8.2.1 *Participants*

Overall, 120 participants (38 women and 82 men) took part in the study. To ensure the diversity of the players, undergraduate and post-graduate students, and members of staff were recruited from various departments at the University of York, as well as some local residents from the city of York. Recruited participants had varied levels of gaming experience, from casual players to dedicated gamers. The average age of the participants was 24.15 ($SD = 4.79$), with the youngest player being 18, and the most mature one – 50 years old.

Most participants were regular gamers who would typically spend over an hour in one session, or up to one hour several times a week, depending on how busy their schedule was. These participants listed FPS, RPGs, strategy, racing, and sports games as their favourite genres. However, almost a half of participants said that they normally play games once a week or even less frequently. Amongst those participants there were people who typically play casual, puzzle and card games on their smartphones.

Out of all 120 participants only 10 said they had never played shooting games. All participants were confident users of the mouse and keyboard controls.

8.2.2 *Materials*

The game used in this experiment was Nightmares, as described in Chapter 7. The general idea was that the player controls a little boy in a nightgown, who is dreaming of his toys becoming zombies and

attacking him. The player has to avoid being hit by the zombie bunnies, bears, and elephants while trying to shoot them. Different enemies are worth different number of points, and spawn at a different rate through the game. Similarly, players lose points depending on the zombie toy attacking them.

The score and the time left until the end of the gaming session are visible to the player at all times. The timer has two options – in the ‘standard’ option it counts down at a rate of one second at a time, for 90 seconds. In the ‘adaptive’ version of the timer, the time speeds up or slows down based on player’s performance at certain points in the game. There are four points in the game during which an individual’s score is evaluated against an estimated score required to achieve the 300 points goal at the end of 90 seconds. Depending on the player’s performance in the game, the countdown rate slows down or speeds up by a factor of 0.6. The countdown rate can also stay neutral if the player’s score is within a certain range for them to be projected to achieve the goal by the end of the session.

The player experience data was collected using the IEQ. Additionally, players who were told about adaptation, either partially or fully, were given an additional questionnaire at the end of the experiment, asking if they noticed the time change, how they thought the timer changed, whether it affected their performance in some way, and whether they thought that knowing about the adaptation changed their experience in any way.

8.2.3 Procedure

At the beginning of the study, participants were given an Informed Consent Form (Appendix a) to read and sign if they agreed with the outlined terms.

Each participant was randomly assigned to one of six conditions, which were based on the presence of adaptive timer in the game, and the information players received about it (Table 16). Half of the players had a standard timer (referred to as the ‘**standard timer**’ condition), while the other half had their timer adjusted based on their performance in the game (referred to as the ‘**adaptive timer**’ condition). A third of each of these two groups were not aware of the adaptation (referred to as the ‘**no info**’ condition Appendix k), another third of the participants were told about the feature but were not told precise information about what the timer was doing (referred to as the ‘**partial info**’ condition, Appendix l). The rest of the participants were given the full

information about the timer and how it would change depending on the score (referred to as the ‘full info’ condition, Appendix m).

		II: INFORMATION		
		None	Partial	Full
I: ADAPTATION	Standard AI	✓	✓	✓
	Adaptive AI	✓	✓	✓

Table 16: Experimental conditions used in study VI.

The experiment then started with a practice round of the game, where players were not limited in time to try out the controls, and to familiarise themselves with the game. Participants were told they can stop practicing whenever they feel comfortable with the controls, and would like to proceed to the actual game play. The time players took to familiarise themselves with the game was used to estimate their level of expertise by the experiment facilitator. Each player was assigned a ‘novice’, ‘intermediate’ or ‘expert’ tag based on the length of the time they spent practicing.

Participants then filled in a demographics questionnaire, in which they provided information about their gaming background and their personal estimation of their expertise level in this particular game (Appendix d). They rated their perceived expertise from 1 to 5, where 1 referred to being a ‘novice’ player, and 5 – to being an ‘expert’ player. This was then followed by the main part of the study, during which participants played the game for 1.5 minutes, or what appeared to be 1.5 minutes. They were instructed to get the highest score they possibly could, but generally they were told to aim for 300 points and above. At the end of the gaming session their score was recorded. Participants then filled in the IEQ (Appendix e), and the additional questionnaire if applicable.

A two-way ANOVA was performed to test for the main and interaction effects of the manipulations. Tukey post-hoc test was used for multiple comparisons at a significance level of $\alpha = .05$. Additionally, the mediation analysis described in this chapter was performed using the PROCESS package (Hayes, 2013) in SPSS.

8.3 Adaptation and Information about Adaptation

8.3.1 The Influence on Immersion

Main effect of adaptation on immersion

With regards to the timer adaptation, the difference between immersion scores in the 'standard timer' condition and the 'adaptive timer' condition was highly significant, as determined by two-way ANOVA ($F(1, 114) = 22.37, p < .001$), with a medium effect size – $\eta_p^2 = .164$.

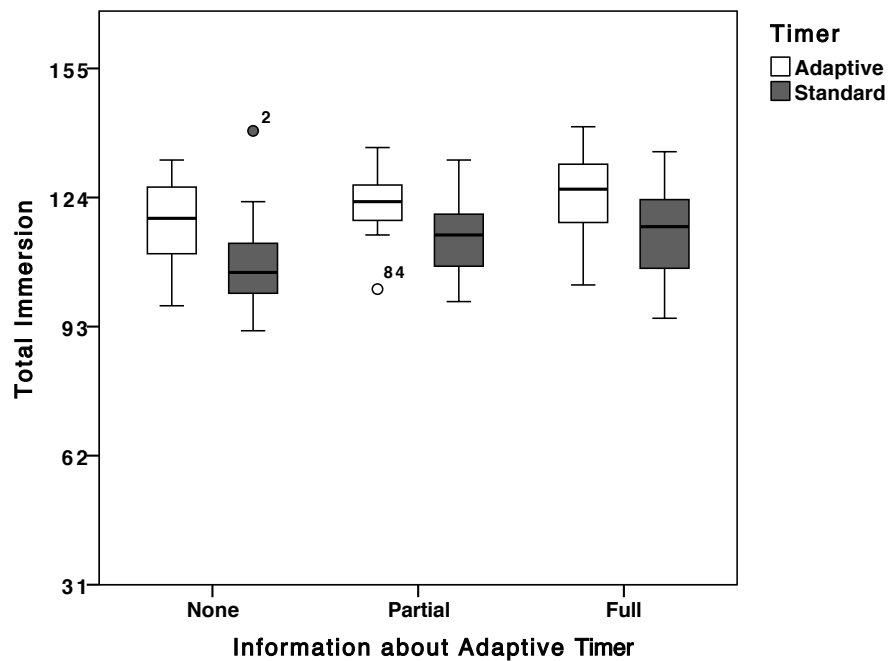


Figure 14: Total immersion in standard and adaptive conditions based on the amount of information about the adaptation.

Participants with time altered during their game play felt significantly more involved cognitively and emotionally with the game, and were significantly less aware of their surroundings, and felt more in control while playing the game. However, there was no significant difference between the two groups in terms of their perception of challenge in the game (Table 17).

Main effect of information on immersion

The effect of information about adaptation on the level of immersion in the game was also significant: $F(2, 114) = 5.08, p = .008, \eta_p^2 = .082$. The immersion scores in the group without the knowledge of adap-

Components	Standard Timer			Adaptive Timer		
	No Info	Partial Info	Full Info	No Info	Partial Info	Full Info
Total Immersion	108.15 (10.86)	114.40 (10.10)	116.25 (11.01)	118.40 (10.69)	122.65 (7.80)	124.45 (11.00)
Cognitive Involvement	34.10 (3.84)	36.35 (4.79)	37.80 (3.98)	38.05 (3.27)	38.45 (3.24)	39.80 (2.86)
Emotional Involvement	18.95 (3.61)	19.40 (3.55)	20.10 (4.62)	21.35 (3.62)	22.75 (4.25)	21.95 (4.56)
Real World Dissociation	22.90 (4.28)	25.55 (3.50)	25.00 (4.16)	25.20 (4.38)	26.30 (2.47)	27.50 (3.72)
Challenge	14.25 (2.65)	13.70 (2.11)	14.35 (2.30)	14.40 (2.62)	14.85 (1.81)	14.45 (2.31)
Control	17.95 (2.26)	19.40 (2.64)	19.00 (2.58)	19.40 (2.52)	20.30 (1.90)	20.75 (2.69)

Table 17: Mean (SD) of immersion and its components based on the adaptation and the amount of information about it.

tation were not significantly different from the immersion of players with only partial knowledge of adaptation ($p = .093$). There was also no significant difference in immersion between the groups with partial and full knowledge of the manipulation ($p = .745$). However, players who received a full description of the adaptive timer felt significantly more immersed in the gaming session than players without this knowledge ($p = .015$).

Out of all five components, three differed significantly between the three groups of players – cognitive involvement, real world dissociation, and control (Table 20).

Components	Effect of Adaptation			Effect of Information			Interaction Effect		
	$F_{1,114}$	p	η_p^2	$F_{2,114}$	p	η_p^2	$F_{2,114}$	p	η_p^2
Total Immersion	22.37	.000***	.164	5.08	.008**	.082	.13	.879	.002
Cognitive Involvement	15.64	.000***	.121	5.38	.006**	.086	.87	.420	.015
Emotional Involvement	11.68	.001***	.093	.66	.520	.011	.35	.706	.006
Real World Dissociation	7.08	.009**	.058	3.89	.023*	.064	.63	.533	.011
Challenge	1.22	.273	.011	.03	.971	.001	.65	.523	.011
Control	9.36	.003**	.076	3.14	.047*	.052	.31	.734	.005

Table 18: Interaction and main effects of timer adaptation and information about it on immersion. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Interaction effect of adaptation and information on immersion

The interaction effect of the adaptive timer and the information provided to the players about on immersion was not significant: $F(2, 114) = .13$, $p = .879$, $\eta_p^2 = .002$. Similarly, there was no significant interaction effect of information and adaptation on immersion components.

8.3.2 *The Influence on Scores*

The influence of adaptation on scores

As it might be expected, the scores were higher and varied less in the group of players who had the timer adapting to their game play. The scores of players in the 'standard timer' condition, where 60 people were engaged in a gaming session for exactly 90 seconds, varied between 103 points and 490 points ($M_s = 345.57$, $SD = 13.37$). While players in the 'adaptive timer' group got between 169 and 647 points ($M_a = 406.18$, $SD = 90.78$). The difference between scores in these two groups of participants was highly significant: $F(1, 114) = 11.63$, $p = .001$, $\eta_p^2 = .090$.

The influence of information on scores

The information provided to the players also had an effect on players' scores. On average, players, who were not informed about the adaptive timer, scored $M_{none} = 335.63$ ($SD = 109.58$), while players with only partial knowledge about the timer scored $M_{part} = 407.85$ ($SD = 80.05$). Players, who were fully briefed about the adaptation, scored an average of $M_{full} = 384.15$ points ($SD = 101.57$). The difference between the scores obtained in all three groups of players was highly significant: $F(2, 114) = 5.66$, $p = .004$, $\eta_p^2 = .088$.

Interestingly, the pairwise Tukey test showed that the players who were not aware of the adaptive timer, regardless of its presence in the game, scored significantly less than the players who only received partial information ($p = .003$). However, the scores were not significantly different from those participants who received the full description of the adaptation ($p = .069$). Similarly, the scores of the players who were aware of the adaptation and the group given the full detail about its functionality did not differ significantly either ($p = .787$).

There was no significant interaction effect of adaptation and information about it on players' scores: $F(2, 114) = .05$, $p = .947$, $\eta_p^2 = .001$. The result was consistent with the outcome of a Mann-Whiney U test.

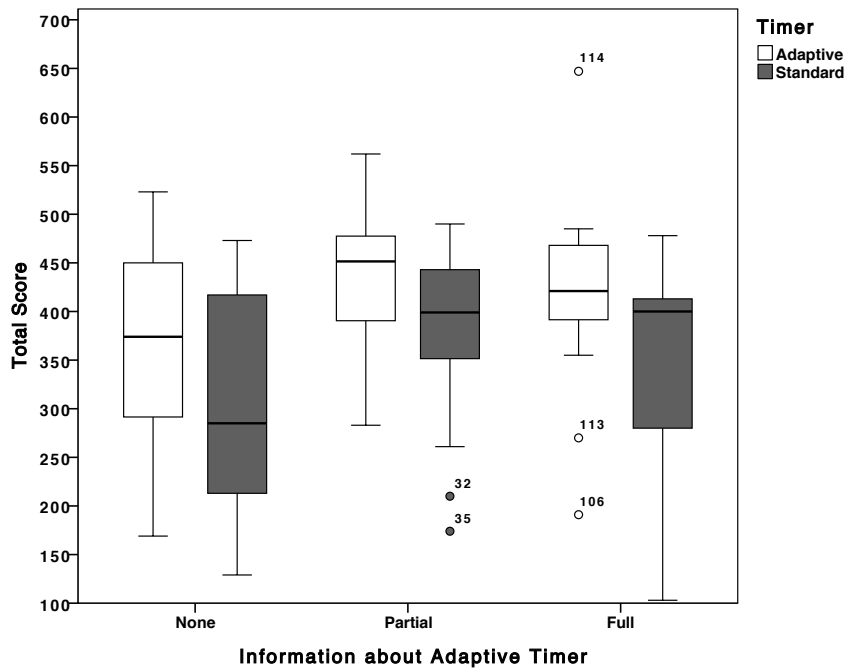


Figure 15: The influence of adaptation and information on in-game scores.

8.4 Mediating the Effect of Adaptation and Information on Immersion

To further probe into the potential relation between adaptation and information about it, game scores, and immersion, a mediation analysis was calculated. It was hypothesised that the achievement of the goal of 300 points can mediate the effect of adaptation on immersion, as well as the effect of the information players know about it on their immersive experiences.

To begin this analysis, a mediation analysis is defined and described in brief detail. The presence of adaptation is the predictor variable, defined as X , immersion of players is the dependent measure (Y), and the scores players obtain in the game is the mediator variable (M). Figure 16 shows the conceptual mediation model for this analysis.

The total effect of adaptation on immersion does not consider the scores. This relationship is shown as the path $(X) \rightarrow (Y)$ in Figure 16. The direct effect considers the role of adaptation when the mediator – players' scores, is included in the model (shown as the path $(X) \rightarrow (M) \rightarrow (Y)$). The indirect effect then shows how the relationship

between the presence of adaptation and immersion operates through a reduction or an increase in the game scores. The significance of the indirect effect can be assessed using analysis of the bootstrapped confidence intervals (CI)(Field, 2009; Hayes, 2013), generated using 5,000 samples. And the mediation is considered to be statistically significant when the bootstrapped confidence intervals do not contain zero (Field, 2009; Hayes, 2013).

The influence of adaptation on immersion via scores

It was hypothesised that the effect of adaptation on immersion could be mediated via players' scores. To check for this hypothesis, the following regression-based approach was used with the presence of adaptation as the predictor (X), the immersion levels of players as the dependent measure (Y), and the scores players achieved in the game as the mediator (M).

Initial simple linear regression revealed that the adaptation has a significant effect on players' immersion, $t(118) = 4.61, p < .001, R^2 = .15$, where the presence of the adaptive timer leads to a heightened sense of immersion in players. This effect was also shown in the ANOVA in section 8.3.1.

The indirect effect of adaptation presence on immersion of players was tested using simple linear regression. The presence of the adaptive timer resulted in higher overall scores in the game: $t(118) = 3.41, p < .001, R^2 = .09$. However, having higher scores in the game did not increase immersion of players: $t(117) = .79, p = .434, R^2 = .16$. The confidence interval was crossing zero $[-.4810, 1.9946]$, which indicated that there was no indirect effect of the adaptation on immersion via game scores, and the effect size of the indirect effect was large: $R^2 = .48$.

When indirect effect of the adaptive timer on immersion via scores was taken into account, the direct effect of the timer on immersion remained highly significant: $t(117) = 4.15, p < .001, R^2 = .16$.

Together, these results show that although the presence of adaptation had an effect on both the immersion levels of players and the scores they achieve in the game, this effect of adaptation on immersion is not mediated by the players' in-game achievements in the form of scores.

The influence of information on immersion via scores

Similarly, the information players knew about the adaptation in the game had an effect on immersion and game scores of players. Therefore, another hypothesis was that the effect of information about adaptation on immersion could be mediated via players' game scores. We used the same regression-based approach to test this hypothesis.

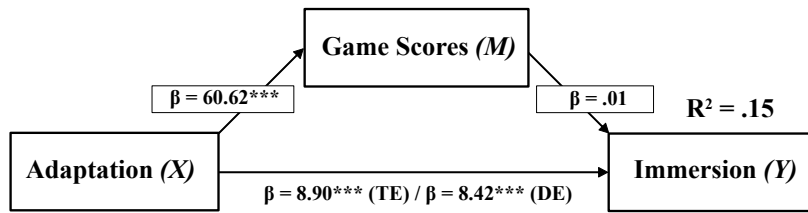


Figure 16: Diagram for the mediator model including the total effect (TE) and direct effect (DE) of adaptation on immersion and game scores; beta-coefficients for the effects of each path are included, $^{***}p < .001$, and the R^2 represents the fit for the whole model.

Initial simple linear regression demonstrated the significant effect of information about the adaptive timer on players' immersion, $t(118) = 2.85, p = .005, R^2 = .06$: more detailed information about the feature lead to a heightened sense of immersion in players.

The indirect effect of information on immersion was tested using simple linear regression. The different level of information given to the participants resulted in a change in the overall scores in the game: $t(118) = 2.17, p = .032, R^2 = .04$, although achieving higher scores in the game did not predict players' levels of immersion: $t(117) = 1.51, p = .134, R^2 = .08$. Bootstrap confidence intervals were calculated for the indirect effect of the adaptive timer on immersion via scores. The 95% confidence interval ranged from $[-.0190, 1.4566]$, which means that the indirect effect of information about adaptation on immersion via scores was not statistically significant.

The direct effect of the timer on immersion remained significant after taking into account the indirect effect of the information players received about the adaptation on immersion via their scores: $t(117) = 2.51, p = .013, R^2 = .08$.

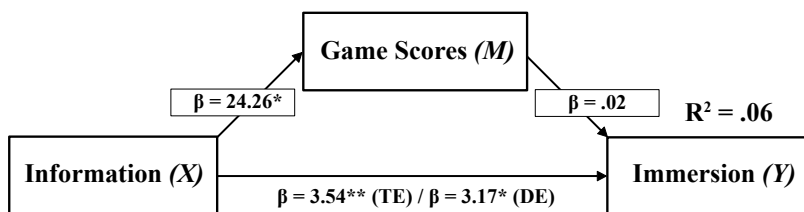


Figure 17: Diagram for the mediator model including the total effect (TE) and direct effect (DE) of information on immersion and game scores; beta-coefficients for the effects of each path are included, $^{**}p < .01$, $^*p < .05$, and the R^2 represents the fit for the whole model.

Overall then, immersion of players was influenced by the information they knew about the adaptive timer in the game, however, this effect does not seem to be mediated via their achievements in the game.

8.5 Scores and Play Duration

Overall, the number of players who had their time extended in the game and the amount of players with reduced time in the adaptive condition was roughly the same. Out of all 60 participants, who had their time altered throughout the gaming round, 35 players received extra time (playing for up to a maximum of 118 seconds) and 24 had their time reduced (having their overall game play time shortened down to a minimum of 78 seconds), while one participant played for 90 seconds in total because their time was equally increased and decreased during their game play.

8.5.1 *The Influence on Immersion*

The influence of play duration on immersion

There was a highly significant difference in the levels of immersion between the three groups of players, who played for exactly 90 seconds (standard timer), who played for a shorter period of time, and those players who got extra time (excluding the one exception in the 'adaptive timer' condition): $F(2, 117) = 10.14$, $p < .001$, $\eta_p^2 = .149$ (Figure 18).

Generally, players in the 'adaptive timer' condition experienced more immersion, though there was no significant difference between players who got extra time and players who had their time reduced, as determined using Tukey pairwise comparison test: $p = .986$. The immersion scores of players with the standard timer were significantly different from those with additional gaming time: $p < .001$, and those with time reduced: $p = .004$.

8.5.2 *The Influence on Scores*

The influence of play duration on scores

People, who played for more than 90 seconds, scored between 169 and 647 points ($M_{>90} = 383.31$, $SD = 108.04$). While participants who played for a shorter period of time had a much narrower variation in their results – they achieved between 320 and 486 points ($M_{<90} = 436.29$, $SD = 43.32$). There was also only one participant in the 'adaptive timer' group, who had their time reduced and then increased to

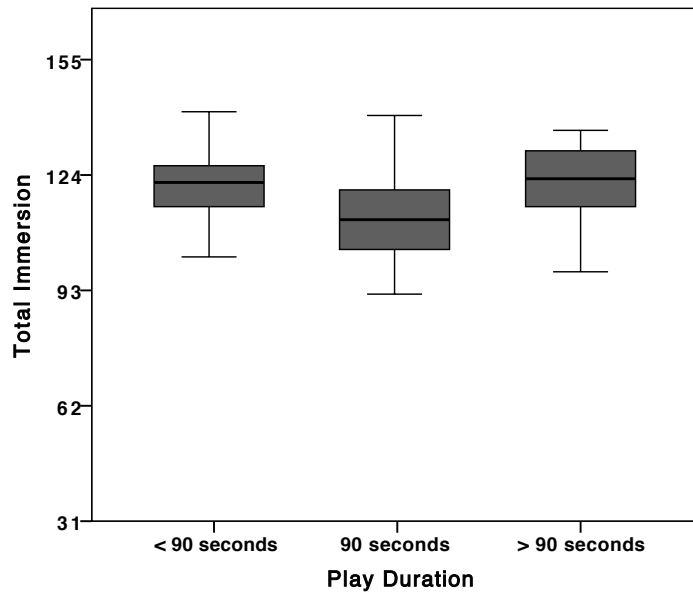


Figure 18: The influence of play duration on immersion.

bring it back to 90 seconds. During this time the participant achieved 484 points. While players who did not have their timer altered scored $M_{90} = 345.57$, $SD = 103.55$ (Figure 19).

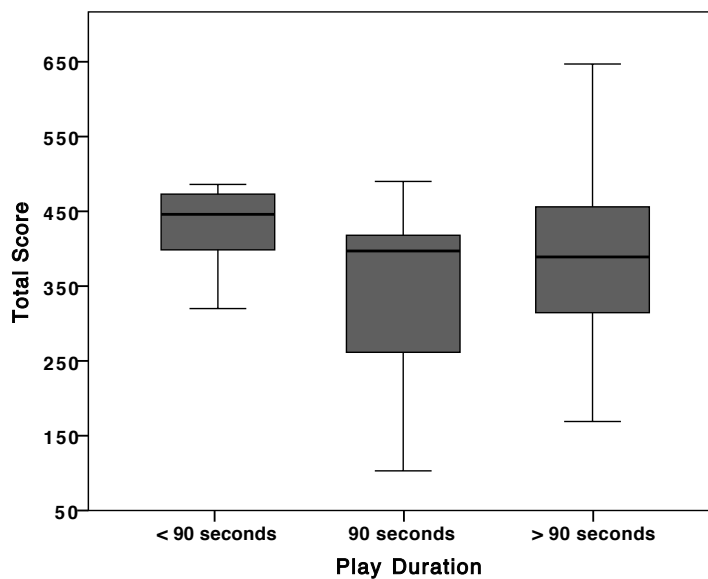


Figure 19: The influence of play duration on the game scores.

The difference between the scores achieved by the the groups of participants, excluding the one participant without change in their play duration, was highly significant: $F(2, 117) = 7.82$, $p = .001$, $\eta_p^2 = .119$. The scores obtained by the players with additional time were not significantly different from the scores of players, who had less time: $p = .239$. Moreover, having decreased time caused the scores differ significantly from those obtained by the group of players with a standard timer: $p = .001$, but having additional time did not: $p = .405$.

8.6 Perceived Expertise

Players' levels of expertise were used to determine whether any additional factors outside the controlled manipulations were affecting their immersion. This information was then used to explore the relationship between the time participants spent playing the game, their scores and immersion during their game play, as well as the effect of adaptation and information about it on these variables.

The players rated their expertise with this particular game after the practice session on a scale from 1 to 5, based on how competent they felt using the controls and their understanding of the gameplay, where 1 being 'Novice' and 5 - 'Expert'. Eight participants rated themselves as 1, 26 people put down 2 as their level of expertise, 38 people chose 3, 34 people listed 4s as their expertise level, and 14 players rated themselves as 'experts' - 5 (Figure 20).

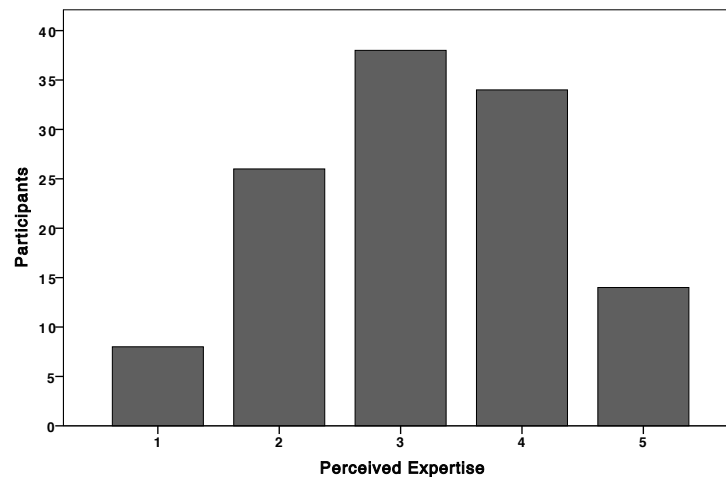


Figure 20: Perceived expertise of the players of the 'Nightmares' game.

8.6.1 The Influence on Immersion

Players' perceived levels of expertise had a highly significant effect on their immersion level: $F(4, 115) = 5.66$, $p < .001$, $\eta_p^2 = .165$. Generally, players who estimated themselves as more proficient at playing the game, were more immersed than those players who thought they were not as good at shooting zombie toys. Tukey test showed the only significant differences between the pairs of groups with ratings '2' and '3' ($p = .007$), '2' and '4' ($p = .001$), and '2' and '5' ($p = .002$).

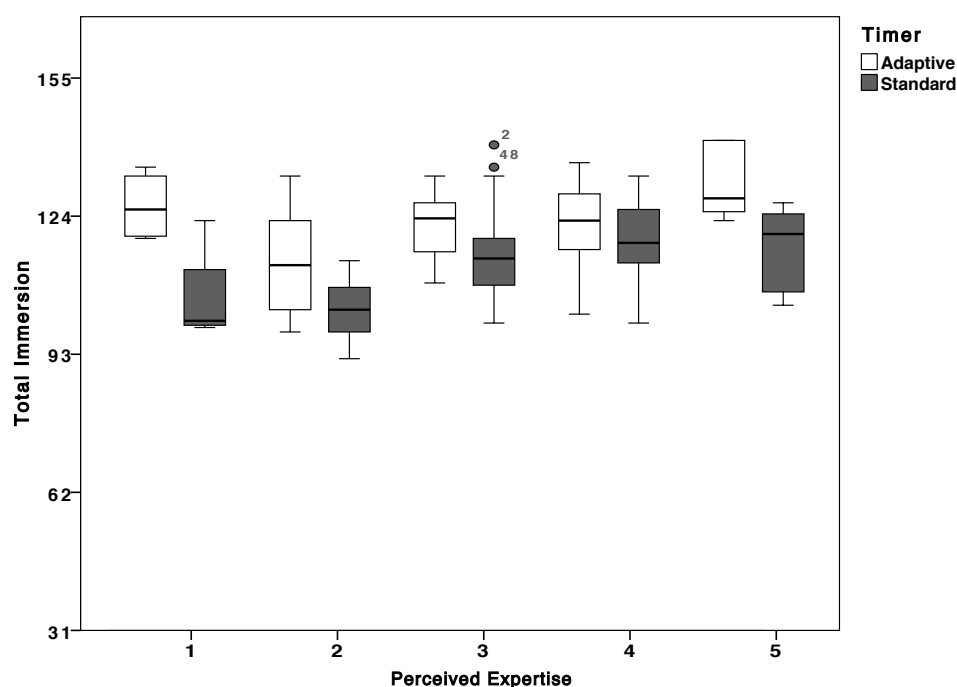


Figure 21: Immersion based on players' perceived level of expertise and the presence of adaptation.

There was no significant interaction effect between perceived level of expertise and adaptation on players' immersion: $F(4, 110) = 1.76$, $p = .143$, $\eta_p^2 = .060$. Similarly, there was no significant interaction effect between perceived expertise and the information about adaptive timer on immersion: $F(7, 106) = 1.38$, $p = .223$, $\eta_p^2 = .083$.

Four out of five immersion components differed significantly between the five groups of players: cognitive involvement – $F(4, 115) = 4.60$, $p = .002$, $\eta_p^2 = .138$; emotional involvement – $F(4, 115) = 2.99$, $p =$

The influence on immersion components

Components	Perceived Expertise of Players					F _{4,115}	p	η _p ²
	1	2	3	4	5			
Total Immersion	116.00 (14.29)	109.15 (11.24)	118.55 (9.82)	120.44 (9.91)	122.86 (11.21)	5.66	.000***	.165
Cognitive Involvement	35.13 (5.44)	35.23 (4.15)	37.95 (3.30)	38.09 (3.72)	39.79 (3.87)	4.60	.002**	.138
Emotional Involvement	21.00 (3.85)	18.81 (4.55)	20.34 (3.57)	21.82 (4.39)	22.71 (3.69)	2.99	.022*	.094
Real World Dissociation	26.87 (5.11)	22.88 (4.25)	25.76 (3.63)	26.29 (2.81)	26.14 (4.67)	3.83	.006**	.118
Challenge	15.50 (3.16)	14.54 (2.16)	14.55 (2.45)	13.97 (2.08)	13.57 (1.95)	1.27	.288	.042
Control	17.50 (3.42)	17.69 (2.36)	19.95 (2.35)	20.26 (2.04)	20.64 (2.06)	7.57	.000***	.208

Table 19: Mean (SD), and the effect of players' perceived level of expertise in the game on immersion and its components. *p < 0.05, **p < 0.01, ***p < 0.001

.022, η_p² = .094; real world dissociation – F(4, 115) = 3.83, p = .006, η_p² = .118 and control – F(4, 115) = 7.57, p < .001, η_p² = .208 (Table 19).

Generally, players' perception of challenge in the game was inversely proportionate to their perceived level of expertise – player with 'novice' ratings felt more challenged by the game than the 'expert' players. However, the difference between the challenge scores was not significant: F(4, 115) = 1.27, p = .288, η_p² = .042.

8.6.1.1 The Influence on Play Duration

The influence of perceived expertise on play duration

Participants with lower perceived expertise, i.e. those ones who rated themselves as "1" or "2", received additional time in most cases, as one would expect, which added up to the following average times for these players: M₁ = 105.00, SD = 6.00 and M₂ = 99.54, SD = 8.57 respectively. Players with medium confidence in their skills played on average for: M₃ = 94.67, SD = 11.00.

Overall, "expert" players, i.e. those who put down "4" or "5" on the expertise scale, had their time mostly reduced, which meant an average time for players with a rating of "4" was M₄ = 89.58, SD = 10.40. While players with a rating "5" had a little more time on average to achieve the goal: M₅ = 90.67, SD = 9.60 (Figure 22).

There was a significant difference between the duration of gaming sessions for players with varied levels of perceived expertise: F(4, 115) = 2.78, p = .030, η_p² = .088.

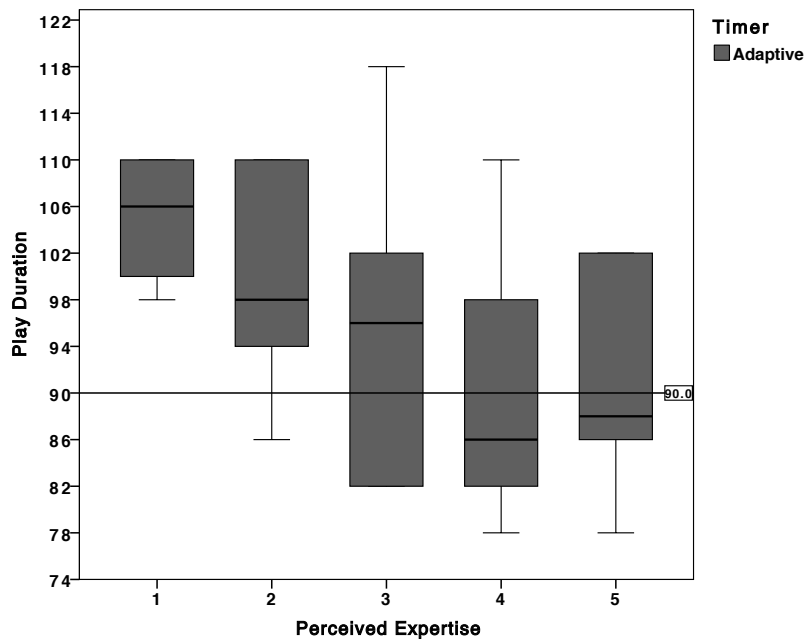


Figure 22: Play duration with adaptive and standard timers based on players' perceived levels of expertise.

8.6.2 The Influence on Scores

A similar pattern emerged in the scores of participants based on their perceived level of expertise. Players, who rated themselves as "1" on the scale from 1 to 5, scored between 174 and 462 points ($M_1 = 287.38$, $SD = 99.50$). Players with "2" as the rating of their expertise got between 129 and 500 points ($M_2 = 323.19$, $SD = 115.70$). The scores of players with medium expertise ("3") ranged from 103 to 487 points ($M_3 = 372.05$, $SD = 94.17$). Players who evaluated their expertise as "4" scored from 178 to 562 points ($M_4 = 419.91$, $SD = 68.96$). And finally, those participants with the highest perceived proficiency in this game scored between 261 and 647 points ($M_5 = 427.71$, $SD = 88.14$).

The influence of perceived expertise on scores

Based on players' perceived expertise, the scores obtained in these 5 groups differed significantly: $F(4, 115) = 6.94$, $p < .001$, $\eta_p^2 = .194$. This was also consistent with the results from a non-parametric Kruskal-Wallis H test.

A Tukey post-hoc test also showed that players with a rating "1" had significantly lower results than players with a rating of "4" ($p = .004$) and "5" ($p = .008$), but not "2" and "3". Similarly, participants who rated their expertise as a "2" got significantly lower scores than

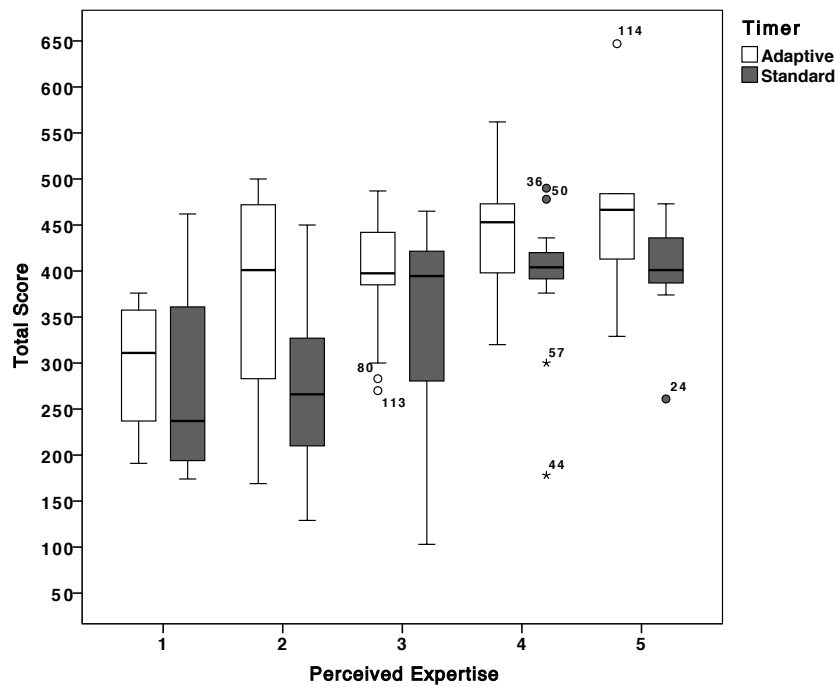


Figure 23: The game scores based on players' perceived level of expertise and the presence of adaptation.

players with ratings "4" ($p = .001$) and "5" ($p = .008$). However, the rest of the players obtained scores, which were not significantly different from the rest of the participants' results.

There was no significant interaction effect between perceived level of expertise and adaptation on the scores players obtained in the game: $F(4, 110) = .33, p = .857, \eta_p^2 = .012$. Similarly, there was no significant interaction effect between perceived expertise and the information about adaptive timer on immersion: $F(7, 106) = 1.30, p = .259, \eta_p^2 = .079$.

8.7 Achievement of the Goal

The influence of goal attainment on immersion

One's ability to achieve the goal affected their immersion significantly – 92 players who scored above the required 300 points in the game were significantly more immersed than those 28 players, who were not able to achieve the required goal within the time limit: $F(1, 119) = 8.59, p = .004, \eta_p^2 = .068$.

All but one immersion component (real world dissociation) differed significantly between players who achieved the required goal, and those players, who did not. Players who achieved the goal were more cognitively and emotionally involved with the game, felt more in control and as a result were less challenged than players who were not able to get above 300 points in the required time.

	Below 300	Above 300	$F_{1,119}$	p	η_p^2
Total Immersion	112.00 (11.10)	119.02 (11.10)	8.59	.004**	.068
Cognitive Involvement	35.00 (3.76)	38.16 (3.88)	14.49	.000***	.109
Emotional Involvement	19.18 (3.33)	21.23 (4.34)	5.28	.023*	.043
Real World Dissociation	24.68 (4.39)	25.63 (3.85)	1.23	.270	.010
Challenge	15.79 (1.95)	13.89 (2.22)	16.54	.000***	.123
Control	17.36 (2.64)	20.11 (2.17)	31.07	.000***	.208

Table 20: Mean (SD) of immersion and its components of players with regards to achieving the 300 points goal. *p < 0.05, **p < 0.01, ***p < 0.001

8.8 Qualitative Results

In addition to the quantitative data gathered using the IEQ, participants who were given partial and full information about the timer adjustment also answered a few questions at the end of the experiment. This was done in order to gather additional information in order to gain further insight into participants' perception of the adaptation, which was done in order to inform the interpretation of the quantitative results.

The data was processed using thematic analysis in order to find common themes, which are then discussed for each group of players based on the condition they played the game in. Overall, only a few participants noticed the change in the timer, while the majority said they were more focused on the score and killing zombie toys. As expected, players who were not aware of precise mechanics behind the changes had some different views on what the timer was supposed to be doing. While players given full details about the adaptation had to guess what exactly the timer was doing based on their own performance in the game.

Participants were asked the three following questions at the end of their gaming session:

1. How do you think the adaptation altered the timer during your game play?
2. How do you think this adaptation affected your performance in the game?
3. Do you think your experience of the game would be different if you didn't know about this adaptation?

8.8.1 *Question 1: Timer Adaptation Interpretation*

The aim of the first question was to get an insight into players' understanding of what the timer did. There was no significant difference between the numbers of players who noticed the timer between any of the groups. As seen in studies II and III (Chapter 6), players are rather susceptible to the information they are being told, which explains why players in the conditions with the standard timer were equally as likely to notice the time change as the players with an actual adaptation. Out of 60 participants playing the game with the standard timer, 10 (equally spread across partial and full info groups) claimed that they noticed the change, while only 6 out of the other 60 players in the 'adaptive timer' condition (only 2 in the 'full info' group) were personally convinced they noticed the timer changing the rate of counting.

Partial Standard

Despite the fact that players in this group were only told about the adaptive timer's presence, without any details about the precise mechanics behind it, a few of them tried explaining what the change might be based on their own observations. Interpretations included an assumption that time was taken off players when they were being hit by the toys, while some players also thought that killing more enemies and scoring higher points would give them additional time. Although players had a clear reasoning behind these assumptions, the adaptation was in fact doing the opposite. Players also described the adaptation based on their personal sense of time, rather than the 'actual' changes in the game. For them it seemed that the time was passing faster when they were engaged in a combat than when they were wandering around looking for some action.

Alternatively, some players' evaluations of the adaptation were more accurate, while in some cases such interpretation was perceived as

somewhat unfair. Considering that the timer did not change at all for these players, this interpretation of being disadvantaged clearly came from their own perception of the time. One of the players felt that being given less time to complete the goal was not fair, and attributed this to their poor performance. Though, there were also a few players who did not notice any changes in the timer, either because they assumed there were none or because they did not pay attention and were unable to make assumptions about the adaptation.

Players in this group were given a full description of the adaptation, so unlike in the partial condition, players were interpreting the 'changes' more accurately. Though still many of the players did not notice the changes in time because they paid more attention to the game events. *Full Standard*

Similarly to one of the interpretations in the *Partial Standard* group, some players felt that the time was passing at a faster rate for them, because they were making good progress or were performing well in general, despite the fact that the timer was counting down at a constant rate. In some cases, players felt that the time they ran out of time too quickly.

Players also confessed that they did not pay much attention to the timer throughout the game, and only looked at it towards the end of the game to make sure they re on target. Though some players did not pay much attention to the timer at all, despite being told about the changes, as they were so engrossed in the game play.

Just like the players in the *Partial Standard* timer group, participants in the adaptive condition made similar assumptions about what the changes in the timer were: better performance in the game lead to additional time, and the other way round if the character got hit by the enemies. *Partial Adaptive*

Again, some players assumed that the time was going down faster for them, even though many of them did not pay much attention to the timer itself, because they were concentrated more on the game. These players, who noticed the changes, were not incorrect when identifying that the faster rate of countdown. In fact, all of them played for less than 90 seconds. While players who had their time reduced did not notice much change in the time at all, even though they admitted checking the timer.

Full Adaptive Participants provided with the full explanation of the adaptation, who played with the adaptive timer, perhaps unsurprisingly, were better at identifying changes than the other groups. However, even in this group some participants did not notice the change, as they did not pay attention to the timer.

Some players used their personal evaluation of their performance in the game to identify how the timer could be changing. For example, players believed they were doing particularly well in the game, so the timer counted down at a faster rate for them. Out of the 7 participants who commented that their time was reduced, one had their time extended, one played for exactly 90 seconds, and the other five indeed identified the reduction in the time correctly.

One of the participants noticed that the timer slowed down for them – this player spent 106 seconds defending their character from zombie toys. While there was also one player, who said that the game session was too long, despite having their time reduced by 4 seconds.

Just like in the other groups, players who did not notice the timer changes, as they concentrated more on the game play and did not feel the need to pay attention to the timer.

8.8.2 Question 2: Influence on Performance

With regards to the performance of players being affected by the timer, many players felt that their performance was something that was more dependent on them rather than on the timer.

Partial Standard Most players felt that their performance in the game was not affected by the adaptation because they did not notice it. However, there were players who pointed out that they noticed changes in their strategies and behaviours as players according to their own interpretation of the adaptation. Players felt more in suspense and put more effort into looking for enemies than they normally would while being unaware of the adaptation.

Full Standard Unlike in the partial condition, being given more detailed description of the adaptation resulted in fewer people thinking that their performance was not affected at all, as more players thought it added more urgency and suspense to their game play, knowing that they are racing against time.

Some players also believed that the adaptation made the game more challenging, as they believed the time in the game was reduced, making it harder to achieve the goal. However, some players still did not

think that their behaviour in the game changed due to the 'adaptation', mainly because these players did not pay attention to the timer, and concentrated more on doing well in the game.

In this group, only one player answered that they did not notice any changes in the timer. While two players assumed that, according to their interpretation of the adaptation, their performance had been worsened due to the increased challenge. *Partial Adaptive*

Though, overall, players in this group found that the adaptation, as they interpreted it, was improving their performance in the game. These players thought that they got additional time, and therefore they could feel calmer knowing that they are capable of reaching the goal within the time limit. Some of them also thought that increased suspense made their game play more intense, which also led to a better performance.

Generally, players, who were given the full details about the possible changes in the timer, felt that the adaptation worked to their advantage, whether it was increased motivation to do better under time pressure or because players felt more relaxed knowing that the timer would help them to achieve the goal on time. *Full Adaptive*

Again, there was more suspense and urgency in participants' game play, making them move around more actively and try harder to score more points. Some players even tried to incorporate the timer into their game play, and changing their strategies accordingly. Some players tried to find the most optimal position to shoot the enemies from, or waiting for many of them to spawn at the same time and shoot them in groups.

As before, there were players who did not think that their performance was altered in any way, or were not so sure, as they did not pay attention.

8.8.3 *Question 3: Influence on Gaming Experience*

This question was aimed at collecting participants' opinions about how knowing about the adaptation could have affected their experience, and whether it would have been better to be unaware of this feature.

Generally, based on the players' own interpretation of the adaptation, some of them thought that if they were not aware of the adaptation their game play could have been less intense. Participants thought *Partial Standard*

they felt more focused and motivated to do well, because they were told about the adaptation.

There were also some players, who thought that knowing about the changes did not affect their experience of the game, mostly because they did not pay much attention to the timer. Moreover, players who were not paying attention to the timer attempted at guessing how the changes to the timer could affect their gaming experience. These players thought they would concentrate more, if they saw the countdown speeding up.

Full Standard The majority of the players did not think that their experience was in any way altered based on the knowledge about the timer. Many of them pointed out that the timer was only a secondary feature in the game, which players tend not to pay much attention to unless needed. Therefore, it is not surprising that not many players paid much attention to it while focusing more on the game itself.

Some players also found it difficult to make assumptions about how different their experience could have been, because they did not notice the timer at all. They mentioned that if the timer was flashing or changing in size, the changes would have been more obvious.

Additionally, a few players made an assumption that they would experience less pressure if they did not know about this feature. One participant did not see this feature as beneficial, and assumed that without this knowledge they would judge their performance in the game based on their skills, rather than it being “handicapped” by the adaptation.

Partial Adaptive Again, more players knowing full details about the adaptation thought that this information made them feel more in suspense, and if they did not know about it, their experience could have been somewhat different. Players’ predictions ranged from assumptions that they would feel calmer without knowing about it, to statements that the lack of this information would lead them to experience more stress.

However, some players were not convinced that their experience was in any way affected by the knowledge of the adaptation. Moreover, some of them stated that their experience came from playing the game, and was not affected by the length of time they spent playing it.

Full Adaptive Most players in the adaptive condition, who knew about the details about this adaptive timer, noticed that being told about the timer changed their strategy in a way, and their experience as a result of that. Players mentioned that knowing that the timer was linked to their

game play made them actively seek action rather than being more defensive, feel more nervous, but have a more enjoyable experience overall. Players also assumed they would be more frustrated if they did not know about the changes in the timer, particularly if they noticed it changing and would not know why.

Participants playing in this condition were also sceptical about the influence of the knowledge on their experience, because they felt that the timer was not their primary focus, and therefore it did not have an effect on their gaming experience.

8.9 Discussion

This chapter presents a study, which evaluated the effect of the presence of an adaptation in the game on immersion, based on players' awareness and understanding of the feature. Overall, the results support the hypothesis that the amount of information that the player knows about the adaptive technology in the game affects their immersion regardless of whether the game contains this feature or not. The results found in this study replicate the findings in Chapter 6, which demonstrated that those players who engaged with a game without an adaptive AI were more immersed when believing that the game is changing based on their performance than the players who were not aware of such 'adaptation' or when they believed it was not present.

Being aware of the adaptation leads to higher immersion

In Chapter 6, players were not provided the full detail about what adaptive AI did in order to avoid confirmation bias. However, it was evident that players who were unfamiliar with the concept were more likely to feel more immersed in the game than those players who were not lured into it by the novelty. Therefore, an assumption was made that if the players knew the full details about mechanics behind the adaptation, they might feel less immersed. This could be either due to the perceived fairness of the feature or simply because fuller understanding of the mechanics may decrease the novelty effect or pro-innovation bias. Similarly, players who are only aware of the presence of this potentially beneficial feature would have more room for interpretation, and would generally perceive it more positively due to this.

The data obtained in this study shows that this was not the case: players felt more immersed when knowing about what adaptive timer did than the other participants who were either unaware of this feature or were just simply told that the game had an adaptive timer without the explanation of what it did. Participants' comments collected at the

Immersion increases with more detailed information about the adaptation

More detailed information about the adaptation changes players' tactics in the game

end of the experiment allowed us to gain more insight into this: in some cases, players evidently used the information about the adaptation to their advantage, i.e. some of them tried to incorporate the feature into their gameplay by trying to extend the time and beat as many zombie toys as possible. This is also reflected in the scores of the players: participants who were aware of the timer adaptation scored significantly higher than the players who were not told about it. Similarly, although not many players did so, some of them kept the track of the timer by looking at it, which they would not necessarily do otherwise, according to their responses. It is possible that the increase in their cognitive involvement was due to their increased focus on the timer.

Alternatively, players who were only aware of the adaptive timer being present in the game without the detailed explanation of its functionality believed it was somewhat beneficial for their experience. However, due to the lack of knowledge about what the timer was doing, players concentrated more on the main gameplay rather than the timer. The realisation that it was continuously adjusting the challenge in the game was something that players were aware of, but did not actively think about during their game play.

The adaptive timer has a positive effect on immersion

An additional goal of the study was to explore the effect of the presence of the adaptive timer on immersion of players. The adaptive timer has already proved itself to be beneficial to player experience, as seen in Chapter 7, and the findings in this study also confirmed this hypothesis. Overall, players felt more immersed when the timer was changing its countdown rate based on their performance in the game regardless of whether the players knew about it or not.

Players perceived the adaptation as fair regardless of their performance in the game

These findings support the idea of adaptive features having a positive effect on gaming experience: the idea of having an adaptive timer was to match the challenge in the game to the players' skills. Therefore, the weaker players, who were somewhat disadvantaged in obtaining the required goal of 300 points, had more time to achieve this goal because of the presence of adaptation. Overall then, players who knew about this assistance perceived this feature as fair. While players who were more experienced had the ability to achieve the 300 points goal without the help from the game. With the implemented adaptation, players felt moderately challenged, however they were not able to score much higher than the weaker players. Interestingly though, contrary to the findings from (Cechanowicz et al., 2014; Gerling et al., 2014) the stronger players did not perceive this feature as limiting. This can be attributed to the fact that, although players were competing

against the clock, there were no other players that they could compare their performance against. Therefore, as seen in the comments of the participants, players felt they enjoyed themselves while playing the game – more time pressure did not have a negative effect on their experience of the game. The implementation of the adaptation was aimed to increase challenge, and not to deprive players from their abilities to obtain high scores. That explains why the stronger players did not feel disadvantaged in the game.

The implemented timer adaptation provided an effective balance between the in-game challenge and the skills of the players, which is supported by results of the challenge component of immersion. The perceived challenge did not differ significantly between players with different expertise levels, and the qualitative data collected at the end of the study also provides an additional support for the claim that players felt moderately challenged.

Interestingly though, in terms of perceived challenge, players did not differ significantly when playing with the adaptive timer or when having the standard countdown. This can be attributed to the fact that players did not pay direct attention to the timer, as it was not a part of the primary gameplay. Players mostly experienced the challenge in the game through the mechanics of shooting zombie toys and avoiding getting hit at the same time, while the time pressure could have indirectly affected their perception of challenge.

The presence of the adaptive timer did have an effect on the players' scores: those players who experienced the adaptation achieved scores, which were more tightly clustered around the goal, as one might expect. While the participants who experienced the game for exactly 90 seconds without any variation in countdown rate had much larger spread of their scores. The mediation analysis, however, demonstrated that despite the adaptation having an effect on the in-game scores and the immersion levels, the effect of the presence of the adaptive timer on immersion was not mediated by the scores players achieved in the game. This means that immersion in the game was not directly dependent on the in-game scores, although, interestingly, the players' achievement of the goal had a significant effect on their immersive experiences. This is an interesting discovery, while not entirely intuitive: the scores were largely perceived as arbitrary numbers by the players because they could not compare them to any other players' scores or to their own, which meant that the immersive experience was not affected by these numbers. However, being able to achieve the goal made players feel more immersed as a result of this achievement.

The adaptive timer balanced the challenge to players' skills effectively

Perceived challenge is not affected by the adaptation

The effect of adaptation on immersion was not moderated by the in-game scores

Achieving the goal increases immersion

The effect of adaptation on immersion was not moderated by the perceived expertise of players

There was a positive relationship between one's ability to achieve the goal and the amount of time they spent playing the game. In the standard condition, players with varied levels of expertise had the same amount of time to achieve the goal, which explains the large variation in the scores they obtained. While the adaptive timer provided weaker players with more time – this meant that weaker players could achieve higher scores than they typically would, while stronger players experienced more challenge in the form of time pressure while their ability to perform well in the game was unaffected. Nonetheless, the effect of adaptation on immersion was not moderated by the players' perceived level of expertise, as there was no interaction effect between the two independent variables on immersion scores.

Awareness of the adaptation increases immersion regardless of the presence of the feature

Interestingly, there was no interaction effect if the presence of adaptive timer and the information players knew about it on their immersion in the game. As the amount of detail players received about the adaptation increased, so did the the immersion level of players, however, this was not dependent on whether the game contained the adaptive timer or not. The presence of the adaptation affected immersion positively regardless of the information precision, and the effect of information was not linked to the effect of adaptation – players felt more immersed when knowing more precise information about the adaptation regardless of whether it was present in the game or not.

Additionally, the component analysis of immersive experience using the IEQ suggested that the presence of the adaptive timer had a somewhat different effect on immersion than the information players knew about it. Being aware of the adaptation had a significant effect on the cognitive involvement of players and their levels of dissociation from the real world, while having the adaptive timer affected almost immersion in a more broad sense – all components apart from the perceived level of challenge. Participants' comments suggest that the players who were aware of the adaptation, particularly the players in the 'full info' condition, changed their tactics according to this knowledge of the game timer adapting to their game play. This potentially increased the cognitive involvement of the players, leading to more focus on the game as opposed to the real world surroundings.

Limitations of the study

Overall, however, this study has several limitations. The adaptation used in this study was not a conventional method of balancing the difficulty in the game – changing the time players have in order to complete a goal based on their performance throughout the game is not entirely something many players would expect from the game with

regards to the adaptive gameplay. Usually, games adapt the number of enemies in the game, their strength and abilities, as well as the number and values of collectible objects, which means that the players' interaction with the game has a direct effect on the adaptation and can be more obvious to the naked eye. As the timer was only a part of the user interface, players were not focused on this feature as much as they were concentrated on the game mechanics of shooting and running. Additionally, as players could not directly affect the effect of the adaptation, many of them deliberately did not pay attention to the timer, as seen in their comments.

Moreover, as the gameplay was somewhat repetitive, it is possible that the players' generally positive perception of the adaptation could change with longer play, as the players' interest in the game would decrease with time. Therefore, longer gaming sessions should be used to evaluate whether the effect of players' perception of the adaptation is durable. Moreover, as players engage with the game for longer periods of time, the effect of information about the adaptation could weaken or become overwritten by the effect the game itself has on their gaming experiences.

8.10 Conclusions

The data collected in this study provides additional supporting evidence that players feel more immersed in a digital game when knowing that it contains adaptive technology. These findings are on a par with the results obtained in Chapter 6. Moreover, this study demonstrated that players feel more immersed in a game when knowing more detail about the adaptation, which, according to the participants' comments and the scores they obtained in the game, tends to affect the way they perceive the game and act inside it. Players who knew about the adaptation achieved higher scores in the game than the players in the standard condition, regardless of whether the adaptive timer was slowing down or speeding up the countdown for the players.

The results also suggest that this effect of players' knowledge about the adaptation is not dependent on the presence of it in the game – players feel more immersed knowing that the game contains this adaptive feature regardless of whether they have a chance to experience it or not. This effect, however, becomes more enhanced with the presence of the adaptive feature, in this case an adaptive timer.

The adaptation, implemented in this study, influences the amount of time players engage with the game for, which affects the scores players are able to achieve within the gaming session. However, the scores players achieved in the game do not mediate the effect of the presence of the adaptive timer on their immersion. i.e. stronger players who achieved higher scores did not feel less or more immersed in the game than the players with lower scores. Moreover, the effect of the adaptation on immersion was not moderated by players' perceived levels of gaming expertise.

The adaptive timer is, however, only one kind of adaptation, which is not a typical adaptation used in digital games. More often, digital games adapt the number and the quality of enemies based on players' performance. While the timer adaptation is a feature that many players did not pay much attention to due to it not being the main mechanic, based on their comments, the more commonly used techniques, such as enemy adaptation, could elicit a different effect. As players directly interact with the NPCs in the game, the adaptation might become more noticeable, which might impact their experience.

Another constraint of the experiment is the duration of the manipulation. Playing for 1.5 minutes might not be enough time for players to properly experience the adaptation. As players make progress in the game, their attitude toward the adaptation might change – the initial boost they experience from knowing that that game has adaptive technology might wear off, and the effect of the actual adaptation would take over their experience. Moreover, as they play for longer, this kind of assistance might become more useful longer term with difficulty of the game rising with players' progress.

Therefore, the effect of players' perception of adaptive technologies in games on their immersion should be explored in more detail using a different game with a different, more conventional, kind of adaptation, which players can engage for longer periods of time, while still remaining within the time period of casual engagement.

Study VII: Durability of the Effect of Adaptation on Immersion

9

THIS chapter presents a study, which was aimed at examining how durable the effect of the awareness of adaptive features in the game on immersion is. For this, a different style of difficulty adaptation was implemented in a casual game designed and developed for this study. This was done to explore the effect of players' expectations of adaptive features on immersion for a different kind of adaptation, while at the same time exploring how durable this effect is.

9.1 Introduction

Previous studies demonstrated the positive effect of neutrally phrased information about the presence of an adaptive game feature in immersion. However, little is yet known about how this effect changes with time. It is hypothesised that while the information can provide an initial boost to enjoyment and have a positive effect on immersion, its effect might fade away as players make progress in the game and concentrate more on the game mechanics, rather than the information they receive before playing it.

In the previous study (Chapter 8), we explored the effect of players' perceptions of the adaptive timer on their immersive experiences. However, as mentioned previously, such kind of adaptation is not entirely conventional, as typically digital games with DDA alter the behaviours and parameters of NPCs, game environment, and the main character's characteristics. Therefore, more research is needed to explore how players' expectations of adaptive technology in digital games affect their perceptions and experiences when playing a game with a more conventional DDA.

Moreover, due to the limited progression in the gameplay of this game, the information about players' immersion was only collected after 1.5 minutes of game play. The amount of time players interacted with the game, however, was sufficient enough to observe the effect of

Durability of the effect of adaptation perception on immersion is not yet explored

information about the adaptation on immersion. On the other hand, the studies described in Chapter 6, the effect of deceptive expectations of adaptive AI was also observed even after longer gaming sessions of 20 minutes. However, durability of this effect is yet to be explored in more detail: we are interested in studying whether the effect of players' perception of adaptive features based on the information they know about it on immersion differs at various points in the game.

*Explore the effect
in a different
game with a
different
adaptation*

A typical casual game play on a PC lasts from between one minute and up to an hour, 31 minutes on average (The Nielsen Company, 2009). Based on this data and set up used in previous studies, it, therefore, was decided that the game required for this experiment should provide sustainable engagement for at least 20 minutes. Additionally, this was a suitable opportunity to explore the effect in a different game with a different kind of adaptation. Some of the most widely used adaptive technologies in games nowadays adjust parameters, such as the speed, power, and health of enemies, their number and frequency of spawning, and the power of the player (Adams, 2014). Hence, to follow the conventions of the existing difficulty balancing techniques, a level-based game was designed and developed, in which the difficulty of each level is adjusted based on the performance of the player in the previous levels.

9.2 Experimental Method

A $(2 \times 2) \times 2$ mixed-measures design study was conducted to test the durability of the effect of information about adaptive features in the game on player immersion. The experiment was designed around four conditions, addressing two independent variables: the presence of the implemented DDA (adaptive condition and standard condition), and the information players receive about the adaptation (some or no information about the concept of DDA).

The experience of feeling immersed in the game was assessed at two measurement points during each participant's gaming session using the IEQ. Additionally, players' performance in the game was recorded, including the number of completed levels within the time limit, and the number of deaths on each level. Moreover, discrete changes in difficulty between levels were also recorded for each player.

9.2.1 Participants

Overall, 60 students and members of staff at the University of York took part in the study (41 men and 19 women). The mean age of participants was 25.60 (SD = 6.61), ranging from 18 to 50 years.

On average, participants had played digital games for just over 15 years, generally between 3 and 35 years. Most people stated that they played games frequently: once or several times a week. Majority of participants played games more than 1 hour on average, regardless of their gaming frequency. Some of the most popular genres were strategy games, RPGs, shooters, and puzzle games.

9.2.2 *Materials*

A digital game chosen for this study was 'Trick or Treat' (Figure 24) – a halloween-themed game, developed using Unity game engine, version 5.2. In the game, a player controls a little girl, who needs to collect candy scattered around the game world and stolen by monsters in a time-contained environment. The game has five levels, where each level increases in difficulty based on the number of sweets required to collect, and the speed, health, and attack strength of monsters. To make the game more challenging, the character has a limited amount of health on each level – if she gets hit by the enemies, she loses some health. When her health reaches 0, she dies, triggering the restart of the same level. There are no items available at any point to restore the health, so the player has to keep the character alive in order to make progress.



Figure 24: Trick or Treat: a Halloween-themed shooting game.

The difficulty of the game increases with each level, which is dictated by the number of enemies, their health and attack strength. These parameters are fixed, however the enemies' radius of player detection,

player's health, and player's attack strength are varied based on the DDA implemented in this game. Unlike the adaptive timer used in Chapter 7 and Chapter 8, this more conventional kind of difficulty adjustment is often used in contemporary games. The number of sweets collected on each level is used to adapt the difficulty for the following level. For example, if the player collects most of the candy available on the level, the difficulty mode increases to 'hard', while collecting the minimum of candy needed to level up decreases the difficulty to 'easy'. Otherwise, the difficulty remains at a 'normal' level.

*Dynamic
difficulty
adjustment*

This kind of adaptivity is in line with the traditional ways of adapting difficulty in games, as the parameters of NPCs and the main character are being altered based on the performance of the player, as estimated at discrete points in the game, i.e. between levels. Similar kinds of DDA are commonly used in level-based games.

Game design

Some trade-offs were taken into account when designing the game. As the gameplay was required to be long enough for players to get engaged with the game, while at the same time being within the time scale of the casual engagement discussed earlier. Level-based design was chosen for several reasons. Firstly, progressing from a level to another provides players with a sense of moving forward. If a player fails to keep the character alive, not all progress is lost. This allows for the DDA to adjust difficulty at specific points in the game, which could not be necessarily possible if the game was open-world, in which the player continuously fights off the monsters and collects candy, like they did in the 'Nightmares' game. Moreover, having different levels allows to vary the content of the game, which should potentially keep players interested in exploring the game further for longer periods of time.

The reasons for choosing a game specifically designed and built for this experiment over a commercial one were as follows. Having a non-commercial digital game meant that players would not be familiar with it, and therefore all players would have the same initial response. Secondly, being able to modify the game provides a greater control over its static and varied parameters, which can be adjusted based on the difficulty of each level, as well as depending on the difficulty set by the DDA. And finally, having a level-based game means that players' engagement with the game could last longer due to its less repetitive nature. This meant that the length of the game could be controlled – the number of levels needed to engage players for at least 20 minutes was estimated from piloting the study. The keyboard controls were

also easy enough to learn regardless of participants' previous experiences of playing digital games.

The data about players' perceived level of immersion was collected using the IEQ. Participants also answered some questions about their experience of DDA at the end of the session, if they were in the condition in which information was presented to them about it at the beginning of the session.

9.2.3 Procedure

At the beginning of the experiment, participants were provided with a consent form outlining the aim of the experiment (Appendix a), followed by the statements about the confidentiality and security of information, anonymity, and voluntary participation in the study. They then signed the form if they agreed to participate and agreed to all the terms. They then filled in a demographics questionnaire about themselves and their gaming habits (Appendix d), which was then followed a more detailed description of the study procedure (Appendix n for participants in the 'Standard' condition or Appendix o for the 'Adaptive' condition).

		II: INFORMATION		
		None	Partial	Full
I: ADAPTATION	Standard AI	✓	✓	✗
	Adaptive AI	✓	✓	✗

Table 21: Experimental conditions used in study VII.

After that, participants played a short introductory tutorial to the game narrated by the main character, so that everyone could familiarise themselves with the controls. After that they proceeded on to the main part of the study, which consisted of two 10-minute gaming sessions. Participants were stopped by the experiment facilitator after 10 minutes to fill in a questionnaire about their experience of playing the game in that particular session. After filling in the first IEQ, players continued playing the game from the point where they paused the game at. Participants then filled in another IEQ after the second part of the game. Those players who were explicitly told about the adaptation at the start of the experiment filled in an additional questionnaire about their experience of the DDA. The experiment then was concluded with a full debriefing session.

9.3 Quantitative Results

Immersion during each 10-minute session

Overall, the difference between immersion scores collected after the first 10-minute session and after the second round lasting 10-minute was highly significant: $F(1,58) = 24.54, p < .001, \eta_p^2 = .305$ (Table 23). There was a significant effect of information about the DDA on immersion for both sessions: $F(1,56) = 9.46, p = .003, \eta_p^2 = .146$; and the presence of the DDA also had a significant effect on immersion: $F(1,56) = 10.66, p = .002, \eta_p^2 = .160$. However, the interaction effect of the DDA and the information about it on immersion was not significant: $F(1,56) = 1.81, p = .180, \eta_p^2 = .031$, as also observed in previous studies.

The interaction effect of the information players received about DDA in the game and the game play session was not significant: $F(1,58) = 1.69, p = .199, \eta_p^2 = .029$. Neither was the interaction effect of the adaptation and the game play duration: $F(1,58) = .96, p = .332, \eta_p^2 = .017$. The interaction effect of the two independent variables and the game play duration on immersion was not significant either: $F(1,56) = 1.08, p = .304, \eta_p^2 = .019$.

Immersion components

All but one immersion components (real world dissociation) differed significantly between the two gaming sessions. Cognitive involvement: $F(1,58) = 12.36, p = .001, \eta_p^2 = .173$, emotional involvement: $F(1,58) = 19.42, p < .001, \eta_p^2 = .257$, real world dissociation: $F(1,58) = 3.20, p = .079, \eta_p^2 = .054$, challenge: $F(1,58) = 14.58, p < .001, \eta_p^2 = .207$, control: $F(1,58) = 24.35, p < .001, \eta_p^2 = .303$.

Components	Effect of Information			Effect of Adaptation			Interaction Effect		
	F _{1,56}	p	η_p^2	F _{1,56}	p	η_p^2	F _{1,56}	p	η_p^2
Total Immersion	9.46	.003**	.145	10.66	.002**	.160	1.81	.184	.031
Cognitive Involvement	3.17	.008**	.054	6.67	.012*	.106	.01	.917	.000
Emotional Involvement	6.66	.012*	.106	8.44	.005**	.131	.81	.372	.014
Real World Dissociation	6.27	.015*	.101	5.68	.021*	.092	4.76	.033*	.078
Challenge	3.91	.053	.065	5.94	.018*	.096	3.91	.053	.065
Control	6.71	.012*	.107	2.79	.100	.047	.72	.400	.013

Table 22: Interaction and main effects of DDA and information about it on immersion. **p < 0.01, *p < 0.05

Overall, the component-wise analysis of immersion revealed similar findings to the ones observed in the previous studies: the information about the adaptive technology had a significant effect on the players' cognitive involvement with the game and their real world dissociation. However, there was also a significant difference in players' emotional

involvement with the game and their perceived sense of control in addition to the other two factors.

The implemented adaptation also affected the cognitive and emotional involvement of the players, and their perceived dissociation from the real world surroundings. Somewhat surprisingly though, the perception of challenge was significantly different between the groups of participants who played the game with the DDA and without it.

	SESSION I				SESSION II			
	No Information		Information		No Information		Information	
	Standard	Adaptive	Standard	Adaptive	Standard	Adaptive	Standard	Adaptive
Total Immersion	103.40 (12.88)	114.87 (10.19)	113.93 (11.29)	119.73 (8.61)	105.27 (17.62)	121.33 (10.58)	121.13 (14.74)	126.80 (10.72)
Cognitive Involvement	35.53 (4.29)	37.33 (3.35)	36.47 (4.55)	38.93 (2.28)	35.87 (5.88)	38.80 (3.12)	38.13 (4.56)	40.80 (2.48)
Emotional Involvement	15.73 (4.92)	19.60 (4.14)	19.27 (4.23)	21.87 (3.25)	16.60 (5.46)	21.33 (4.24)	20.93 (5.22)	22.87 (4.37)
Real World Dissociation	22.53 (3.31)	25.40 (3.04)	25.53 (3.07)	25.67 (4.65)	22.07 (4.18)	26.73 (2.89)	26.80 (4.00)	27.00 (4.09)
Challenge	12.53 (1.19)	14.53 (1.73)	14.13 (1.51)	14.60 (1.24)	13.93 (1.94)	15.13 (1.73)	15.20 (2.14)	15.07 (1.62)
Control	17.07 (2.94)	18.00 (2.70)	18.53 (3.00)	18.67 (2.64)	16.80 (3.30)	19.33 (2.82)	20.07 (2.74)	21.07 (2.52)

Table 23: Mean (SD) of immersion and its components based on the adaptation and the information players were given about it when playing for 10 and 20 minutes.

Considering the first 10-minute session, there was a significant difference in immersion scores of participants based on the presence of the adaptation: $F(1,59) = 9.49, p = .003, \eta_p^2 = .145$. The information about the adaptation also had a significant effect on immersion: $F(1,59) = 7.55, p = .008, \eta_p^2 = .119$. However, the interaction effect between the two independent variables on immersion was not significant: $F(1,56) = 1.02, p = .316, \eta_p^2 = .018$, which was on par with the results observed in Chapter 8.

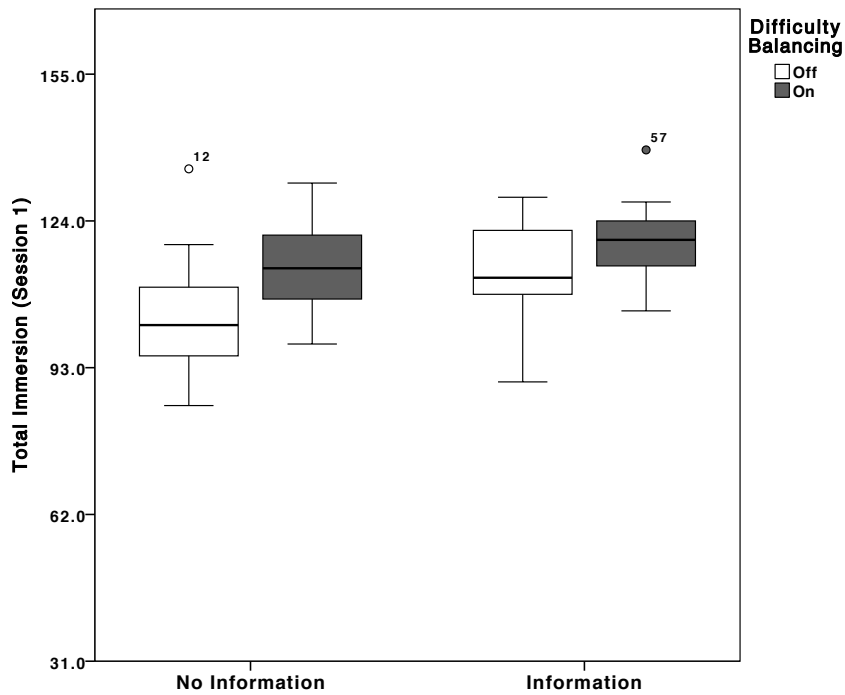


Figure 25: Immersion during the first 10-minute gaming session.

SESSION I	Effect of Information			Effect of Adaptation			Interaction Effect		
	$F_{1,59}$	p	η_p^2	$F_{1,59}$	p	η_p^2	$F_{1,56}$	p	η_p^2
Total Immersion	7.55	.008**	.119	9.49	.003**	.145	1.02	.316	.018
Cognitive Involvement	1.73	.193	.030	4.92	.031*	.081	.12	.730	.002
Emotional Involvement	7.23	.009**	.114	8.99	.004**	.138	.35	.559	.006
Real World Dissociation	3.12	.083	.053	2.63	.110	.045	2.18	.145	.038
Challenge	5.08	.028*	.083	11.13	.002**	.116	4.30	.043*	.071
Control	2.14	.149	.037	.54	.467	.009	.30	.585	.005

Table 24: First 10-minute session: The effects of information and adaptation on immersion.

**p < 0.01, *p < 0.05

Immersion in the second gaming session

During the second 10-minute session, participants also felt significantly more immersed in the game when playing with adaptation than those players, who had a standard difficulty increase: $F(1, 59) = 9.39, p = .003, \eta_p^2 = .144$. The information about the adaptation also had a significant effect on immersion: $F(1, 59) = 9.05, p = .004, \eta_p^2 = .139$. However, the interaction effect on immersion was not significant: $F(1, 56) = 2.05, p = .148, \eta_p^2 = .037$.

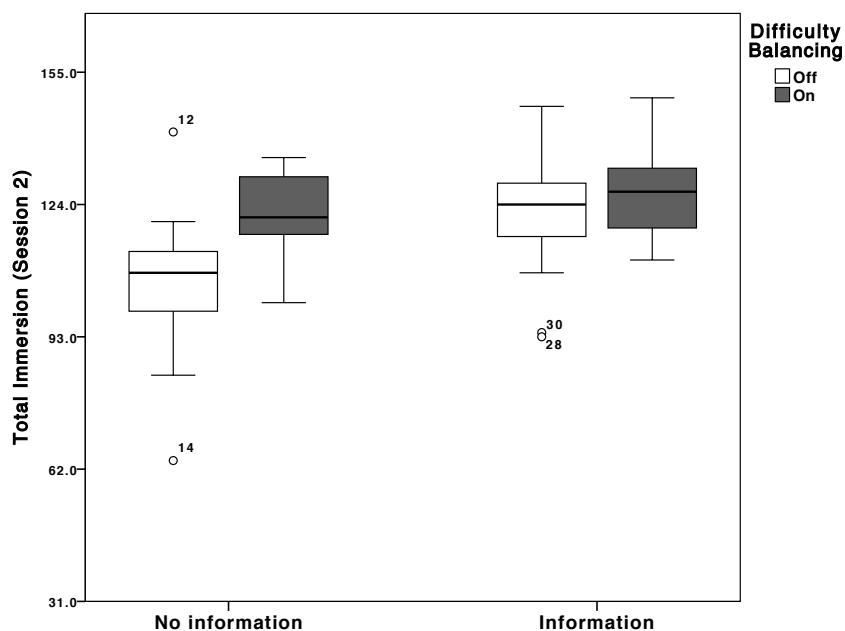


Figure 26: Immersion during the second 10-minute gaming session.

SESSION II	Effect of Information			Effect of Adaptation			Interaction Effect		
	$F_{1,59}$	p	η_p^2	$F_{1,59}$	p	η_p^2	$F_{1,56}$	p	η_p^2
Total Immersion	9.05	.004**	.139	9.39	.003**	.144	2.05	.148	.037
Cognitive Involvement	3.83	.055	.064	6.60	.013*	.105	.02	.903	.000
Emotional Involvement	5.49	.023**	.089	7.08	.010**	.112	1.25	.268	.022
Real World Dissociation	6.40	.014**	.103	6.06	.017*	.098	5.11	.028*	.084
Challenge	1.54	.219	.027	1.22	.274	.021	1.91	.173	.033
Control	11.47	.001**	.170	5.73	.020*	.093	1.08	.303	.019

Table 25: Second 10-minute session: The effects of information and adaptation on immersion.
 ** $p < 0.01, *p < 0.05$

Familiarity with the concept of DDA did not have a significant effect on the difference in immersion between the two gaming sessions: $F(1, 28) = 2.89, p = .100, \eta_p^2 = .093$.

Performance in the Game

Overall, the number of levels players fully completed within the required time ranged between two and five, out of the five levels in the game. Majority of players (33) completed all 5 levels, while only one participant was unable to make further progress after completing level 2. 17 participants completed 4 levels, and only 9 participants made no further progress after completing 3 levels in the game.

The number of levels players completed within the 20-minutes limit did not have a significant effect on immersion during the two gaming sessions: $F(3, 56) = .82, p = .489, \eta_p^2 = .042$. Immersion during the second gaming session was likely to be affected by the number of levels completed in the game, however the difference was not significant: $F(3, 56) = .66, p = .583, \eta_p^2 = .034$. Similarly, players who completed the game and those who did not finish the game within the time limit did not have a significant effect on immersion difference between the two gaming sessions: $F(1, 58) = .18, p = .675, \eta_p^2 = .003$.

Number of game levels completed

The influence of level completion on immersion

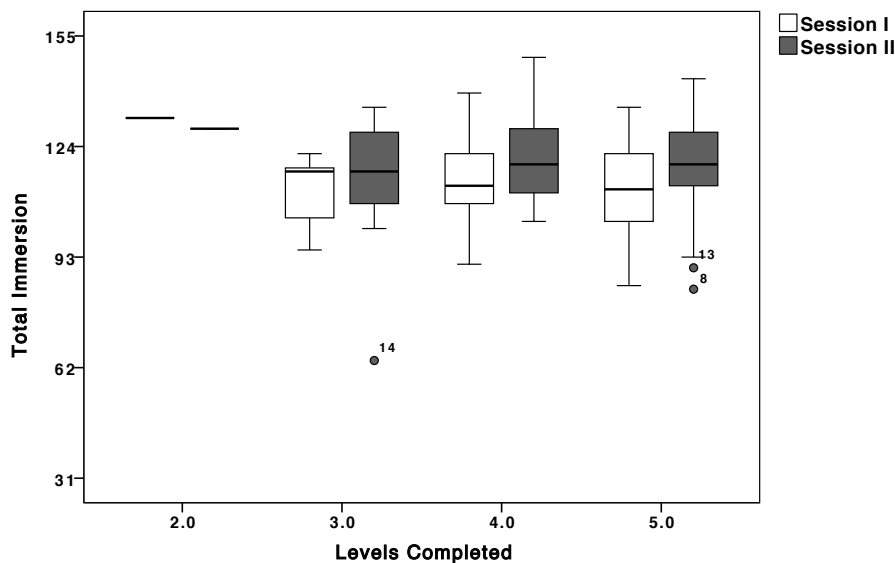


Figure 27: The influence of the number of levels completed in the game on immersion during the two gaming sessions.

*The influence of
in-game deaths
on immersion*

Not all players were able to keep the main character alive at all times: only 18 participants played the game without dying once, while the other 42 players had to restart the level during which the character lost its life. The largest number of deaths in the game was seven. However, the difference between immersion scores in the two gaming sessions was not significantly influenced by the death of the main character in the game: $F(1, 58) = .83, p = .368, \eta_p^2 = .014$.

*The influence of
DDA and
information on
level completion
and in-game
deaths*

There was no significant difference in the number of levels completed by players who had DDA and those who did not: $U(60) = 335, p = .059$. Similarly, the information about the DDA did not have a significant effect on the number of levels players completed: $U(60) = 435, p = .805$. The presence of the DDA did not have a significant effect on the number of the main character's deaths in the game: $U(60) = 369, p = .220$.

9.4 Qualitative Results

In addition to the quantitative data gathered using the IEQ, 30 participants who were informed about the presence of the DDA in the game also answered five questions at the end of the experiment. This was done to gather additional information in order to get a better insight into the participants' perception of the adaptation, which would help to interpret the quantitative results.

Overall, most participants noticed the changes in difficulty between levels. However, almost no participants noticed how the game adjusted the difficulty based on their performance, which meant that the DDA was integrated seamlessly into the gameplay. Players perceived such adaptation as fair, and their comments support the idea that this kind of DDA could work well in casual single-player games, where one's progress is important to their overall enjoyment.

Participants were asked the following questions at the end of their gaming session:

1. Did you notice the effect of dynamic difficulty balancing? If yes, what do you think changed in the game to balance the difficulty?
2. Do you think the dynamic difficulty balancing made the gameplay easier or harder? Why do you think so?
3. In your opinion, did the difficulty in the game match your skill level? Why do you think so?

4. In your opinion, is such dynamic difficulty balancing fair? Why?
5. Do you think your experience would have been different if you were not told in the beginning about the dynamic difficulty balancing?

Participants' individual responses are available on the University's PURE system.

9.4.1 *Question 1: Changes in the Game due to DDA*

The first question was aimed at gathering some information about whether participants noticed the adaptation happening in the game. However, many players interpreted this question more in terms of the overall changes in difficulty throughout the game, than with regards to the game balancing the difficulty. Amongst the things that changed in the game between levels were correctly identified by the participants: the strength of monsters, their types, behaviours, HP, and the number of enemies. These answers imply that although players experienced the rise in difficulty between different levels, the DDA integrated more seamlessly to their experience, as its purpose was to match the skills of players by offering them appropriate challenge in the game. *Standard*

Three participants admitted they did not notice the effects of the DDA. This could be partially attributed to the fact that two of them died 5 and 6 times in the game, and, therefore, were able to notice that the game was not matching the difficulty to their skills, as it remained the same. Interestingly though, their self-reported immersion levels were not influenced by this.

Participants, who experienced the DDA in the game noticed the changes more than the players in the Standard condition – only one participant said that they did not notice the adaptation. Overall, the answers were on par with the ones collected in the Standard group: participants noticed the increase in difficulty between levels in terms of the enemies' strength, behaviours, and health. However, they did not notice how the DDA matched their skill level. Only one participant said that they experienced the adaptation: (P₃) "I died in the fifth level and when I played the second time it seemed more manageable." *Adaptive*

9.4.2 *Question 2: Difficulty in the Game Based on the DDA*

Standard Overall, participants stated that the game difficulty increased with each level, as many of them only noticed the static changes in the game difficulty, not the one occurring as a result of adaptation. However, three players said that the game became harder as they were more successful and improved their skills in the game, implying that they felt the effect of the adaptation in the game.

Two players stated that they did not experience any changes to the challenge the game offered them, as the game felt well balanced and was “more enjoyable and less boring”.

Adaptive Players, who experienced the DDA in the game also believed that, overall, the game was harder for them. However, unlike the Standard group, four participants the Adaptive group stated that the DDA made the game play easier for them, and more enjoyable.

One participants stated that the DDA “made the game exactly the right level at a hand: it wasn’t easy but it was still possible to beat”, which was precisely the aim of the feature. Though it is not surprising that players experienced the increase in difficulty even with the DDA present in the game – its aim was to help players in their journey to the final goal, and not over-balance the difficulty to be constant throughout the game. We expected players’ skills to develop as they play the game for longer period of time, and increase the difficulty accordingly. However, if the skills did not develop as quickly as players made progress to the next level, at this point the DDA was supposed to decrease the difficulty, or the other way round if players’ skills were beyond the game’s standard difficulty setting.

9.4.3 *Question 3: DDA Matching Skills of Players*

Standard Most players in the Standard group stated that they felt that the DDA matched their skills well in the game. They all agreed that although the game felt challenging in the later stages, it was still possible to make progress and it kept them interested. Only two participants responded that the DDA did not match their skills, one player said it was due to the fact that they were unable to pass beyond level 4, and the other one was more concerned with their ability to control the character in the game, than the actual difficulty.

Similarly, the Adaptive group experienced the DDA matching their skill levels. Most of the participants stated that their abilities were well matched by the challenge in the game, which made it “*very engaging*”. One participant believed that although the game matched their skills, it was not entirely consistent throughout the game, as the first two levels were easier than the rest, while the other two players thought that the game could have been harder, overall. *Adaptive*

9.4.4 *Question 4: Fairness of the DDA*

All players thought that such difficulty balancing would be fair and appropriate in a digital game, like this one. Several participants specified that this kind of adaptation would be more appropriate for single-player casual and “*story*” games more than it would be for multiplayer games. Participants explained their reasons in terms of the progress in the game – as in single-player games the goal is mainly to advance forward, getting stuck can be rather frustrating. Therefore, having such DDA would allow players with different level of skill enjoy the same game to the same extent as the others. *Standard*

Similarly, the Adaptive group thought that such DDA would be beneficial for players with different skill levels. With such assistance player can develop at their own pace without being stuck on the same level / point in the game for long periods of time. Some also believed that such adaptation should be subtle, otherwise it may hinder players’ experience because they might feel like they were being unnecessarily assisted. *Adaptive*

9.4.5 *Question 5: Awareness of DDA and Player Experience*

With regards to whether players would experience the game differently if they were not aware of the adaptation, there were mixed opinions amongst the participants. Majority of the Standard group believed that the lack of this knowledge would not have affected their game play or experience, as they would have still played it the way they did, and they would have expected the game to increase in difficulty and be fun regardless of what they had been told prior to the gaming session. *Standard*

Only three participants thought that the experience could have been different, as they would not actively look for changes and it would not have encouraged them to try better.

Adaptive

Participants playing the game with the DDA had different opinions about them being aware of the feature and this information affecting their game play and gaming experience. Almost a half of the players stated that there would be no difference, as they would have played the game in a similar manner, or possibly because they would have noticed the presence of the DDA themselves.

While the other participants believed that they would not have noticed the DDA without being explicitly told about it, and assume a linear increase in difficulty. Moreover, they would not have paid as much attention to the changes in the game if they were not told about the presence of DDA.

9.5 Discussion

The study was designed with an aim to explore the durability of the effect of the players' perceptions of the adaptation in a digital game based on the information they know about it on immersion. An additional goal also set up at the start of the experiment was to test the effect of a different type of adaptation and the information about it on players' perceptions of the feature in a different game.

It was hypothesised that the effect of information about adaptivity in the game might not be durable, i.e. knowing that the game contains a potentially beneficial feature might enhance the player's first impression, but as the player engages with the game for longer periods of time, they might forget about the presence of the feature and instead focus on the game mechanics. Alternatively, they might not perceive it as useful or fair, which could potentially decrease their sense of immersion.

Hence, the main hypothesis was that the effect of information about adaptation would fade away with time. This could potentially lead to a lower sense of immersion for those players who are deceptively told about playing with the DDA, as with time they could observe that the game's difficulty increase is static, and not based on their behaviour. However, regardless of the gaming session, the information about the adaptation increased players' immersion, which was on a par with the results shown in previous studies. Interestingly, this effect did not change with longer game play, i.e. after 20 minutes of playing. Despite the different nature of the adaptation in this game compared to the one used in Study VI, in which the difficulty was varied by changing the timer, the effect of information was still significant. In the previ-

*Being aware of
the presence of
the DDA
increases
immersion
regardless of the
gaming session*

ous studies the duration of play varied depending on the game: in the 'timer adaptation' study (Chapter 8) the players were playing for 1.5 minutes, while in the 'placebo' studies (Chapter 6) the duration of play was 20 minutes. In both cases, the effect of information about adaptation was significant, and as seen in Chapter 8, the full information about adaptation caused higher immersion amongst players than the partial one.

The results of this study were on a par with the ones obtained in the previous experiments, suggesting that the players' immersion increases when being aware of the adaptive feature. This effect was observed both after the first gaming session, and at the end of the experiment, despite the general increase in immersion as the players made progress in the game. These findings suggest that the effect of information about adaptation on immersion is durable, i.e. players felt consistently more immersed when being aware of the adaptation after playing the game for 10 and 20 minutes, regardless of whether the game contained the DDA or not.

The players who did not experience the DDA but were told that they played with the feature being present in the game felt more immersed, and generally had a more enjoyable experience than the players who were not aware of the existence of such feature. However, this is somewhat surprising, considering that in their qualitative responses some of them mentioned not noticing the changes to the game done by the adaptation. These results, therefore, provide an additional support to the argument that simple adaptations that are not obvious to the players have the potential to lead to a more positive gaming experience.

The fact that the effect of information is consistent for different adaptations, and is not dependent on the presence of adaptation, indicates that, although players may not actively think about the game changing its behaviour according to their actions, reading about its presence prior to the start of the game can provide players with initial boost in enjoyment and increase their immersion. As seen in this study, this boost appears to be consistent throughout the entire duration of play for the players who knew about the adaptation.

Interestingly, the perception of the adaptation implemented in this game was generally rather positive, even though the players were not told the precise details about its implementation. As the qualitative data suggest, the players believed that this adaptation would be beneficial to their game play due to the fact that it would allow them to experience the game and enjoy it regardless of their level of skill and expertise.

Immersion is higher in both sessions when players think it contains adaptation regardless of its presence in the game

Positive perception of the implemented DDA

Additionally, the findings in this study suggest that players' immersion in the game increases when playing with the implemented DDA. The nature of this adaptation was more fitting with the conventions of a typical game adaptation than the one implemented in the previous studies – changing the main character's health and their attack power, while varying the enemies' radius of player detection on each level, matched the skills of the players fairly closely, leading to a heightened sense of immersion. These results, therefore, provide an additional support for the claim that adaptive features in games lead to an improved immersive experiences of players.

Although participants were not aware of the precise details of the functionality used to adapt the gameplay, the qualitative data collected from participants suggests that players had a good understanding of the adaptation implemented. It was, however, not possible for the players whose character did not die at any point in the game to evaluate the difference in the difficulty. Nonetheless, the general perception was that players' performance in the game remained consistent as they made progress in the game, as seen in the responses of the participants to question 3 of the post-experimental questionnaire.

Some parts of the implemented DDA were more obvious to the players than others – the radius of detection for enemies, and difficulty of destroying them. However, the players did not notice the changes in the main character's health, as it always was deliberately displayed to them as a percentage of the total health. Player's health was crucial to their ability to make progress in this game, as players not only were required to collect a certain number of sweets to pass a level, but also to keep the character alive, while shooting enemies that had those sweets. A similar observation was made in 'Nightmares', where the information displayed to the players on the timer was taken for granted. Therefore, these features that players do not explicitly control can be used to adapt the difficulty in the game without disrupting the main gameplay.

'Nightmares', used for the previous experiments, is a quick engagement shooting game, which due to its rather repetitive nature was only played for 1.5 minutes in the context of the experiments. Therefore, there was no opportunity to test whether the positive effect of adaptive features changes with longer game play. As difficulty in the game increases with further levels, players with different experience and skill level may experience challenge in the game differently – some might get frustrated if the difficulty is too high, while others might get bored if the challenge is not matched with their skills (Csikszentmi-

halyi, 1991). Adaptive digital games have a potential to be played for longer, as players would get assistance when being stuck in the game, while making progress through levels in a much smoother fashion. The DDA implemented in this game improved immersion of players not only short-term, but the effect lasted until the end of the experiment. This is an interesting discovery, as it suggests that the adaptation used in this game was effective in balancing the challenge based on the performance of the players.

During the debriefing of participants, some of them questioned whether having the DDA would lead to different performance in the game by players in the standard condition and the players with this 'assistance'. This hypothesis that players in the adaptive condition would perform better in the game and, as a result, complete more levels and die less in the game than players without the DDA was put to the test, and demonstrated no significant difference between the results of the two groups of participants. In general, this kind of adaptation was perceived as fair, and many participants stated that having such 'assistance' could improve many single-player games, however they had their reservations about adaptive multiplayer games.

Overall, the players who were aware of the adaptation in the game and experienced it had the highest immersion level out of all participants. Surprisingly though, the players who were told about the game's DDA but did not experience it had a similar level of immersion in general to the players who experience the DDA while were not aware of it. A similar phenomenon was observed in the previous study (Chapter 8). Considering that there was no interaction effect between the two independent variables on immersion of the players, this suggests that the way the adaptation affects immersion might be potentially different from the effect of the information players know about this feature. This is supported by the analysis of the components of immersion: while overall the adaptation and the information about it both affect the cognitive and emotional involvement with the game, and their real world dissociation, the implemented DDA also changed the perceived challenge of players.

These results, however, do not suggest that, because players' immersion increases equally much when being aware of the presence of the DDA while playing without it and when playing with the DDA without being aware of it, digital games creators should not implement adaptive features in their games. Instead, the findings should be interpreted as a supporting evidence for the idea that the players' expectations, when met, can positively influence gaming experiences of

players. These expectations should be nurtured not only solely through the effective game mechanics, but also via a realistic and truthful explanation and advertisement of these features.

A prominent example of a digital game that did not meet players' expectations after setting them too high is *No Man's Sky*, as mentioned in Chapter 2. Poor match between players' expectations and the game delivery can deter players from further engagement, and in the world where the word spreads really fast, this mismatch can affect the potential future players too. Therefore, it is paramount to set the players' expectations of the game based on realistic descriptions of game capabilities and features, as the first impressions that players have of the game carry on with them for longer periods of play than just the first minute.

There were however, certain limitations to this study, as one might expect. Players engaged in game play for 20 minutes in total for this experiment, which is within the typical amount of time people casually engage in a gaming activity. However, to probe the durability of this effect in much more detail, more research needs to be done over longer periods of time and over multiple gaming sessions. It is possible that as players come back to play the game again the next day or a week after, the effect of their knowledge about the DDA might weaken.

9.6 Conclusions

The findings from this study and the results from the previous studies demonstrate the importance of first impressions based on the expectations of players of a supposedly beneficial feature in the game, such as the adaptive technology. The first several minutes of game play are crucial to the overall gaming experience, as at that point many players decide whether they want to continue playing the game. There are many ways in which players' impression of the game during the first encounter can be affected by factors outside the actual gameplay: reading reviews, watching trailers and playthroughs, recommendations from friends. However, to present moment it has not been shown whether the players' perception of the adaptive features changes their opinion about the game, their behaviour inside it, and their gaming experiences, as a result of these.

Overall, the studies in this thesis demonstrate that awareness of certain features in the game, particularly in the case of adaptive AI, can change players' behaviour, which could lead to a different perception

of the game, resulting in a higher level of immersion. This kind of information is beneficial to players of casual single-player games, in which players have a positive expectation of the feature and therefore feel that they enjoy the game more when playing with it. In some cases adaptivity does not have to be present to improve players' perception of the game, and it appears that players do not doubt neither the information they are provided with outside the game (as in the case of the description given to them before the experiment), nor the information the game displayed to them (like the timer or the health bar in this study).

Part V

CONCLUSIONS AND FUTURE WORK

Conclusions

10

THIS thesis explored the effect of players' expectations of adaptation in digital games on their immersion. The aim of this work was to provide further insight into the nature of immersion as player experience and its dependence on players' perception of digital games. This was done using quantitative methods in empirical studies of the effects of personal preferences (Chapter 5) and players' awareness and expectations of adaptive features in games (Chapter 6) on immersion. Players' expectations of adaptive technology in digital games influence on immersion was studied in greater detail using different levels of accuracy and precision of information players know about these features in a game with and without such functionality (Chapter 7 & Chapter 8). The durability of this effect was also studied to explore this effect at different points in a game (Chapter 9).

The research described in this thesis produced consistent results across the conducted experiments, which suggests that players' perceptions of digital games influence immersion based on the information players know about adaptive technologies in the game. These findings make theoretical contributions to the immersive experience research, as well as practical contributions, which act as a guide to game developers, testers, and researchers who wish to avoid bias when evaluating games.

10.1 Answering Research Questions

The main research question that guided the research in this thesis was *'Do players' perceptions of a digital game based on the the information they know about its adaptive features influence their immersion?'* Studies II, III & IV described in this thesis provide the initial contribution to the answer of this question.

Focusing on adaptive technologies in digital games, the insights from the initial experiments were then used to explore in more detail how different information about adaptation in digital games can influence immersion, and whether this effect can be deemed durable.

These experiments focused more on how players' expectations of digital games affect their gaming experiences, and provided the consolidation of a broad range of experiential evidence to support the claim that players' perceptions of adaptive technology based on the information they know about it affects immersion in various single-player games.

Do players' perceptions of a digital game based on the information they know about its adaptive features influence their immersion?

Main research question

Overall, the experimental evidence described in this thesis suggests that players' perceptions of digital games based on the information they know about its adaptive features does, in fact, influence their immersion. This effect was initially explored with regards to the players' preferences in a digital game that offers an adaptable selection system of visual perspectives (Chapter 5). Anecdotal evidence suggested that, depending on the point of view through which the player views and interacts with the game world, the challenge in the game can be perceived differently, which is also dependent on their expertise level of the player. However, the results of the study demonstrated that playing in the preferred perspective does not lead players to experience more immersion, instead it is dependent on the perspective alone.

Preferences, however, are a pseudo-independent variable that players form outside the controlled environment used in these empirical studies, and are, therefore, difficult to manipulate. Hence, the focus of this research was diverted to study a more controlled manipulation – players' expectations of adaptive technology based on the information they know about it before trying the game for the first time (Chapter 6). Players form their expectations during the experiment based on the information they are read about it prior to the experiment initiation. In order to gain initial insight into whether players' perceptions of such technology affect their gaming experiences, we conducted two studies. Participants played a commercial digital game that they were not familiar with, and their first impressions of the game were motivated with neutrally phrased information that suggested to the players that the game had adaptive functionality, while this was not true. Exploring this effect without the presence of adaptation was crucial to the understanding of this effect: players not only believed that the game adapted its behaviour based on their actions, but also were able to experience the hypothetical functionality during their game play. This, in turn, positively affected their immersive experiences. The ef-

fect was observed both when players compared two gaming sessions (repeated-measure design) and when engaging with the game only once (between-subject design).

The effect was further probed in the experiments described in Chapter 8 and Chapter 9, where the relationship between immersion and the players' perceptions of adaptivity was explored in a game with adaptive features. The findings were consistent with those described in Chapter 6: players generally perceive adaptations in single-player games as beneficial to their experience, which then leads to an improved enjoyment of the game and increased immersion. Being aware of the game having such feature has a positive effect on immersion regardless of whether the feature is present in the game or not, and the effect appears to be durable, i.e. players were convinced that the game effectively adjusted difficulty based on their performance even if this functionality is not present in the game, and even after longer play.

The research described in this thesis also provided further insights into the following questions, which were set as the research objectives at the start of the thesis.

How does player awareness of adaptive features in and knowledge about them in a digital game affect their immersion?

Players' perceptions of adaptive technologies in single-player digital games were generally positive. Many participants expressed their appreciation for the technology, as indicated in their opinions gathered using open-ended questions at the end of the studies. Participants also expressed that these features allow players to have fun and experience the game in the same way as other players regardless of their skills and abilities. Unlike multiplayer games, where the competition runs high, and such assistance is, therefore, often perceived as unfair, adapting difficulty in single-player games does not hinder players' experiences of the game. Instead, players are able to have a smoother progression through the game when the challenge is matched to their performance.

*Research
objective 1*

Therefore, being aware of such technology present in the game provides players with a more positive first impression and increases their confidence in being able to make progress in the game. While at the same time this knowledge did not hinder players' perceptions of personal achievement in the game. Instead, players reported higher enjoyment of the game when being aware of the adaptivity, and the quanti-

tative data collected using the IEQ also suggests that their immersion was significantly higher too.

Overall, players experienced more immersion when knowing that the adaptation was present in the game, which did not depend on whether the adaptive feature was present in the game or not. This is an interesting discovery, as it suggests that players are able to perceive the game adapting to their game play even if it is not the case.

Does the accuracy of information players know about adaptive features a digital game affect their immersion?

*Research
objective II*

Generally, the accuracy of the information available to the players about the presence of adaptive features in the game did not have an effect on their gaming experiences, i.e. players were convinced that the games they played contained an adaptive technology adjusting gameplay based on their behaviours and performance in the game. This result remained consistent across several experiments, which probed into this effect in different games with and without different adaptive features being present in the game. In all cases, the effect of players' awareness of this feature lead to an increased level of immersion and enjoyment.

Interestingly, players were also able to perceive the effects of the adaptation, without being explicitly told what the adaptation did or was supposed to do. Players provided rather accurate descriptions of the adaptations when playing with them or even when the game did not adapt its gameplay based on their performances.

Moreover, players incorporated their knowledge about the adaptive technologies into their gameplay. Even when being told that the game contains an adaptation while playing without it players changed their tactics to include the feature into their gameplay or to gain more benefits from having it. It is somewhat surprising, as most participants were only provided with a brief explanation of adaptive technologies in general to avoid confirmation bias. While players were able to use this knowledge to adjust their perceptions of the games and experience such adaptivity, even if it was not present there.

Does the precision of information players know about adaptive features a digital game affect their immersion?

*Research
objective III*

Previous studies demonstrated that awareness of adaptive features can hinder one's experience of the game (Bateman et al., 2011; Gerling

et al., 2014). However, awareness is not always perceived negatively. Chapter 6 demonstrated that even the generic and brief description of adaptivity is enough for players to form an opinion about how this feature changes their gameplay, and to perceive these changes even if they are not there. Players with different background knowledge about adaptive technologies, however, varied in their perceptions of the feature in the game: players who were experts in the field of artificial intelligence were more sceptical about ‘experiencing’ adaptation when it was not present in the game than the players who only learnt about the generic effects of adaptive features prior to the experiment. However, this was only observed when players compared two gaming sessions – familiarity with the concept of adaptivity did not affect immersion when playing the game only once.

As players gain more detailed knowledge about the adaptive features in the game, it is possible that they would form a different perception of them to those players who only base their views on their observations in the game. Knowing the precise mechanics could potentially be viewed as unfair or somewhat distracting. However, the data collected in the experiments suggest that this is not the case. Players who knew how the adaptation worked changed their tactics in the game and tried to incorporate the feature into their game play even more than those players who were merely aware of its presence. It appears that the players who were aware of the adaptation accepted the fact that it was there, but chose to focus more on the gameplay they had direct control of, while players who knew how the adaptive timer changed the countdown tried to incorporate the feature into their game play. Neither groups of participants perceived the feature as unfair.

How durable is the effect of information about adaptive features in a digital game on immersion?

Overall, the effect of players’ perceptions of adaptive technologies in digital games on immersion is durable. Several studies explored the effect using different games and different kinds of adaptations, with which players engaged for different amounts of time. The final study, described in Chapter 9, gathered additional evidence to explicitly explore how the effect potentially changes at different points in one’s game play. The findings suggest that in this game players’ immersion increased as they made progress in the game, and the effect of one’s awareness of the adaptation enhanced this experience. This effect was

*Research
objective IV*

observed both after 10 minutes of gameplay and at the end of the experiment (20 minutes in).

This is a somewhat surprising discovery, as we hypothesised that the effect would fade away with time. As players spend more time playing the game, they would eventually focus more on the game mechanics they directly interact with, and the information they had received prior to their first encounter with the game would become less prevalent. However, analysis of quantitative data demonstrates that players who are aware of the adaptation feel more immersed on average than the players who do not know about it, as seen in the results of studies described in Chapter 6, Chapter 8 & Chapter 9.

Additionally, the quantitative data gathered in these studies suggests that players retain this information after playing for short periods of time, as seen in Chapter 8, as well as longer periods of time, as seen in Chapter 6. In the former study, participants also actively thought about this feature as they attempted to influence its functionality and incorporate this feature into their game play.

10.2 Contributions and Implications

The work described in this thesis provides various insights into the relationship between players' immersion and their perceptions of adaptive technologies in digital games. A substantial body of evidence was gathered to support the claim that players' awareness and knowledge about adaptive features in single-player digital games have a positive effect on their immersive experiences. This evidence was gathered through a combination of quantitative and qualitative measures, and involved different kinds of manipulations in the form of adaptive features in different games and varied level of precision and accuracy of information players knew about these features.

Overall, players perceived the idea of having adaptive technologies in single-player digital games positively, which contributed to their increased enjoyment when playing a game with the feature (or even without it). Previously, the perception of fairness of adaptive features has been studied in multiplayer games, while this research provides additional contributions to the knowledge about players' perception of this technology in single-player games.

This positive perception was observed both in players who were knowledgeable in the field of artificial intelligence and adaptive technologies, and people who were not familiar with the term, as well as

both in experienced and novice players. However, participants who had previously experienced adaptive technologies were less likely to have an improved experience as a result of their awareness of this feature.

In addition to the evaluations of players' perceptions of adaptive features, this research also provides empirical evidence which supports the claim that adaptations in digital games, even the most simplistic, can enhance player experience in single-player games, as mentioned by (Hunicke, 2005). This effect appears to be durable and the adaptations implemented in the games were generally received positively by players with different expertise levels.

Moreover, the timer manipulation was a novel and experimental kind of adaptation. Nonetheless, the dynamic adjustment of the countdown in the game allowed players to feel equally challenged regardless of their skills, which also increased their immersion levels. The results discussed in the Chapter 7 and Chapter 9 suggest that adaptations that are not explicit, i.e. the modifications to the features that players do not directly interact with, such as the timer or the characters' health levels, can improve player experience while keeping the players moderately challenged.

Outside the scope of the main research question, this thesis provides a secondary contribution to the field of player experience research. Chapter 4 provides a comprehensive overview and comparison of three widely used questionnaires measuring player experience in digital games. The work described in this chapter demonstrates the similarities between the supposedly different concepts that the questionnaires measure, discusses the benefits and drawbacks of each of the scales, and provides an analysis of validity for each of the questionnaires. These findings could be of use to the researchers who are looking for the most suitable questionnaire for their research.

Another contribution that was outside of the scope of the research goals concerned the visual perspectives in digital games. The results suggest that players feel more immersed when they view the game world from the point of view of the character, rather than having the camera positioned behind it. This finding provides empirical evidence to the claims in the literature that suggest that first-person point of view is more immersive because the player feels closer to the game world and feels less dissociated from the character. Interestingly though, the results also indicate that the two perspectives offer a different level of challenge to the players: participants who prefer playing in first-person perspective found the third-person POV less challenging

than those players who typically engage with the game in first-person perspective but had to play in their least preferred POV. These results, however, need further investigation with regards to other kinds of games. Exploring how players with different levels of expertise perceive challenge in different perspectives can also provide further insight into the effect of game features on immersion and players' perceptions of challenge.

10.2.1 *Game User Research*

This work has various potential implications for a number of academic and industrial areas of research. In the field of games user research, these findings provide further insight into the theoretical understanding of immersion and contribute towards the development of an immersion model. According to the definition of immersion by Jennett et al. (2008), cognitive involvement is one of the five factors that contribute towards the feeling of immersion. Interestingly, cognitive involvement was consistently higher for those players who believed that they played games with adaptive technology, and it was the only factor that was consistently observed in studies III, VI, and VII to change, alongside immersion, as a result of the information manipulation. This could be due to the fact that what players know about a digital game feeds back to their cognition of the experience – players think about the gameplay more and possibly analyse their play according to this knowledge. This was observed in the qualitative responses gathered at the end of these sessions: players frequently mentioned how they tried to incorporate the adaptation into their game play, whether the adaptation was present in the game or not. Therefore, it is possible that players think about their actions in the game more actively when using this information during their game play.

Considering that cognitive involvement in this context means curiosity and interest, according to Jennett et al. (2008), it is evident that players who were told about the presence of adaptivity felt more involved with the game and, as a result, felt more engaged with it. As cognitive involvement is measured as a part of immersive experience using the IEQ, the difference in immersion scores was evidently related to the difference in the scores for this component. These findings contribute to our understanding of immersion and the factors it is dependent on: information about potentially beneficial features in the game leads to higher cognitive involvement of players as a result of their increased interest and curiosity.

Curiosity could, however, be invoked in different ways to the ones explored in this thesis. The information players were given about the adaptation in the game was neutrally and generically phrased. Depending on the phrasing of the information about the game and its features, certain other components of immersion could be studied as well, e.g., a more subjective description could be used to evaluate how players' emotional involvement with the game is affected. Perceived challenge can be studied using information of different precision that focuses more on the difficulty aspects of the game and the skills of the player. This, however, is outside the scope of this thesis, and more research is needed to explore these topics.

Previous research in this area has focused primarily on exploring the effects of game features on player experience, as discussed in Chapter 2. While the effects of players' expectations and perceptions of these technologies has not received as much attention, it evidently contributes to these experiences, as shown in this thesis. Studying the expectations and perceptions of players can help researchers form more advanced understanding of gaming experiences, which in turn can help design and develop games that can be enjoyed by players with diverse previous experiences and personal skills.

10.2.2 *Games Industry*

This work has several important implications not only for the digital game user researchers who wish conduct unbiased experiments with their players, but also for game developers and testers. First, any experimental investigation into the influence of new features in a game, such as adaptive technologies, on player experience must be made carefully, without any opportunity for players to second guess what the investigation is about. For example, a study in an artificial intelligence lab that uses an existing game may trigger the expectation of 'something good'. The mere expectation of a difference can be sufficient to change the experience. This becomes even more challenging in the context of play-testing where surely players called in for play-testing must be expecting something new even if it is not explicitly communicated what. As this thesis suggests, players are able to experience features in the game when told about their presence, even if the game does not provide this functionality.

Digital game testing

Secondly, given the prevalence of sequels in the game industry, we must take any claims for advances in the underlying technology with a pinch of salt. Players may have an improved experience over earlier

Game sequels

versions of the game simply because they expect it. Evaluating the real effects of new versions of a game will need to be considered cautiously if companies are not to end believing the claims of their own hype, mediated by their willing play-testers.

Apart from game testing and empirical studies, this work may have implications for design and marketing of digital games. The findings suggest that benevolent deception could be potentially used in digital games without hindering the experience of players or the reputation of the developers. Making players aware of the feature and carefully using deception to suggest to the players that the game contains adaptive technology should not affect their gaming experiences negatively, at least temporarily. Instead, this could boost their initial engagement and enjoyment of the game while allowing players to feel moderately challenged as a result of their belief. This can motivate players to overcome challenges without the help from the system and provide them with more confidence in doing so, knowing that if the adaptation can assist them in making further progress if the game becomes too challenging.

Similar systems are already being developed and studied for educational and training purposes (Göbel et al., 2010). Adaptability is used to personalise and tailor systems to the players based on their respective needs and performances. As seen in the studies described in this thesis, digital game players enjoy their play and feel more engaged with the game when they believe that their system is adjusting its parameters based on their performance.

Deceptive adjustment of features has been proposed as a design suggestion previously. Dijk, IJsselsteijn, and Westerink (2016) suggest that due to players' interpretation of their own performance and results, it is possible to use ambiguity to personalise visualisations of one's personal informatics data. Colusso, Hsieh, and Munson (2016) explored the concept of closeness to increase players' performance in a digital game by adjusting the visual representation of their performance in such a way that the player's scores appear closer to the comparison target. Similarly, Bowey, Birk, and Mandryk (2015) manipulated leaderboards in a game to induce the sense of failure or success in players. This kind of deception encourages competition, and as Bateman et al. (2011) and Klarkowski et al. (2016) demonstrated, players enjoy games more when the level of skills and challenge as perceived by the player is higher than the subjective difficulty offered by the game.

The effect of deception does depend on the context in which it is used. In design of persuasive systems deception has to be subtle – as

Adar, Tan, and Teevan (2013) point out, benevolent deception could enhance one's experience as long as the user is not aware of such functionality. This could be applied to designing serious games for behaviour change and educational purposes, where players' skills and behaviour could only be manipulated using deceptive functionality if it is hidden from the user. On the other hand, the work described in this thesis demonstrates the opposite effect – explicit information about adaptive features does have a positive effect on players.

The boundary between an ethical use of deception in design and marketing and unethical and illegal use is, however, rather blurred. While designing a system that encourages players to perform better in a digital game is within the acceptable ethical norms, deceiving players into purchasing a digital game by claiming that the game has features it does not come with would be malicious and would certainly damage the reputation of the game and the developer. The work described in this thesis was aimed at exploring the effects of benevolent deception on player experience, with the intention not to encourage false advertisement. Instead, the goal was to explore whether subtle information about certain features would increase immersion and improve overall enjoyment. Incorporating benevolent deception in designs of serious games could have a great potential. However, with regards to marketing of digital games, this kind of deception could be rather questionable.

*Deception for
marketing*

10.2.3 *Placebo Effect of Technology*

Outside the scope of games user research, this research provides useful insights into the overall idea and potential areas for exploration with regards to our attitudes and perceptions of technology in general. As seen in the studies conducted during the course of this PhD, our poor understanding of technology often leaves us vulnerable and susceptible to the effects of such technology. Ignorance of technological methods and basic concepts used to create modern devices and services means that the designers and engineers, and, in most cases, marketing people, can use or abuse this vulnerability as a method of persuasion and social engineering.

Majority of the participants taking part in the studies conducted during the course of this PhD were recruited from one of the top universities in the UK, which leads to a fair assumption that these people are educated and are capable of critical thinking. However, even those participants who had previous experiences of adaptive technol-

ogy were susceptible to the placebo effect created in the studies. Technology users rarely question the functionality of a system if it provides them with the service they want and expect.

Moreover, as technology is developing faster than we can keep up with familiarising ourselves with the details behind it, in many cases most of us use systems and services without knowing or willing to learn about how the technology works. A prominent example of devices we use on a daily basis would be a mobile phone or a fridge – despite our frequent interaction with these devices, most of us have never questioned how they work. A satellite navigation (SatNav) system is another example of complex technology, which provides us with accurate estimations of distance until our final destination and calculates the fastest or shortest route based on real-life updates from the satellite. We use it and trust it to provide us with accurate and relevant information, but do we know for sure that this data is correct? Is this really the fastest route? We trust this technology to provide us with truthful information, and typically as long as we are not aware of it being otherwise, this information is used and trusted. Often, such technology is trusted to the extent that people using it would blindly follow the device’s instructions¹, and, in some cases, people are also being fooled by technological claims, e.g. buying a fraudulent device².

Similarly, we trust the creators of technology to be honest and professional. Lawson et al. (2015) describe a fictional system in the form of a dog-collar, which displayed emotional states of the dogs wearing these to their owners. Interestingly, when evaluating such technology with pet-owners, nobody questioned the theoretical basis for the product. Typical users confidently use devices assuming that the people behind these creations know and use truthful and accurate information about the world.

This phenomenon of asserting that a proposition is true because of the lack of evidence to suggest it to be false is known as *argument from ignorance*. An example of this way of thinking was described by Carl Sagan in his “The Demon-Haunted World” book (Sagan, 1997). He tells a story about convincing an open-minded, rational thinking person that he has a fire-breathing dragon in his garage and offers them to meet this creature. The visitor remarks on the fact that they are unable to see the dragon, to which Sagan responds that the creature is invisible. When the visitor offers to check with infra-red scanner, Sagan responds that the dragon is heatless. Any proposed test is then re-

¹ <http://www.bbc.co.uk/news/uk-38775559>, accessed on 29 March, 2017

² <http://www.bbc.co.uk/news/uk-36540816>, accessed on 29 March, 2017

peatedly refuted with reasons why these tests would not work. Sagan concludes:

“Now what’s the difference between an invisible, incorporeal, floating dragon who spits heatless fire and no dragon at all? If there’s no way to disprove my contention, no conceivable experiment that would count against it, what does it mean to say that my dragon exists? Your inability to invalidate my hypothesis is not at all the same thing as proving it true.”

However, in most cases it is not only the inability to prove somebody wrong, it is the personal choice to stay ignorant. We rely on our technology to be truthful and even if we suspect otherwise, many of us would not gather enough evidence to prove it. Therefore, we can be easily susceptible to this effect – we experience what is not there. Dietary and fitness applications and devices so commonly used nowadays are prominent examples of such submission to technology. The users trust the applications to be tailored specifically for them, and they follow any advice the device suggests to them. Trusting the creators to know what is best for the users increases a system’s credibility as well (Fogg, Cuellar, and Danielson, 2009). The users rarely do their own research on the followed dietary plan being suitable for them or on whether the fitness plan they are following is helping them get fit rather than damaging their health.

Research of the placebo effect in technology is particularly important when it comes to personalised suggestion systems, i.e. systems that offer personalised choices to their users based on their historical choices and actions, for example films on Netflix, suggested purchases on Amazon, or targeted advertisements on Google. According to Adar, Tan, and Teevan (2013), during busy times or when servers are down, Netflix makes a switch to a simpler recommender system based on popular movies. The users do not notice the difference because it maintains the same visual appearance. Therefore, it leads to the question of to what extent does the recommender system have to be tailored to the user?

Similarly, when playing digital games, many players rarely look beyond the game world they directly interact with. Procedural generation of levels and content (Hendrikx et al., 2013), as well as teaching AI to behave more naturally (Lidén, 2003), are some of the most widely researched topics in digital games research nowadays. The general assumption is that these technologies improve our experiences of playing games. However, as more complex systems are being developed,

players are not always able to objectively say if the technology is improving their game play or it is their own perception that affects their experiences.

This then raises many questions and certain concerns for the future technologies, including autonomous vehicles and the internet of things. Having more complex automated and personalised systems at home and on the streets is the direction in which research and development is currently going, therefore it is crucial to understand the implications of the users' perceptions of such technologies in broader contexts not only to design systems that are usable, but also to create systems that are safe and secure.

10.3 Limitations and Future Work

While the research in this thesis has provided sufficient evidence to answer the research question concerning the effect of players' expectations and perceptions of adaptive features in digital games on immersion within the scope outlined in the introduction, it leaves other alternatives open for continued research. For instance, to gain further insights into how players' perceptions of adaptive technology changes their gaming experiences, we propose exploring the effect of in-game suggestions about the presence of the feature, as opposed to the explicit information, as used in the context of this thesis. Similar research already exists in the domain of multiplayer games, e.g. Bateman et al. (2011) and Gerling et al. (2014) argue that there is no clear consensus with regards to whether the players should be aware of the skill assistance applied to other players or not. As discussed previously, single-player games benefit greatly from adaptive technology assisting players with different experience levels, and therefore disclosing the feature in the game has a potential to be perceived more positively by players with different expertise levels.

Moreover, this research suggests that players' preferences did not have an effect on their immersion levels. Additional studies could provide further insights into how preferences with regards to having adaptive technology in the game affect gaming experiences of players, i.e. whether the ability to turn the DDA on and off would make players feel less immersed as they focus more on this functionality as opposed to the gameplay, or, alternatively, increase immersion as they would experience more control in the game.

Work could also be performed involving single-player games of other kinds. For example, games that are focused more on the narrative than action could be potentially be perceived differently by players when becoming aware of the presence of adaptive technology within them. It is not yet possible to generalise the findings to the games that involve longer engagement, as in the case of RPG and strategy games.

Studies described in Chapter 8 & Chapter 9 explored how players with different expertise levels perceived the adaptations implemented in the games. Generally, the results suggest that the adaptive timer in 'Nightmares' and the DDA used to adjust difficulty between levels in 'Trick or Treat' both were perceived as fair features, and participants expressed that the challenge in the game was balanced well for them, regardless of their perceived expertise ratings. However, as the implementations were somewhat simple, more rigorous research is needed in order to explore the effect of more sophisticated algorithms on gaming experiences of players in games that provide opportunities for longer engagement.

Lastly, the study described in Chapter 9 explored the durability of the effect of players' perceptions of adaptivity on immersion during a casual gaming session. Ideally, more research is needed over longer periods of time and potentially over multiple gaming sessions in order to gain additional evidence for the claims. However, testing for this effect over longer periods of time is rather challenging in the scope of this research. In order to evaluate the effect of the players' perception of adaptive technology when playing games with and without the features being present in the games, the games had to be implemented specifically for the experiments, because commercially available games do not tend to provide the option to switch the DDA on and off. Creating games that are enjoyable to play for much longer periods of time is challenging, and the main concern is that lab experiments might not provide players with the engagement that one might have when playing games on their phones or PCs. Therefore, the risk is that players would become naturally bored, which would create a serious confound when testing for the effect of adaptation of the information about it on players' immersion levels over long periods of time. Further research on studying this effect in commercial games over longer periods of time and multiple sessions would strengthen the understanding of players' perceptions of adaptive technology in games and its effect on immersion.

10.4 Concluding remarks

The research described in this thesis provides empirical insights into the relationship between immersion of players and their expectations and perceptions of adaptive technology in single-player games. The outcome of this work represents a contribution to the theoretical understanding of immersion in digital games, and has some potentially useful implications for game developers, testers, and games user researchers with regards to the design of unbiased games evaluations and research studies into player experience. This work also provides additional support for the argument that adaptive technologies in single-player games improve player experience, which could be of interest to some game developers.

APPENDICES

Consent form

a

The purpose of the form is to tell you about the study and highlight features of your participation in the research.

Who is running this?

The study is being run by Alena Denisova, who is a PhD student in the Department of Computer Science at the University of York.

What is the purpose of the study?

The aim of this study is to investigate how people experience playing digital games.

What will I have to do?

You will be asked to play a video game on a MacBook Pro. Prior to the main part of the experiment you will be provided with full instructions about the game controls and the description of the experiment. After this you will be asked to complete a questionnaire related to your experience of playing the game.

Alena will also ask you some demographic questions about yourself and your usual gameplaying habits. The questionnaires are relatively straightforward but if you are unsure how to answer any part you may ask the experimenter or leave out the question.

Who will see this data?

Your results are anonymous, private, and confidential – only Alena will see your results. She will compile the data from all participants into a large spreadsheet that will be used to analyse the data. However,

once it has been compiled, it will be completely anonymised, and you will not be able to be identified with your data.

Do I have to do this?

Your participation is completely voluntary. You can therefore withdraw from the study at any point, and if requested your data can be destroyed.

Can I ask a question?

Do ask Alena any questions you may have about the procedure that you are about to follow. However, during the main part of the study, please refrain from talking to the experimenter, and save any questions you may have until the end of the test. If you have any questions about the purpose or background of the experiment, please wait until the end of the experiment, and you will have an opportunity to ask Alena your questions.

Consent

Please sign below that you agree to take part in the study under the conditions laid out above.

This will indicate that you have read and understood the above and that Alena will be obliged to treat your data as described.

Name:

Signature:

Date:

IEQ and GEQ Items (Study I)

b

Component	Item ID	Questionnaire item
Immersion	GEQ18	I really get into the game.
Presence	GEQ1	I lose track of time.
	GEQ2	Things seem to happen automatically.
	GEQ13	My thoughts go fast.
	GEQ17	I play longer than I meant to.
Flow	GEQ5	The game feels real.
	GEQ6	If someone talks to me, I don't hear them.
	GEQ7	I get wound up.
	GEQ10	I don't answer when someone talks to me.
	GEQ11	I can't tell that I'm getting tired.
	GEQ12	Playing seems automatic.
	GEQ15	I play without thinking about how to play.
	GEQ16	Playing makes me feel calm.
	GEQ19	I feel like I just can't stop playing.
Absorption	GEQ3	I feel different.
	GEQ4	I feel scared.
	GEQ8	Time seems to kind of stand still or stop.
	GEQ9	I feel spaced out.
	GEQ14	I lose track of where I am.

Table 26: The GEQ items used in Study I.

Item ID	Questionnaire item	Original item
IEQ1	The game has my full attention.	To what extent did the game hold your attention?
IEQ2	I feel focused on the game.	To what extent that did you feel you were focused on the game?
IEQ3	I put effort into playing the game.	How much effort did you put into playing the game?
IEQ4	I am trying my best.	Did you feel that you were trying your best?
IEQ5	I lose track of time.	To what extent did you lose track of time?
IEQ6	I feel consciously aware of being in the real world whilst playing.	To what extent did you feel consciously aware of being in the real world whilst playing?
IEQ7	I forget about my everyday concerns.	To what extent did you forget about your everyday concerns?
IEQ8	I am very much aware of myself in my surroundings.	To what extent were you aware of yourself in your surroundings?
IEQ9	I notice the events taking place around me.	To what extent did you notice events taking place around you?
IEQ10	I feel the urge to stop playing and see what is happening around me.	Did you feel the urge at any point to stop playing and see what was happening around you?
IEQ11	I feel like I was interacting with the game environment.	To what extent did you feel that you were interacting with the game environment?
IEQ12	I feel that I was separated from the real world environment.	To what extent did you feel as though you were separated from your real world environment?
IEQ13	The game is something that I am experiencing rather than just doing.	To what extent did you feel that the game was something you were experiencing rather than something you were just doing?
IEQ14	The sense of being in the game environment is stronger than the sense of being in the real world.	To what extent was your sense of being in the game environment stronger than your sense of being in the real world?
IEQ15	I find myself so involved that I was unaware I was using controls.	At any point did you find yourself become so involved that you were unaware you were even using controls?
IEQ16	I move through the game according to my own will.	To what extent did you feel as though you were moving through the game according to your own will?

Item ID	Questionnaire item	Original item
IEQ17	I find the game challenging.	To what extent did you find the game challenging?
IEQ18	There are times in the game in which I just want to give up.	Were there any times during the game in which you just wanted to give up?
IEQ19	I feel motivated when playing the game.	To what extent did you feel motivated while playing?
IEQ20	I find the game easy.	To what extent did you find the game easy?
IEQ21	I feel that I am making progress towards the end of the game.	To what extent did you feel like you were making progress towards the end of the game?
IEQ22	I perform well in the game.	How well did you think you performed in the game?
IEQ23	I feel emotionally attached to the game.	To what extent did you feel emotionally attached to the game?
IEQ24	I am interested in seeing how the game's events will progress.	To what extent were you interested in seeing how the game's events would progress?
IEQ25	I want to "win" the game.	How much did you want to "win" the game?
IEQ26	I feel in suspense about whether or not I would do well in the game.	Were you in suspense about whether or not you would do well in the game?
IEQ27	I find myself so involved that I want to speak to the game directly.	At any point did you find yourself become so involved that you wanted to speak to the game directly?
IEQ28	I enjoy the graphics and the imagery.	To what extent did you enjoy the graphics and the imagery?
IEQ29	I enjoy playing the game.	How much would you say you enjoyed playing the game?
IEQ30	When I stop playing, I am disappointed that the game is over.	When interrupted, were you disappointed that the game was over?
IEQ31	I would like to play the game again.	Would you like to play the game again?

Table 27: The original IEQ items and the paraphrased IEQ items used in Study I.

Principle Component Analysis of the PENS



PENS		Factors		
Components	Items	1	2	3
Competence	PENS1	.092	.766	-.340
	PENS2	.316	.616	-.491
	PENS3	.189	.615	-.450
Autonomy	PENS4	.384	.236	-.822
	PENS5	.340	.447	-.841
	PENS6	.322	.373	-.749
Relatedness	PENS7	.704	.305	-.473
	PENS8	.736	.197	-.410
Immersion	PENS10	.724	.372	-.300
	PENS11	.761	.249	-.363
	PENS12	.807	.217	-.282
	PENS13	.530	-.150	-.018
	PENS14	.697	.180	-.532
	PENS15	.724	.119	-.279
	PENS16	.767	.292	-.411
	PENS17	.382	.497	-.597
Controls	PENS18	.825	.128	-.319
	PENS19	.165	.745	-.160
	PENS20	.196	.777	-.297
	PENS21	.142	.785	-.408

Table 28: 3-Factor solution using the PCA on the PENS items. Loadings over .4 are highlighted.

PENS		Factors			
Components	Items	1	2	3	4
Competence	PENS1	.301	.725	-.371	-.233
	PENS2	.503	.551	-.519	-.077
	PENS3	.397	.549	-.473	-.181
Autonomy	PENS4	.348	.222	-.818	.229
	PENS5	.429	.397	-.846	.040
	PENS6	.353	.348	-.753	.109
Relatedness	PENS7	.554	.346	-.508	.601
	PENS8	.585	.227	-.445	.626
Immersion	PENS10	.845	.298	-.349	.276
	PENS11	.851	.172	-.405	.334
	PENS12	.834	.167	-.329	.448
	PENS13	.233	-.058	-.040	.714
	PENS14	.503	.226	-.558	.649
	PENS15	.508	.178	-.314	.712
	PENS16	.809	.240	-.453	.396
	PENS17	.371	.505	-.617	.213
Controls	PENS18	.675	.149	-.360	.685
	PENS19	.192	.789	-.202	.059
	PENS20	.261	.800	-.336	.021
	PENS21	.179	.820	-.439	.015

Table 29: 4-Factor solution using the PCA on the PENS items. Loadings over .4 are highlighted.

PENS		Factors				
Components	Items	1	2	3	4	5
Competence	PENS1	.152	.551	-.247	.007	.788
	PENS2	.355	.337	-.388	.192	.787
	PENS3	.244	.339	-.346	.081	.779
Autonomy	PENS4	.332	.208	-.852	.335	.263
	PENS5	.365	.318	-.836	.223	.510
	PENS6	.336	.346	-.786	.220	.321
Relatedness	PENS7	.486	.233	-.419	.747	.389
	PENS8	.541	.133	-.370	.745	.291
Immersion	PENS10	.850	.260	-.320	.394	.326
	PENS11	.868	.139	-.390	.440	.254
	PENS12	.859	.146	-.309	.532	.195
	PENS13	.259	-.045	-.016	.676	-.154
	PENS14	.478	.176	-.521	.742	.221
	PENS15	.501	.142	-.266	.766	.122
	PENS16	.812	.198	-.428	.511	.290
	PENS17	.264	.373	-.534	.406	.570
Controls	PENS18	.686	.122	-.325	.749	.131
	PENS19	.196	.883	-.218	.089	.286
	PENS20	.213	.807	-.308	.128	.471
	PENS21	.121	.825	-.417	.129	.491

Table 30: 5-Factor solution using the PCA on the PENS items. Loadings over .4 are highlighted.

Demographics Questionnaire

d

1. Gender:
2. Age:
3. How often do you play digital games? This includes console games, PC games, and games on your mobile and tablet devices:
 - Never
 - Very rarely
 - About once a month
 - About once a week
 - Several times a week
4. When you play digital games, how long do you usually play for in a single session?
 - Not applicable
 - Up to 10 minutes
 - Up to 30 minutes
 - Up to 1 hour
 - More than 1 hour
5. How many years have you been playing video games for?
6. If you play digital games regularly, what video games have you played recently?
7. In general, which genres/types of video games do you prefer to play?
8. How would you rate your overall level of gaming experience?

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

1	2	3	4	5
Not at all				A lot

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

1	2	3	4	5
Not at all				A lot

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

1	2	3	4	5
Not at all				Very much so

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

1	2	3	4	5
Not at all				A lot

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

1	2	3	4	5
Very poor				Very well

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

1	2	3	4	5
Not at all				Very much so

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

1	2	3	4	5
Not at all				A lot

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

1	2	3	4	5
Not at all				Very much so

26. Were you in suspense about whether or not you would do well in the game?

1	2	3	4	5
Not at all				Very much so

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

1	2	3	4	5
Not at all				Very much so

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

1	2	3	4	5
Not at all				Very much so

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

1	2	3	4	5
Not at all				A lot

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

1	2	3	4	5
Not at all				Very much so

31. Would you like to play the game again?

1	2	3	4	5
Definitely no				Definitely yes

This concludes the questionnaire.

Experiment Explanation (Study II)



Overview

This experiment is aimed at studying the experience of playing a digital game, and it involves playing a 15-minute session of The Elder Scrolls V: Skyrim on a PlayStation 3.

Procedure

You are about to begin a short quest to find the 'Golden Claw', which was stolen from a shopkeeper, Lucan, by bandits in a nearby village, Riverwood. You kindly agreed to retrieve this claw for the shopkeeper, and are now about to enter the Bleak Falls Barrow, where these bandits reportedly were headed to.

To move the main character use the left analog stick, and to look around – the right analog stick. Your character is equipped with a mace in his right hand and a shield in his left hand. To attack the enemies with a mace, press R1, to shield the character from incoming attacks, press L1. You can access the quest description and instructions in the Journal by pressing the Start button. Your character can open doors, and pick up items using the action button X, to jump press Triangle, and to toggle the player's menu press Square (there you can look up the items that your character already collected, and equip any of these items if necessary).

The experiment will begin with a short trial session, in which you will fight off the three bandits guarding the barrow from outside. The aim of this small task is to give you some time to get used to the controls, and ask questions, if you might have any.

After this, the experimenter will leave the room for 15 minutes and will return when the time is up to stop the gaming session. While the experimenter is gone, you will have to go through the barrow looking for the golden claw. You are allowed to collect any objects that you

might find useful, and you will have to fight off any enemies that will prevent you from making progress towards your goal. If your character dies in the process, the quest will begin from the point where you enter the barrow, so make sure to keep an eye on the character's health. In order to complete the quest, you will also need to solve a puzzle to make progress towards the claw.

Overall, the aim of the quest is to find the claw and make your way out of the barrow. Upon completion of the 15-minute session you will be asked to fill in a questionnaire about your gaming experience.

Experiment Explanation (Study III)

g

Overview

This experiment will consist of completing two video game sessions under one experimental condition – the presence of adaptive artificial intelligence (AI). Prior to the main part of the study, you will be given a tutorial which will explain in detail how to play the game.

Procedure

During this short session, you will become familiar with the gameplay and the controls of a survival video game, 'Don't Starve'. As in a typical survival game, the main character, Wilson, will have to collect and build objects in order to survive. During the trial session, your character will appear in a randomly generated world with objects that you will have to collect and monsters that you will have to avoid.

Your character has a number of needs – you will have to feed him with berries, meats, eggs and carrots, such that he doesn't die of starvation. The heart shows your character's health – as long as nothing attacks him and he doesn't starve, he will be pretty much fine. To recover his health, he can eat flowers. Lastly, the brain shows his sanity – if Wilson enters a graveyard, walks in the darkness and doesn't shave, his sanity will go down, and as a result of that, more likely to be attacked by imaginary monsters. However, you can pick flowers to bring it back up.

The objects you collect are self-explanatory, but feel free to ask about any of them during the tutorial session. The creatures you will come across in the world can either attack you, protect you if you feed them, or become your dinner. Rabbits and birds can be caught and either eaten raw or cooked. Pigs are harmless unless you attack them – you can also befriend them if you give them meat. Most of the other crea-

tures are likely to be deadly so it would be a good idea to run away if they spot you.

The aim of the game is to survive – that is, your result will be composed of how well you do in the game, together with how many days you last. Your character is afraid of darkness, so you better light some sort of fire before it gets dark to keep him happy, dry and warm.

What is Adaptive AI?

All video games have a decision-making process that controls opponents and objects, which is called game artificial intelligence (AI).

Typical game AI controls the events and occurrences in the virtual world of the game – the number and location of opponents, strength of equipment that can be found on different levels, or even the skills that can be obtained from levelling-up; while a more effective game AI would make the gameplay more realistic by making the characters and environment inside the game able to reason effectively.

One of the possible ways to moderate the challenge levels for each person is to make the game AI adaptable to player behaviour. Dynamic game difficulty balancing involves helping players avoid getting stuck, adapt gameplay more to an individual's preference and taste, or even detect players using or abusing an oversight in the game to their advantage. Adaptation is used to learn about a player in order to respond to the way they are playing, for example adjusting opponents' speed and accuracy in order to present a more appropriate challenge level.

Some modern video game developers create game AI capable of adapting to the player behaviour. You are about to test one of these projects yourself.

Main Experiment

The main part of the study consists of two gaming rounds during which you will be playing the game you have just tried during the tutorial. During one of the sessions you will be playing the game with adaptive AI switched on, while the other round will be with the standard game AI.

Adaptive AI implemented in this game will be using the information about you as a player, and will be learning from your behaviour as a player. To keep the game balanced and challenging, it will be collecting information about you as a player during this session, and also from the tutorial part.

The other session involves playing the same game with a default randomly generated world.

Upon completion of each session you will be asked to fill in a questionnaire about your gaming experience.

Experiment Explanation (Study IV: Standard Condition)

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Overview

This experiment will consist of completing a video game session, prior to which you will be given a tutorial which will explain in detail how to play the game. The aim of this experiment is to evaluate player experience when playing a survival video game.

Procedure

During this short session, you will become familiar with the gameplay and the controls of an survival video game, 'Don't Starve'. As a in typical survival game, the main character, Wilson, will have to collect and build objects in order to survive. During the trial session, your character will appear in a randomly generated world with objects that you will have to collect and monsters that you will have to avoid.

Your character has a number of needs – you will have to feed him with berries, meats, eggs and carrots, so that he doesn't die of starvation. The heart shows your character's health – as long as nothing attacks him and he doesn't starve, he will be pretty much fine. To recover his health, he can eat flowers. Lastly, the brain shows his sanity – if Wilson enters a graveyard, walks in the darkness or doesn't shave, his sanity will go down, and as a result of that, it will be more likely that he'll get attacked by imaginary monsters. However, you can pick flowers to bring his sanity back up.

The objects you collect are self-explanatory, but feel free to ask about any of them during the tutorial session. The creatures you will come across in the world can either attack you, protect you if you feed them, or become your dinner. Rabbits and birds can be caught and either eaten raw or cooked. Pigs are harmless unless you attack them – you can also befriend them if you give them meat. Most of the other crea-

tures are likely to be deadly so it would be a good idea to run away if they spot you.

The aim of the game is to survive – that is, your result will be composed of how well you do in the game, together with how many days you last. Your character is afraid of darkness, so you better light some sort of fire before it gets dark to keep him happy, dry and warm.

Main Experiment

The main part of the study consists of one gaming round during which you will be playing the game you have just tried during the tutorial. In the main part of the study, just like in the tutorial part, you will be playing in a randomly generated game world. Upon completion of this gaming session you will be asked to fill in a questionnaire about your gaming experience.

Experiment Explanation (Study IV: Adaptive Condition)



Overview

This experiment will consist of completing a video game session, prior to which you will be given a tutorial which will explain in detail how to play the game. The aim of this experiment is to evaluate player experience when playing a survival video game with adaptive artificial intelligence (AI).

What is Adaptive AI?

All video games have a decision-making process that controls opponents and objects, which is called game artificial intelligence (AI).

Typical game AI controls the events and occurrences in the virtual world of the game – the number and location of opponents, strength of equipment that can be found on different levels, or even the skills that can be obtained from levelling-up; while a more effective game AI would make the gameplay more realistic by making the characters and environment inside the game able to reason effectively.

One of the possible ways to moderate the challenge levels for each person is to make the game AI adaptable to player behaviour. Dynamic game difficulty balancing involves helping players avoid getting stuck, adapt gameplay more to an individual's preference and taste, or even detect players cheating in the game. Adaptation is used to learn about a player in order to respond to the way they are playing, for example adjusting opponents' speed and accuracy in order to present a more appropriate challenge level.

Some modern video game developers create game AI capable of adapting to the player behaviour. You are about to test one of these projects yourself.

Procedure

During this short session, you will become familiar with the gameplay and the controls of an survival video game, 'Don't Starve'. As a in typical survival game, the main character, Wilson, will have to collect and build objects in order to survive. During the trial session, your character will appear in a randomly generated world with objects that you will have to collect and monsters that you will have to avoid.

Your character has a number of needs – you will have to feed him with berries, meats, eggs and carrots, so that he doesn't die of starvation. The heart shows your character's health – as long as nothing attacks him and he doesn't starve, he will be pretty much fine. To recover his health, he can eat flowers. Lastly, the brain shows his sanity – if Wilson enters a graveyard, walks in the darkness or doesn't shave, his sanity will go down, and as a result of that, it will be more likely that he'll get attacked by imaginary monsters. However, you can pick flowers to bring his sanity back up.

The objects you collect are self-explanatory, but feel free to ask about any of them during the tutorial session. The creatures you will come across in the world can either attack you, protect you if you feed them, or become your dinner. Rabbits and birds can be caught and either eaten raw or cooked. Pigs are harmless unless you attack them – you can also befriend them if you give them meat. Most of the other creatures are likely to be deadly so it would be a good idea to run away if they spot you.

The aim of the game is to survive – that is, your result will be composed of how well you do in the game, together with how many days you last. Your character is afraid of darkness, so you better light some sort of fire before it gets dark to keep him happy, dry and warm.

Main Experiment

The main part of the study consists of one gaming round during which you will be playing the game described above. During this session the game AI will adapt to your behaviour depending on your gaming style and the choices you make in the game.

Adaptive AI implemented in this game will be collecting and using the information about you as a player throughout the session, and will be learning from your behaviour as a player in order to keep the game balanced and challenging. Upon completion of the session you will be asked to fill in a questionnaire about your gaming experience.

Experiment Explanation (Study V)



Overview

This experiment will consist of completing a video game session, prior to which you will be given a short tutorial explaining how to play the game. The aim of this experiment is to evaluate player experience when playing a survival shooting game.

Premise

You are about to play a short cartoon-style video game, in which you will be playing as a boy who is having a dream that all his toys have come to life. The main idea is to run around shooting zombie bunnies, bears and elephants, each of which will score you 10, 20 and 50 points respectively. Additionally, each time a toy attacks you, you lose 2, 3 or 5 points depending on the toy.

The controls are relatively straight forward – to move around use either the arrow keys or the “WASD” keys (‘w’ for forward, ‘a’ for left, ‘s’ for backward, and ‘d’ for right move). To rotate the character for precise aiming, use the mouse – drag the cursor around the screen to face the character in the direction of the zombie toys, and shoot them using left mouse click.

The goal of the game is to score 300 or more points in 1.5 minutes. If you do well in the game, you will have a chance to win £10 amazon voucher, and if your score is the highest amongst all, you will receive a £15 amazon voucher.

After this short gaming session you will be asked to fill in a questionnaire about your gaming habits and your experience of this particular gaming session.

Experiment Explanation (Study VI: No Information)

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Overview

This experiment will consist of completing a video game session, prior to which you will be given a tutorial which will explain in detail how to play the game. The aim of this experiment is to evaluate player experience while playing a shooting game.

Procedure

You are about to play a short cartoon-style video game, in which you will be playing as a boy who is having a dream that all his toys have come to life. The main idea is to run around shooting zombie bunnies, bears and elephants, each of which will score you 10, 20 and 50 points respectively. Additionally, each time a toy attacks you, you lose 2, 3 or 5 points depending on the toy.

The controls are relatively straight forward – to move around use either the arrow keys or the “WASD” keys (‘w’ for forward, ‘a’ for left, ‘s’ for backward, and ‘d’ for right move). The character is facing the cursor, so if you spotted an enemy – you need to rotate the character in the direction of it, and shoot it by using left mouse click.

The goal of the game is to score 300 points or more before the timer runs out. If you meet the requirements, you will automatically qualify for a prize draw to win a £15 amazon voucher, and if your score is the highest amongst all, you will receive a £20 amazon voucher.

After this short gaming session you will be asked to fill in a questionnaire about your gaming experience of this particular gaming session.

Experiment Explanation (Study VI: Partial Information)



Overview

This experiment will consist of completing a video game session, prior to which you will be given a tutorial which will explain in detail how to play the game. The aim of this experiment is to determine the effectiveness of adaptive technologies in relation to the player performance and experience.

Procedure

You are about to play a short cartoon-style video game, in which you will be playing as a boy who is having a dream that all his toys have come to life. The main idea is to run around shooting zombie bunnies, bears and elephants, each of which will score you 10, 20 and 50 points respectively. Additionally, each time a toy attacks you, you lose 2, 3 or 5 points depending on the toy.

The controls are relatively straight forward – to move around use either the arrow keys or the “WASD” keys (‘w’ for forward, ‘a’ for left, ‘s’ for backward, and ‘d’ for right move). The character is facing the cursor, so if you spotted an enemy – you need to rotate the character in the direction of it, and shoot it by using left mouse click.

The goal of the game is to score 300 points or more before the timer runs out. The game is using adaptable timer, which will be adjusting time left until the end of the session based on your current performance.

If you do well in the game, you will automatically qualify for a prize draw to win a £15 amazon voucher, and if your score is the highest amongst all, you will receive a £20 amazon voucher.

After this short gaming session you will be asked to fill in a questionnaire about your gaming habits and your experience of this particular gaming session.

Experiment Explanation (Study VI: Full Information)



Overview

This experiment will consist of completing a video game session, prior to which you will be given a tutorial which will explain in detail how to play the game. The aim of this experiment is to determine the effectiveness of adaptive technologies in relation to the player performance and experience. That is, whether matching the challenge in the game to players' skills would affect their overall experience of the gaming session.

What is Adaptive Technology?

Digital games have a decision-making process that controls opponents and objects, which is called game artificial intelligence (AI).

Typical game AI controls the events and occurrences in the game world: the number and location of opponents, strength of equipment that can be found on different levels, or even the skills that can be obtained from levelling-up; while a more effective game AI would make the gameplay more realistic by making the characters and environment inside the game able to reason effectively.

One of the possible ways to moderate the challenge levels for each person is to make the game AI adaptable to player behaviour. Dynamic game difficulty balancing involves helping players avoid getting stuck and adapt gameplay more to an individual's preference. Adaptation is used to learn about a player in order to respond to the way they are playing, for example adjusting opponents' speed and accuracy in order to present a more appropriate challenge level.

Many modern video game developers aim to improve player experience by making the AI of their games regularly adaptable to the player behaviour. You are about to test one of these projects yourself.

In this experiment you will play a game with adaptive timer, which will be adjusting time left until the end of the session based on your performance. To reduce anxiety, time left until the end of the session will increase if you are not doing so well, or, if you are doing well, the timer will speed up to increase the challenge.

Procedure

You are about to play a short cartoon-style video game, in which you will be playing as a boy who is having a dream that all his toys have come to life. The main idea is to run around shooting zombie bunnies, bears and elephants, each of which will score you 10, 20 and 50 points respectively. Additionally, each time a toy attacks you, you lose 2, 3 or 5 points depending on the toy.

The controls are relatively straight forward – to move around use either the arrow keys or the “WASD” keys (‘w’ for forward, ‘a’ for left, ‘s’ for backward, and ‘d’ for right move). The character is facing the cursor, so if you spotted an enemy – you need to rotate the character in the direction of it, and shoot it by using left mouse click.

The goal of the game is to score 300 points or more before the timer runs out. If you do well in the game, you will automatically qualify for a prize draw to win a £15 amazon voucher, and if your score is the highest amongst all, you will receive a £20 amazon voucher.

After this short gaming session you will be asked to fill in a questionnaire about your gaming habits and your experience of this particular gaming session.

Experiment Explanation (Study VII: Standard Condition)

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Overview

This experiment will consist of completing a 20 minutes video game session. Prior to this, you will be given a tutorial, during which you can familiarise yourself with the game. The aim of this experiment is to evaluate player experience while playing a shooting game.

Procedure

You will begin by answering a short demographics questionnaire about yourself and your gaming habits. This is then followed by a short trial of the game, and then two 10 minute sessions of the game. You will be asked to fill in a questionnaire after each round about your gaming experience of this particular session. For the second round, you will continue where you left off in the game during the 10 minutes of game play. At the end of both gaming sessions, you will be asked to fill in a short questionnaire about some features in the game.

If your performance in the game is the highest amongst all participants, you will qualify for a £30 prize. Otherwise, if you perform well, you can enter a prize draw to win a £10 Amazon voucher. For the prize draw, the experiment facilitator will ask you to leave your email address at the end of the session. This information will not be used for anything else, and will be deleted as soon as the prizes are sent out to the recipients.

About the Game

You are about to play a video game, in which you will be asked to help a little girl to have a great Halloween. She needs to collect all the

sweets that her villagers left outside before midnight – the end of halloween (and her bedtime). Unfortunately, the village was attacked by halloween monsters, which are stealing the candy. In order to meet her goal this year she needs to cast spells on the monsters to get the candy back. However, she doesn't know which monsters have her candy, so she needs to get rid of as many monsters as possible.

Overall there are 5 levels. Each level in the game is an hour of her world's time. You will only level up if you collect more than a half of the candy available on that level, otherwise you will need to replay the level once more. You will also automatically level up if you collect all candy on the level before the time runs out. She begins her journey at 7pm – the clock in the bottom right corner is a good indicator of how much time you have left until the level is over, so make sure you check that occasionally. The candy goal for the level is also displayed next to the clock, so make sure you collect at least a half of the original number of sweets available on the level.

Your character has Health Points (HP), which is displayed at the top left corner at all times. The orange slider is also a good indicator of how much health she has left. Every time she gets attacked by monsters, her health decreases. If the health reaches 0, she will die, and you will need to replay that level once again. So make sure you keep her alive! There are no items available to restore her health.

Every level is harder than the previous one, as you need to collect more candy and there are more monsters which are more powerful than before. As you level up, less candy will be lying around and more candy will be stolen by monsters, with the latter levels having no candy left lying around at all. So try to get the candy back by getting rid of as many monsters as you can.

To control the character you can either use the arrow keys or WASD, whichever you prefer. To pick up candy, run towards it. To cast spells on monsters use SPACE key.

Experiment Explanation (Study VII: Adaptive Condition)

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Overview

This experiment will consist of completing a 20 minutes video game session. Prior to this, you will be given a tutorial, during which you can familiarise yourself with the game. The aim of this experiment is to evaluate player experience while playing a single-player game with dynamic difficulty balancing.

Dynamic difficulty balancing (or adjustment) is the process of automatically changing parameters and behaviours in a video game in real-time, based on the player's level of skill, in order to prevent them from becoming bored, if the game is too easy, or frustrated, if it is too hard.

Traditionally, game difficulty increases along the course of the game, while the parameters of this increase can only be modulated at the beginning of the experience by selecting a difficulty level. This can lead to both experienced and inexperienced gamers to following a preselected learning or difficulty curve. Dynamic difficulty balancing attempts to overcome this by creating a tailor-made experience for each gamer. As the players' skills improve through time, the level of the challenges also continually increases.

Procedure

You will begin by answering a short demographics questionnaire about yourself and your gaming habits. This is then followed by a short trial of the game, and then two 10 minute sessions of the game. You will be asked to fill in a questionnaire after each round about your gaming experience of this particular session. For the second round, you will continue where you left off in the game during the 10 minutes of

game play. At the end of both gaming sessions, you will be asked to fill in a short questionnaire about some features in the game.

If your performance in the game is the highest amongst all participants, you will qualify for a £30 Amazon voucher. Otherwise, if you do well, you can enter a prize draw to win a £10 Amazon voucher. For the prize draw, the experiment facilitator will ask you to leave your email address at the end of the session. This information will not be used for anything else, and will be deleted as soon as the prizes are sent out to the recipients.

About the Game

You are about to play a video game, in which you will be asked to help a little girl to have a great Halloween. She needs to collect all the sweets that her villagers left outside before midnight – the end of Halloween (and her bedtime). Unfortunately, the village was attacked by Halloween monsters, which are stealing the candy. To meet her goal this year she needs to cast spells on the monsters to get the candy back. However, she doesn't know which monsters have her candy, so she needs to get rid of as many monsters as possible.

Overall there are 5 levels. Each level in the game is an hour of her world's time. You will only level up if you collect more than a half of the candy available on that level, otherwise you will need to replay the level once more. You will also automatically level up if you collect all candy on the level before the time runs out. She begins her journey at 7pm – the clock in the bottom right corner is a good indicator of how much time you have left until the level is over, so make sure you check that occasionally. The candy goal for the level is also displayed next to the clock, so make sure you collect at least a half of the original number of sweets available on the level.

The amount of candy you collect on each level is then used to determine the difficulty of the next level. If the amount of candy you collect is close to the goal, the difficulty will increase. However, if you collect just enough candy needed to pass the level, the difficulty will decrease. Otherwise, the difficulty will remain the same. The aim of this adaptation is to match the challenge in the game to your skill set.

Your character has Health Points (HP), which is displayed at the top left corner at all times. The orange slider is also a good indicator of how much health she has left. Every time she gets attacked by monsters, her health decreases. If the health reaches 0, she will die, and

you will need to replay that level once again. So make sure you keep her alive! There are no items available to restore her health.

Every level is harder than the previous one, as you need to collect more candy and there are more monsters which are more powerful than before. As you level up, less candy will be lying around and more candy will be stolen by monsters, with the latter levels having no candy left lying around at all. So try to get the candy back by getting rid of as many monsters as you can.

To control the character you can either use the arrow keys or WASD, whichever you prefer. To pick up candy, run towards it. To cast spells on monsters use either SPACE key.

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