Immersion And Players' Time Perception in Digital Games

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ABSTRACT

Immersion is a commonly used term by players, designers and reviewers of digital games to describe their experience of playing digital games. It represents the cognitive sense of "being in the games". One of its consequences is players are losing track of time. However, little has been done to further investigate the effect of immersion on players' time perception whilst playing digital games. This thesis describes a series of experimental investigations to discover the relationship between immersion on players' time perception during a gaming session. The first five experimental studies are focused on manipulating immersion to test its effect on players' time perception. The next six experiments are focused on manipulating players' time perception to test its effect on immersion whilst gaming. The results from these experiments are rather inconsistent. Immersion in some experiments was successfully manipulated it but there were no significant effects on players' time perception. Similarly, in the other experiments players' time perception was manipulated but there were no significant effects on their immersion experience.

To further consolidate these findings, a meta-analysis was conducted to produce the single estimate effect on players' time perception during the experimental investigations. The result suggests that participants either overestimate or underestimate time whilst playing. Further, there is substantial heterogeneity across experiments suggesting that the experimental manipulations affect players' time perception differently depending on the experiments. Together, the evidence suggests both immersion and players' time perception are rather sensitive. The manipulation of either one of them could also affect the other but not in a consistent manner. Moreover, there are clear challenges in studying this phenomenon in the lab context.

Furthermore, considering the literature on time in digital games environment, the final qualitative study is conducted using grounded theory to understand how players perceive time whilst playing digital games. The theory suggests that players are aware of time but they give themselves a "self-consent" to ignore it during the gaming session. However, when they evaluate about their playing time they realise that they have spent a lot of time and they use statements such as losing track of time to justify why they have been playing for so long. Many research opportunities open from here. Measuring players' time perception whilst being immersed in digital games in the lab settings is complicated. However, other techniques available in the area of HCI can be applied to measure players' time perception specifically in the context of digital games. This is essential because time is needed for gaming and by understanding how digital games players perceive time allows game designers to better understand player experience.

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DECLARATION

I, Aliimran bin Nordin, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis. Although some of this research has been published with my supervisor Paul Cairns and other co-authors, the work reported is my own.

List of Publications

1. Nordin, A. I., Cairns, P., Hudson, M., Alonso, A., & Calvillo, E. H. (2014). The Effect Of Surroundings On Gaming Experience. In *Proceedings of the 9th International Conference on the Foundations of Digital Games*
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3. Cairns, P., Li, J., Wang, W., & Nordin, A. I. (2014, April). The influence of controllers on immersion in mobile games. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 371-380). ACM.
4. Nordin, A. I., Ali, J., Animashaun, A., Asch, J., Adams, J., & Cairns, P. (2013, April). Attention, time perception and immersion in games. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems* (pp. 1089-1094). ACM.
5. Nordin, A. I., & Cairns, P. (2013). Evaluating Immersion and Time Perception in Digital Games. In *Games User Research Workshop at CHI'13.*
6. Thompson, M., Nordin, A. I., & Cairns, P. (2012, September). Effect of touch-screen size on game immersion. In *Proceedings of the 26th Annual BCS Interaction Specialist Group Conference on People and Computers* (pp. 280-285). British Computer Society.

1. INTRODUCTION

Digital games are games such as board games, card games, roleplaying games, etc that are played on computer devices. These include all type of electronic devices namely PC, mobile phones, and consoles amongst others. There are several experiences that can occur whilst playing digital games. Terms such as engagement (Brockmyer et al., 2009), fun (Huizinga, 2003), flow (Chen, 2007), playability (Bernhaupt et al., 2008), and immersion (Brown and Cairns, 2004) – amongst others – have been used by digital games players, designers, and player researchers to describe the experience of playing digital games.

These terms can be found in both the results from empirical investigations into the experience of playing digital games, but are also used by players themselves (Cairns et al., 2014a). Depending on the objective of the research, these terms can often be used interchangeably: sometimes they are referring to the same experience, but in others cases, have a different and specific meaning. Similar to when digital games players interpret their experience from playing digital games, they may use a term that is commonly used amongst players which may contradictory to the exact definition of the term.

Indeed, the process of identifying and defining the experience of playing digital games is not an easy or straightforward task. This is due to the lack of fine grained methods, and limited guidelines on how to evaluate player experience in digital games (Bernhaupt et al., 2007, 2008). Moreover, the terms used vary, and it entirely depends on how players and researchers define them (Cairns et al., 2014a). The terms available to describe the experience can be used interchangeably. Moreover, the rich variety of experiences and the inter-play between them, makes it challenging to identify the factor that influences the gaming activity and leads to a positive experience (Cairns et al., 2014a).

Among the many terms that are used to describe the experience of playing digital games, there is a particularly common one called *immersion*, used by players, designers, and reviewers of digital games (Brown and Cairns, 2004). Colloquially, immersion is understood to be the sense of being "in the game" and can be defined as a psychological absorption, where players invest their entire attention, thoughts, and goals into the game as opposed to their surroundings (Sanders and Cairns, 2010). Immersion has also been viewed as a component that hooks in players, and draws them into the gameplay making the activity more engaging (Jennett et al., 2008). Indeed, digital games are known to allow players to lose themselves in a "different" world, to the extent that the players do not notice things around them (Jennett et al., 2008).

This feeling is important because it is viewed as a critical factor to game enjoyment, and is one of the outcomes of a positive gaming experience (Jennett et al., 2008). Jennett et al. (2008) state that immersion is affected/influenced by five components when gaming: cognitive involvement, emotional involvement, real-world dissociation, challenge, and control. Its consequences include specific characteristics where gamers are less aware of their surroundings, become more involved with the games, and also experience losing track of time (Haywood and Cairns, 2005). These consequences can be observed when players find themselves absorbed in the game and engaged with gaming session.

The existing studies on immersion suggest that there are several approaches to conducting research on immersion. Several researchers divide immersion into several categories based on the type of games or on the game mechanics (Adams, 2004; Arsenault, 2005; Ermi and Mayra, 2005; Michelsen and Björk, 2014). Other researchers have defined it as a *graded* experience, rather than dividing the immersive experience into several categories (Brown and Cairns, 2004; Jennett et al., 2008; Cox et al., 2012; Cairns et al., 2014a). Nevertheless, immersion is also argued to be a subset of a bigger theory of player incorporation, which describes the process of "transportation into the games (Calleja, 2011).

The focus of research into immersion in digital games is not only restricted to defining what immersion is. Researchers in the area of Games User Research (GUR) have found many aspects related to immersion in digital games. This includes: factors that influence immersion (Nordin et al., 2014; Cox et al., 2012; Thompson et al., 2012; Sanders and Cairns, 2010), the development of a measurement tool for immersion (Jennett et al., 2008), and immersion as the movement of attention across dimensions in games (Calleja, 2011). In addition to this, there has also been an investigation into whether it plays a part in the game enjoyment experience (Cairns et al., 2014a; Mekler et al., 2014). This wide array of recent activity emphasises the importance and interest of immersion in the area of GUR.

1.1 Motivation and Research Question

The broad aim of this thesis is to understand more about immersion whilst playing digital games; however, this is clearly an extensive topic. To narrow down the scope of this research, the focus of the investigation will be on immersion and one of its consequences related to the players' time perception.

One of the aforementioned consequences of immersion is players losing track of time. Indeed, Sanders and Cairns (2010) successfully manipulated immersion levels by playing background music during the gaming session and they found that players are underestimating time when they are immersed in the games. Players' immersion levels increased when the music that they played in the background was the music that players liked. However, the underestimation of time was only captured prospectively (i.e. participants are aware of the task to measure time) and not retrospectively (i.e. participants are not aware of the task to measure time but they are required to measured time after they completed the task).

There is a debate generally on players' time perception whilst playing digital games, and several studies have been conducted to better understand how it is perceived. For example, a report has been produced to show that players are are losing track of time whilst playing games (Luthman et al., 2009). Similarly, another study found that time loss was commonly reported by gamers when they described their experience of time (Wood et al., 2007). In contrast, Rau et al. (2006) conducted a study on time perception in an internet cafe. They found that instead of losing track of time, players tended to experience the distortion of time. Whereas, Tobin and Grondin (2009) investigated gamers' time estimates when playing over a long period of time (58 minutes) and found that not all gamers underestimated the time spent playing.

The results of these studies are not uniform. Both notions – "losing track of time" and "underestimating time" – may represent the same phenomenon or they could have been interpreted differently. Today, there is still no common theory on player's time perception in the context of digital games to explain and to support the findings from these studies.

The distinct findings from these studies could be influenced by the researcher's understanding and their representation of time perception whilst gaming. Alternatively, it could be the result of the complex structure of research into time perception, due to its different paradigms, and several distinct measurement methods.

It is argued that immersion can cause players to lose track of time in digital games. This suggests that there is a relationship between immersion and time perception. Yet, we cannot accept this hypothesis completely because research on immersion and time perception is still new. A solid foundation is needed to support this argument, which this research aims to provide. Therefore, the research question for this thesis is focused on answering the following question:

"Does immersion alter players' time perception whilst playing digital games?"

1.2 Research Approach

To answer the research question, a series of experiments have been conducted. The primary methodology in this thesis concentrates on quantitative analysis; the benefit being that a specific phenomenon can be tested in a laboratory environment. It allows the experimenter to control the entire lab setting and only manipulate the phenomenon being tested. This helps to increase the validity and to reduce the confounds of the study (Cairns and Cox, 2008).

Furthermore, most existing studies in the area were done quantitatively. By applying models from psychology, these studies bring the phenomenon into the lab and attempt to change it by manipulating the factor being tested. This exercise allows us to manage the level of control that other techniques might not be able to do. Within the experiment, we can manipulate any variable to investigate their effect on a specific phenomenon.

However, this method has been critised. Kaye (2011) argues that quantitative investigations on user experience whilst playing digital games is less efficient and biased due to a number of methodological limitations within experimental gaming research. She identifies a few drawbacks of experimental methods in the gaming field – such as convenience sampling – as not being generalisable to real-life situations. Further, the potential covariates, namely time spent playing the game and the gaming experience, are not measured prior to gaming experiments. In addition, she identifies gender as one of the most likely ignored variables by researchers. She added that further limitations of experimental research for studying effects of gaming include: time period, social factors and participants' familiarity of the game. In addition, she argues that existing research has failed to examine the above factors within the experimental context due to the difficulties of manipulating and controlling these factors.

This research acknowledges that quantitative research methods do have their limitations. However, based on the nature of the research question, the quantitative research method is believed to be the most suitable method to test whether immersion influences players' time perception. In the setting of a lab, it is possible to specifically control all of the variables and thus allow a focus on one particular phenomenon/variable (either manipulating immersion or time perception).

In regards to Kaye (2011)'s argument of gender bias in the games user research, I have tried to randomly select the participants for my studies covering both genders equally. However, it was not an easy task. Three major problems were identified; Firstly, most of the students in the Department of Computer Science, University of York are male. Secondly, during recruitment process, only male participants seems to be interested to participate. Female participants decided not to join when they heard that they have to play a digital games. Therefore, it is difficult to only recruit both gender. Male participants seems to be more interested in participating. Therefore, in this thesis most of participant recruited were male.

It is important to be able to isolate the phenomenon to understand what influences it and how it affects the other test components. By manipulating immersion, it is possible to test its effect on time perception. Similarly, by manipulating time perception we could test its effect on immersion. If the results show a significant difference, it would be possible to suggest an association between immersion and time perception out of the lab, and in the real gaming environment. It is important to isolate the phenomena in the lab to avoid the confounds (i.e the environment, noise, lighting, conversations, distractions etc) that could be experienced when trying to study this topic in a real world gaming environment. It is a starting point to understand the gaming phenomena in the real world.

In this thesis, the experimental investigation consists of two manipulations, namely: manipulating immersion to test its effect on time perception (Chapter Three), and manipulating time perception to test its effect on immersion (Chapter Four). Moreover, time perception is measured retrospectively for all experiments in Chapter Three and prospectively for all experiments in Chapter Four.

The results from all of the experiments are rather inconsistent. It however, suggests a dissociation between immersion and time perception. Chapter Three shows a successful manipulation of immersion but no significant effect on time perception was found. In contradiction, the reverse was found in Chapter Four whereby time perception was manipulated but there was no significant effect on immersion.

The results did not suggest that immersion alters players' time perception which seems to contradict the literature. The results are inconsistent between studies. To further investigate the apparent dissociation, meta-analysis is conducted to find out the overall effect of the manipulation on time perception during the experimental investigations. Meta-analysis is a statistical techniques that combines the effect size from several individual studies (which usually are inconsistent) to produce a single estimate effect. It was described in Chapter Five and show an inconsistency between the results of time perception across the studies that could be affected by the experimental manipulations. Although, the design of the experiments aimed to manipulate time perception in the same way, the manipulations affect time perception differently. In some studies, players seems to overestimate time and in others they underestimate it.

It is unclear what the nature of the relationship between immersion and time perception is within the confines of these experiments Therefore, to further understand what happens to time perception whilst gaming, our investigation is concluded with a qualitative study. This study was done by interviewing gamers on how they perceive time whilst gaming, and as such, a grounded theory is developed. The interpretation of the results – based on the grounded theory – suggest that players are aware of time during the gaming session; however, they give themselves permission (i.e. "self-consent") to ignore it and continue playing. In retrospect, it seems that players may claim they are unaware of time or that they are losing track of time just to justify the time they spent gaming. At the same time, they refuse to admit that they voluntarily give themselves permission to ignore time. The grounded theory is described in Chapter Five.

1.3 Research Scope and Contributions

This thesis does not attempt to push the boundary in defining immersion and time perception in digital games. This is essential, because to define these elements could constitute a separate piece of research entirely. This research is more focused on investigating in more details their effect rather than defining them. But the exploration of the existing definitions of immersion will be described in the literature review.

For immersion, this work focuses on the theory of immersion operationalised by Jennett et al. (2008). They developed the Immersive Experience Questionnaire (IEQ) to measure immersion levels whilst playing digital games. Immersion is not differentiated based on the games genres, or the game mechanics; rather, immersion is considered as a graded experience. In this research, immersion is mainly manipulated by changing external factors to the game.

Time perception is measured using two paradigms, namely prospective and retrospective (Block and Zakay, 2001). Prospective paradigm is an estimation of the in which participants are aware of the task to measure time at the beginning of the experiment. In contrast, for retrospective time perception paradigm, participants are not told that they have to measure time but at the end of the task they are required to make an estimation. The most appropriate methods to measure time perception in the context of playing digital games, and which are used in our studies, are production, comparison and verbal estimation (Grondin, 2010).

The scope presented here will provide the basis with which we evaluate the work to be presented in the following chapters. To this end, the major contributions of this thesis are:

Immersion and time perception. This research presents a series of experiments to investigate the relationship between immersion and time perception. In merit of this research, it is potentially the first to conduct a very focused empirical investigation to test whether immersion alters time perception whilst playing digital games. The theory and the results from the literature on immersion and time perception are extended. The findings from studies conducted in this research show that both notions were successfully manipulated using current findings from the literature. Thus, those findings are extended with empirical studies which suggest that there is dis-association between immersion and time perception.

*Methodological contributions.*This research provokes the methodological dilemma in conducting Games User Research with regards to time perception. It identifies several possible limitations that researchers should consider when conducting research on time perception in a digital games environment, offering a set of appropriate techniques and methods to conduct research on it.

As one of the contribution that this thesis makes on the methodology to measure players' time perception, is it provides empirical data on how retrospective time perception paradigm could be problematic in measuring players' time perception whilst playing digital games. It suggests that in the retrospective time perception paradigm, it is difficult to stop participants to use verbal estimation when they were ask to produce the estimation. Secondly, it is hard to control to ensure that participants did not think about time. For example, it is hard to ensure that participants were not thinking on how long the session would take at the beginning of the experiment in the retrospective time perception paradigm. If they did, they paradigm is no longer retrospective but it automatically became prospective.

Thus, in this thesis, I argue that prospective paradigm is the most suitable paradigm to measure time perception whilst playing digital games. It helps to reduce the possibility of verbal estimation during the duration estimation.

Theory of how players perceive time whilst gaming. Finally, a theory on how players perceive time whilst playing digital games is proposed. This theory supports the existing findings on players' time perception whilst playing, and also justifies why players claim to lose track of time, or to underestimate time whilst gaming. The theory also justifies why the empirical investigations produced inconsistent results. This study theorises that this could be due to a process of "self-consent", that could not be easily replicated in the lab setting. This theory will help other researchers to design future investigations on time perception during gaming, and to better understand the results.

2. LITERATURE REVIEW

Digital games are a current topic of interest for a wide range of computer scientists. Research has typically focused on hardware, software, and the game development process; but recent years have seen a growing interest in the players of such games as well. Researchers of the latter are motivated by the importance of better understanding the interaction and relationship between players and the games (Nacke et al., 2009).

As well as intellectual curiosity, building an understanding of players is motivated from a business point of view. The number of players is increasing with time. In 2012, the number of players in both the US and Europe had reached approximately to 338.8 miliion (182.1 million in the US; 154.7 million in the Europe) [1], [2] and this number was expected to surpass 1.2 billion players globally in 2013 [3].

Knowing exactly what players want from digital games will help games developers to produce games that players like to play. In fact, the digital games industry is one of the most successful money-making industry. The profit from the sales globally has increased from USD 79 billion in 2012 to USD 93 billion in 2013 [4]. Knowing what players want will secure the profits. Hence, it is difficult for us to reject the fact that both the number of players and the profit made from sales are too huge to be ignored. Therefore, understanding players in now very crucial to ensure games companies deliver games that players enjoy to play.

Furthermore, the state-of-the-art allows designers and developers of games to create more sophisticated digital games. These days digital games have progressively improved their quality especially in terms of graphics (Wolf, 2003). Furthermore, controls to games are also more practical and this allows gamers to control the games using several new methods, especially in synchronising a wider variety of strategies and movements in the game. In addition, with the internet, gamers are able to play digital games with

[1] http://www.theesa.com/facts/pdfs/ESA_EF_2013.pdf

[2] http://www.isfe.eu/sites/isfe.eu/files/attachments/euro_summary_-_isfe_consumer_study.pdf

[3] http://www.newzoo.com/press-releases/newzoo-announces-new-reported-and-projects-global-games-market-to-grow-6-to-70-4bn-in-2013

[4] http://www.gartner.com/newsroom/id/2614915

other people who are in different parts of the world (Toivonen and Sotamaa, 2010). Also, games are now can come in pocket size devices to allow players to play it anywhere at any time.

In the arena of user experience (UX) playing digital games, there has been a recent surge of interest and research on immersion. Immersion in digital games is a commonly used term by gamers, designers and reviewers of digital games to represent and describe the experience from playing digital games (Brown and Cairns, 2004). It represents the cognitive sense of "being in the games". It is a result when players invest all of their attention, goals and thoughts in the games as opposed to their surroundings. Players claimed that when they "immersed" in the games, they are not aware of what happened in their surroundings. Indeed, in the past decade, a number of researchers have sought to investigate this experience further. The further discussion about immersion is explained in the next section in this chapter.

One of the consequences from immersion is losing track of time (Haywood and Cairns, 2005). However, little has been done to investigate in detail the relationship between immersion and time perception. It is essential to investigate whether immersion influences time perception because players always claim that their time perception is altered whilst gaming. If this is true, by understanding the relationship between immersion and time perception helps to justify whether players' immersive experience affects their time perception during gaming sessions.

Therefore, this chapter is structured to discuss further about the experiences of playing digital games, immersion in games and its measurement, time perception, time perception paradigms, methods to estimate time perception, and the issues between immersion and time perception. But before we proceed to discuss these topics, we will define more precisely what we mean by digital games in the context of this research.

2.1 Digital Games

Researchers have proposed a number of different definitions as to what exactly a "digital game" is, exemplifying the variety of viewpoints from which they can be considered. In one research area, it might be most appropriate to view and define them to as a form of art (Squire and Jenkins, 2002); in another, it might be more appropriate to define them as a type of system (Buckingham, 2006). In this section we do not aim to contribute another definition to the literature, but rather review those that have been proposed already and choose one most appropriate for the goals of this thesis. Then, we explore the different types of digital games, proposing and justifying one of them in particular for our studies.

2.1.1 Definitions

Some researchers claim that digital games are a form of “art”. Squire and Jenkins (2002) argue that digital games are a “lively” art of the modern day, i.e. an art form that is interactive. Their arguments were focused on the aesthetic qualities of digital games, how they evolved from “traditional” art, how they can invoke various moods (e.g. through textures, colour, and light), and how they can stimulate the players. The discussion of digital games as a form of art is also explored by Poole (2000), who describe them based on well-established concepts from literary criticism, such as genre, narrative, and character.

In contrast, Pearce (2002); Buckingham (2006) argue that it is crucial for digital games to be studied as games themselves, and not to be treated as a new form of hypertext, drama, literature, or art. These authors define games in terms of their particular characteristics, e.g. their goals, rewards, obstacles, and rules. As well as such characteristics, Juul (2011) asserts the rule-based nature of such games, and that they come with multiple variables and quantifiable outcomes, with different outcomes requiring varying efforts and emotional attachments from the players. He also emphasises the “digital” part in definitions, mentioning computer power, video display, and audio settings.

Similarly, McGonigal (2011), defines digital games based on four traits from games, namely goals, rules, feedback systems, and voluntary participation. According to her, any well designed and developed game—regardless of being digital or not—is an invitation to players to tackle the obstruction. Players engage with such games because they want to play, to learn, to explore, and to improve their experience. All of this process is voluntary and they are genuinely interested in the outcomes of their actions. She adds, that if the goals of the games are clear and compelling, and the feedback received from the games is motivating enough, then this will result in players engaging with them for longer periods of time.

In this thesis, we will define *digital games* as games played on any electronic device—including PCs, mobiles, consoles, and handhelds—consisting of the following characteristics derived from the literature: goals, subgoals, rules, obstacles, feedback, rewards, penalties, and anticipation to play. We prefer such a definition over the art-based ones, because it fits into our research area to investigate how immersion whilst playing games with said characteristics influences player experience rather than justifying digital games from philosophical point of view.

2.1.2 Some Type of Games

As with art, literature, films, and board games, digital games are assigned genres too. Buckingham (2006) claims that digital games can be differentiated based on the point of view that players adopt (first person, third person, or "god" view [5]), whether it is single- or multi-player, whether competitive or cooperative, whether challenging or casual, whether there is a notion of progress, whether it is linear or open, or whether it is offline or online (i.e. a shared experience with gamers across the world).

Many games however are not easily assigned to specific categories as above (many games for example have both single- and multiplayer modes). Hence, genre more often describes the most prominent type of gameplay that the game exhibits. For example: action, action-adventure, adventure, role playing, simulation, strategy, sport, puzzle, or even lifestyle (exemplified by games like Wii Fit, which is concerned with the health and exercise habits of its players); among many others[6].

Different genres of games feature very different types of gameplay, and this wide variety of genres is a major challenge in generalising research in user experience whilst playing digital games (consider, for example, the puzzle-based gameplay involved in *Tetris* with the massively-online role-playing experiences in a game like *World of Warcraft*). Calleja (2011) demonstrates this, by showing that different types of games invoke different levels of changes to players' moods and emotional states.

It is impossible to discuss the immersive experience and time perception of players for all genres of games and all type of digital games within the scope of one PhD—there are simply too many. Casual puzzle games with clear, straightforward rules, controls, and goals (Wallace and Robbins, 2006) has been used in most of the experiments conducted in this thesis. Immersion is not only happens whilst playing a shooting game, RPG games but it does occurs in the casual games as well (Cairns and Cox, 2008).

Such games do not require prior experience or skills—a short tutorial suffices for players to understand them—and playing sessions do not necessarily need to be very long. This flexibility broadens the pool of potential participants, because such games are designed to be played by anyone. Also, we are focusing on casual games because of its gameplay that suits for a short playing session that suitable for laboratory investigation of time perception in the digital games environment.

Although the main focus is on the digital games with casual type of play, we will explore a variety of different platforms: consoles, tablets, or PCs;

[5] for example, overhead pull-out third-person in the SimCity game
[6] See e.g. the genres of `http://www.mobygames.com/glossary/genres/`

the games either "standalone" (e.g. a console game) or embedded in a web browser. We are using different game platforms because some commercial games are only available for specific ones (for example, the free Bejeweled online game does not have the "endless mode" whereas purchased app store versions of the game do). Also, this helps to generalise our findings. In addition, on the basis that our research is focused on the immersive experience of players and its effect on their time perception, the games we use are mostly conventional ones (e.g. available in app stores, available to be played online), except for one study (explained in Chapter Three). One of the reason why because game designers have more experience in developing games that players love to play, and in-house developed games might not be comparable as well as biased (Cairns and Cox, 2008). This would influence the players' decisions. And clearly, they are the only players who play the game whereas many conventional ones have large numbers of players.

2.2 The Experiences of Playing Digital Games

Pearce (2002) emphasises that what makes playing digital games different to other engaging media such as watching film, reading a novel, etc is that digital games are being played and controlled by the players. Playing digital games is an activity that stands consciously outside an ordinary life and at the same time it absorbs the player intensely and utterly towards the activity (Huizinga, 2003). Malaby (2007) adds that playing digital games also defines our modern digital society. He believes digital game is not only a form of entertainment but it does represent how the modern society interact, socialise and integrate between each other. After all, playing digital games is all about the experience (Jennett et al., 2008).

A good digital game is believed to be a unique way of structuring positive experience and emotion (McGonigal, 2011). Salen and Zimmerman (2006) argue that playing digital games provides a better experience than playing traditional games or other engaging activities such as watching a film, reading a novel, or watching a theatre production. Juul (2005) asserts the interaction between gamers and the agency in the digital games makes playing digital games distinct from these engaging experiences. The experience of playing digital games can be viewed in three phases: selecting the game, engaging with the game, and mastering the game. These three different phases provide different experiences, because each has its own characteristics (O'Brien and Toms, 2008). The process of selecting the game initiates the player's engagement with the games follow by the period of engagement (engaging with the games) and mastering the game will allow the process of re-engagement of disengagement with digital games. The combination of all of these contributes to the whole experience of playing digital game.

Although some digital games are developed to be narratively interesting (for example *The Legend of Zelda, Diablo, etc*), the experience of playing narrative digital games is still distinct from reading a novel or watching a film. Reading a novel and watching a film allows you to engross with the characters; but the storyline and plot were created and determine by the author or director prior to being published. Rather than just following the plot and the storyline, in playing digital games, the actions of players have consequences which are often related to the level of skill involved. This happens within the magic circle of play (Zimmerman, 2007). This magic circle covers the virtual world and protects the fantasy world from the real world. This makes the experience of playing digital games different from other experiences found in other types of digital media. Calvillo-Gamez and Cairns (2008) support that the main objective of digital games is to provide players with a positive experience. The ideal experience for players is to have fun in a positive way. Calvillo-Gamez and Cairns (2008) add in order to build that fun, a series of components namely the interaction process and the outcomes from playing digital games need to be consolidated. Otherwise, the experience would be poor.

However, it is fairly difficult to define and measure the exact experience of playing digital games. Bernhaupt et al. (2008) find that common terms to describe experiences in gaming are *fun, flow and playability.* Usually, the descriptions of the experience of playing digital games are based on the interpretations from the gamers', researcher and the area of research. Depending on the objective of the research, these terminologies could be used interchangeably. Sometimes they referring to the same definition but sometimes they represent a different meaning. Similar to player's interpretation, they may use a term that commonly used amongst gamers which could be contradicted to the exact definition of the term (Cairns et al., 2014a).

Bernhaupt et al. (2008) assert that there is no general accepted framework to show the kinds of methods that should be used to identify the experience of playing digital games. Indeed, Bernhaupt et al. (2007) argue that there is no common agreement about what type of method can be used to evaluate the experience. In addition, one more problem in evaluating the gaming experience is that there are no guidelines available on how to identify and categorise the exact experience of playing digital games. This is due to multiple paradigms and methodologies to evaluate the experiences (Bernhaupt et al., 2008). Despite the difficulties in identifying the exact experience, several well known concepts—namely flow, presence and immersion (amongst others)—have been identified by researchers as the engaging experiences of playing digital games. The following are brief descriptions of these concepts in regards to the experience of playing digital games.

2.2.1 Flow

Flow is a concept introduced by Csikszentmihalyi (1998), who describes the experience as the "optimal experience", i.e. the state in which individuals are so involved in an activity that nothing else seems to matter. The result from his qualitative study shows that people think that what they really want is the happiness that comes together from the absorption in the activity, but actually, people preferred to be engaged with the activity. This means that they are looking forward to the experience of having something to attend to, as opposed to being or feeling empty.

Flow is an extreme experience that can be reached when we are performing any activity. Previously it has been used to describe the experience people achieved from artistic performances, playing sport, partaking in rock climbing, playing chess, and many other activities. Flow is a state that requires full attention and intense concentration whilst performing an activity. Furthermore, it consists of several other characteristics, namely: a balance between challenge and skill, clear goals, immediate feedback, merging action and awareness, loss of self-consciousness, a sense of control, time distortion, and experiencing the activity as intrinsically rewarding (Csikszentmihalyi, 1998).

In digital game environments, the question is now rather: can the gamer experience flow, i.e. where they are absorbed in the game and being fulfilled by the game? Technically, yes—based on the description and the characteristics of flow, one can say that gamers can experience flow. Indeed, several studies have been done that apply the theory of flow to digital games (for example Sweetser and Wyeth (2005); Chen (2007); de Kort et al. (2007); Cowley et al. (2008)). Their investigations use the theory of flow to explain the model of player experiences in digital games.

One application of the flow theory to explain the experience of playing digital games is the notion of GameFlow. GameFlow is a model developed by Sweetser and Wyeth (2005) that aims to integrate flow as part of the gaming experience, although it was more focused as a framework to review games instead of measuring the experience. It describes the features of a game that are proposed to lead to flow experiences in digital games. With flow as the structural fundamental foundation, the components in GameFlow were mapped to flow components to ensure the GameFlow model fits into flow theory. Sweetser and Wyeth (2005) list the core components in GameFlow as concentration, challenge, skills, control, clear goal, feedback, immersion and social interaction. These components are extracted to be linked to the nine characteristics of flow. More recently, to make GameFlow more useful in the design and evaluation of games, GameFlow has been validated and augmented as a set of detailed heuristics based on the analysis of game reviews (Sweetser et al., 2012). However, in doing so they acknowledged a gap of what they believe to be immersion which is perhaps on a different level from the other elements of GameFlow. This suggests an interesting line of inquiry where a link is made from the analysis of the game under GameFlow to the experiential outcome of the game with particular concern for the role of immersion.

GameFlow uses the theory of flow to identify, describe, and discuss the elements of digital games. It is not being used to explain user experiences, which Sweetser et al. (2012) believe to be another sort of experience—not GameFlow. Cowley et al. (2008) also believe that whether a flow state is experienced in a gaming session depends on how the player relates to the game as an activity. They believe that when gamers treat the gaming activity as an important activity they can achieve flow. This is because the characteristics of digital games that allow gamers to master the game as the challenge develops allow gamers to be absorbed in the activity. Hence within digital games, flow could be considered to be an important element for gaming experience.

Flow has been applied in gaming environments to measure gaming experiences. de Kort et al. (2007) add that flow can be operationalised as a graded experience. In this case, they argue that flow allows gamers to grade their level of flow whilst playing digital games. This makes little sense—as discussed earlier—since flow is intended to be an optimal and extreme experience and not some partial, graded, and therefore sub-optimal experience. It is "all or nothing". You either experience flow or not. The establishment of a GameFlow model that was based on theory of flow is suitable as a framework to review what a digital game can offer rather than explaining what player experience is whilst playing game.

2.2.2 Presence

Another engaging experience is *presence*. Slater et al. (1994); Tamborini and Skalski (2006) define presence as the cognitive sense of "being in a virtual environment", but at the same time, realising that they physically remain in the "real world" (as opposed to the virtual one). Presence can be divided into six different forms (Lombard and Ditton, 1997). The first three are related to social presence: social interaction in the environment, the sense of being the actor in the environment, and the awareness of the interaction between actors in the environment. The other three forms relate to spatial presence: sense of realism, sense of "transportation" (otherwise described as the sense of "being there"), and finally, the psychological and sensory immersion.

Theory on presence has been applied previously to test users' presence experience on the television in which viewers have no control on the character (Lombard et al., 2000). The results suggest that presence is influenced by the size of the display. The larger the television display, the greater the presence experience. On the other hand, it also has mainly been used to discuss the experience of using Virtual Reality (VR) applications. Steuer (1992) adds that presence in VR is an experience that a person receives when surrounded by a three dimensional computer generated representation, and is able to move around in the virtual world and see it from different angles, to reach into it, grab it, and reshape it. This happens because VR provides an artificial environment which can be experienced by user through sensory stimuli (such as sights and sounds), provided by a computer, and in which one's actions in the real environment partially determine what happens in the virtual environment.

In addition, Virtual Environments (VE) which apply this VR technology allow users to be on the other side of the screen and experience "the moment" on the other side of the screen (Slater and Usoh, 1993). With regards to digital games, this can be seen most in 3D games or first person shooter games (McMahan, 2003; Eastin and Griffiths, 2006). This genre of games allow players to control the character from the perspective of the person in the game world. Players experience cognitive thoughts that they are in the game world but knowing they are physically in the real world. This influences how players engage with the game world (McMahan, 2003).

Digital games can facilitate the experience of all six forms of presence. For example, first-person shooter games allow gamers to experience the process of transportation, because of the richness of interaction with the games (especially they provide a high sense of realism). Furthermore, when playing with friends—perhaps in a team—they experience social presence. The requirement to work together and communicate with each other helps to increase this phenomenon.

A form of presence which has particular interest for digital games is spatial presence, which refers to the sensation of being physically situated within a spatial environment and the perceived possibility of acting within it. Ravaja et al. (2006) argues that digital game is one of the factor that engender a greater sense of presence that often eliciting greater self-reported both on the valence and physiological arousal dimensions of emotions during the gaming session.

Slater and Usoh (1993) argue that the sense of presence is a mechanism based on the forming and evaluation of a person's thoughts on what is they are experiencing. At the same time, the real world around them provides information supporting their thoughts that they are present in that world. That is to say, presence occurs when the perceptual hypothesis on the VE wins out over that on the real world. Cairns et al. (2014a) describe that presence in digital games is the sensation being in the digital game environment whilst knowing that you are not. They add that if a player is really somewhere in the game world, then there is no sense presence because there is no conflicting perceptual hypothesis to be resolved.

2.2.3 Immersion

Another experience of playing digital games is captured by the notion of *immersion*. Immersion in digital games is a phenomenon that occurs when gamers are engaging with a game. It is viewed as an important element in providing a positive experience for digital game players, and even by some as a means of helping the players to improve their skills (Calvillo-Gamez and Cairns, 2008). Whilst immersion is difficult to precisely define, it is a concept that gamers can intuitively relate to their feeling of "being in the game" (Brown and Cairns, 2004).

Carr et al. (2006) define immersion as a concept which implies different aspects in games, depending on whether it is borrowed from literary theory, Virtual Reality analysis, or presence theory. They divide immersion in digital games into two categories: perceptual immersion and psychological immersion. Perceptual immersion refers to the degree to which a technology or experience monopolises user senses, whereas psychological immersion emphasises the cognitive rather than the sensory features of the game, referring to immersion as involving the gamer's "mental absorption" in the game world.

Sanders and Cairns (2010) argue that immersion occurs when gamers invest their entire attention, thoughts, and goals to be focused in the game as opposed to being concerned with anything else around them. It is a psychological absorption which causes gamers to be less aware of their surroundings, more involved with a sense of being in the task environment and losing track of time (Haywood and Cairns, 2005).

As a cognitive sense, immersion is rather difficult to be explained objectively. There has been much research to investigate immersion in digital games, however it is still unclear what is meant by immersion, and what is causing it (Jennett, 2010). The grounded theory from the qualitative study of Brown and Cairns (2004) suggests that immersion is a measurement of the degree of engagement gamers experience with a digital game. As mentioned, the theory suggests immersion as a graded measurement of involvement in digital games and it can be divided into three levels namely engagement, engrossment and total immersion. This theory also shows barriers are present in every level which gamers must overcome for them to increase their engagement. These barriers arise from the combination of both the gamer and the game context, examples of which we will now explore.

Gamer preference is identified as the main barrier in the first (engagement) level. If the player does not like the genre of the game, or the storyline of the game, it is difficult for them to engage with the game (Brown and Cairns, 2004). Researchers have found that it is important to ensure that the participants like the type of the game being used in a study, otherwise the immersion level will be very low (Sanders and Cairns, 2010; Cox et al., 2012; Thompson et al., 2012). Their preferences on the type of game they play help them to engross themselves in the gameplay.

The second level is engrossment. In this level players are attached to the game features—the graphic, audio and controller. The features need to be combined in such a way that it would affect the gamer's emotion and the capability to master the game controls; the gamer becoming less aware of their surroundings as they become more engrossed and more involved with the game.

From this level, they may be further involved and enter into total immersion by overcoming the barriers of game atmosphere and empathy. At this moment, when gamers are able to empathise with the game character – for example, as in a role-playing game – they become totally involved. On top of that, the game atmosphere (plot, graphics, and sound) help to add to involvement.

The degree of engagement level whilst playing digital games provides a clear measurement for the experience. However, not only that, immersion is argued by others to be divided into several groups. Ermi and Mayra (2005) argue that immersion connotes the mental processes which are involved in the game. They believe it plays a central role of active participation. Instead of referring to immersion as a graded experience, they differentiate immersion into three different groups: sensory immersion, challenge-based immersion, and imaginative immersion. These are the three components of their so-called SCI-model for immersion.

Sensory immersion refers to the audiovisual execution of games. Games that are being played with a big 3D display screen and with the impressive audiovisual components, for example a high-quality stereophonic speaker would produce high sensory immersion. Less-experienced gamers can usually – and easily – experience this type of immersion when playing digital games with the latest audiovisual components (Ermi and Mayra, 2005).

This argument is similar to another engaging experience known as presence or perceptual immersion (Slater et al., 1994). As Carr et al. (2006) mentioned, perceptual immersion is about the degree of which technology monopolises the player's senses suggesting sensory immersion is similar to presence. However, this is not true. Presence and immersion are distinct given that some games simply do not offer a virtual world for the player to be present in, and likewise, players may feel present in a virtual world but not immersed in the activities they have to do there (Cairns et al., 2014a).

Challenge-based immersion is usually experienced in games that required a balance of challenges in the game and gamer's abilities. Challenge can be related to the gamer's motor skills in controlling the game, mentally challenging such as building up strategies, or their ability to solve problems. Imaginative immersion usually involves games with a vast storyline and narrative elements. With this kind of game, gamers can absorb themselves as the characters, following the plot and the story in the game which allow them to fantasise and to let them use their imagination.

The categorisation was based on the elements related to the pleasurable gameplay experiences including the audiovisual quality and style, level of challenge, and imaginary world and fantasy. Ermi and Mayra (2005) believe that all games contain all these three types of immersion; however, they differ in terms of which gameplay component is the most dominant. The type of the game determines the dominant type of immersion in the games. For example, Ermi and Mayra (2005) argue that *Half-Life 2* game has more sensory immersion because the gameplay and the audiovisual components of the game overpowers player's sensory channel to increase their sensory experience whilst playing the game.

Several other categorisations of immersion have also been proposed. Arsenault (2005) proposes a refinement and combination of multiple theories on immersion in order to better understand it. He believes that the differentiation between the grading is not fine enough to describe immersion. Arsenault (2005) argues that the SCI-model should be refined into fictional immersion and narrative immersion. He believes these two terminologies are the best to describe how immersion works. His argument unfortunately was not empirically demonstrated.

Adams (2004) divides immersion into tactical immersion, strategic immersion, and narrative immersion. Tactical immersion is defined as the moment-by-moment act of playing the game and it is typically found in fast-paced action games. In this grouping of immersion, Adams (2004) suggests that higher brain functions are largely shut down, and the gamer becomes a pair of eyes directly communicating with their finger. It is physical and immediate, produced by challenges simple enough to allow the gamer to solve them in a fraction of a second. Strategic immersion is about seeking a path to victory. It is more about observing, calculating, and deducing the steps to win the game. In order to achieve strategic immersion a game must offer an enjoyable mental challenge. Narrative immersion is achieved when the gamer starts to care about the character and wants to know how the story is going to end. This is similar to reading a book or watching a film, where storytelling is essential. This breakdown of immersion is similar to the SCI model, where strategic immersion is similar to challenged based immersion, narrative immersion to imaginative immersion, and tactical immersion to sensory immersion. However, they do not completely complement one another. For example, tactical immersion only refers to the physical response of the game, described in terms of challenge rather than sensory features of the games.

Calleja (2007) suggests a model that describes gaming experience using six components: tactical involvement, performative involvement, affective involvement, shared involvement, narrative involvement, and spatial involvement. To avoid confusion, immersion in this model is referred to as incorporation. Incorporation results from a synthesis of internalised tactics (tactical involvement), designed and personally created narrative (narrative involvement), the presence of other agents and communication (shared involvement), and movement (performative involvement) within a habitable domain (spatial involvement). Calleja (2011) argues that rather than looking at immersion as a single small part of a gaming experience, he suggested investigating immersion as a subset of a larger and richer concept. He introduces a notion of "incorporation" in his the extended studies based on his player involvement models. With incorporation, the gamer is able to absorb (incorporate) the game environment into their perception, and concurrently be incorporated again into the game environment as an avatar.

In Calleja (2011)'s argument, immersion arises as a component of incorporation that comes together with the sense of transportation in the game (presence). All these six dimensions are available in all types of digital games. To achieve high involvement, high attention on one or more dimensions in the game is required. It is clear though, based on his theory, that it is difficult to attain immersion. It is difficult because immersion cannot be made up from all these different types of involvement at one time. Moreover, the theory does not covers external elements that could influence the player's attention. Nordin et al. (2014) found that immersion is affected by high awareness of the surroundings. They did a study to show that immersion levels decrease as the lighting level on the surroundings increases. This finding is not compatible with Calleja (2011)'s model as it only describes the movement of attention across the dimensions of the games. Calleja (2011)'s model has similarities with the SCI-model in that it recognises that immersion can arise from different game components – but the components themselves differ.

Relating immersion into several groups based on different concepts is less convincing and to categorise immersion into different groups is less convenient, because in all digital games, there appears a common gradation of immersion (Jennett et al., 2008). Brockmyer et al. (2009) support that immersion is a graded experience and based on that they develop another tool to measure player's deep engagement with violent games. This gradation allows us to gauge our engagement level with the game, whereas it is impossible to do this if we differentiate immersion into several groups. Therefore, we argue that the method used by Brown and Cairns (2004), which treat immersion as a graded experience, is the most suitable basis for research on immersion in this research.

In conclusion, flow, presence and immersion are three main terminologies used to describe the engaging experience. There are some similarity in their characteristics but as discussed we argue that these three experience are not similar.

2.3 Other Tools to Measure Engagement in Games

Some researchers tailor their questionnaires for measuring engagement according to particular game genres, or to their particular research questions. Brockmyer et al. (2009) developed the Gaming Engagement Questionnaire (GEQ), which was initially developed to assess the impact of deep engagement in violent video games. The GEQ consists of 19 positively worded questions answered on a five-point Likert scale; the higher the score that the user gives for each question, the more engaged they are deemed to be. The formulation of the questionnaire puts engagement on a single dimension that ranges from immersion to flow. They applied theory of absorption, flow, presence and immersion in developing the questionnaire. This questionnaire, however, has received relatively little empirical validation to establish its reliability; in part because of its (relatively) recent introduction to the field.

Qin et al. (2009) also proposed an alternative to the IEQ based on comprehension, control, challenge, and empathy, naming it the "Game Engagement Questionnaire" (not to be confused with the GEQ of Brockmyer et al. (2009)). This tool is mainly used to measure how player engaged with the games rather than grading the level of involvement with the game which is what IEQ operationalised by Jennett et al. (2008) aims to measure. A final example is the Player Experience of Need Satisfaction (PENS) questionnaire developed by Ryan et al. (2006) for measuring engagement based on player's motivation which needs for autonomy, competence, and relatedness independently predict enjoyment and future game play. This questionnaire was developed based on four main elements namely competence, autonomy, presence (physical presence, emotional presence and narrative presence) and intuitive controls. Similarly, the main objective of this questionnaire is to measure how player's motivation influences their engagement with the games and not how much engagement they experienced whilst playing digital games.

Existing models of player experience use their own questionnaires to measure overall engagement based on certain aspects that influence the game enjoyment. That there is such a large number of questionnaires to choose from poses a challenge for new researchers, who may not necessarily be familiar with the specific details of the theories that they are based upon. Choosing one of them is therefore often based on their availability – many are not available publicly (for example Game Experience Questionnaire (Poels et al., 2007)) – or it may be needlessly challenging to obtain some of them. In practice, only those that are easily accessible tend to be used for measuring player experience.

In addition, (Pavlas et al., 2012) develop a questionnaire to measure play experience in digital games. Their measurement tool called “Play Experience Scale” focuses on the measurement of the subjective experience of play. This scale was developed based on the theory of play with additional concepts from psychology theories.

Moreover, in order to obtain reliable results on engagement whilst playidng digital game, the data needs to be gathered using a reliable questionnaire. Unfortunately, some of existing questionnaires are not statistically validated, and are hence avoided as they are presumed to not be trustworthy. But rather than helping to suggest an easy way to measure the experience, the presence of several questionnaires in the literature becomes a dilemma; especially for new researchers. This is not to say that there should only be one questionnaire. The variety in questionnaires is necessary to allow a nuanced focus on different aspects of games. But where, for example, different questionnaires claim to be measuring engagement, they ought to produce consistent and correlated results.

In this research, the IEQ is applied as the main tool for measuring the level of engagement whilst playing digital games. The decision of using IEQ was made based on the fact that it is one of the available tools with substantial validation to operationalise immersion experience. Further, it is also an established, well-validated, and well-used questionnaire (Jennett et al., 2008). Many studies on immersion – e.g. the effect of surroundings (Nordin et al., 2014), effect of controller Cairns et al. (2014b), effect of challenge in games (Cox et al., 2012), and the effect of screen size (Thompson et al., 2012) amongst others – have used the IEQ questionnaire.

2.4 Operationalising Immersion

The formulation of immersion was operationalised (i.e. developed for the measurement of the experience) by Jennett et al. (2008) into a questionnaire called the Immersive Experience Questionnaire (IEQ). Measuring immersion is one of the most important elements in researching immersive experience. The grounded theory study in Brown and Cairns (2004) produced a strong fundamental measure in the gradation of immersion, but at the same time we should be able to measure immersion quantitatively, because it is important to have a tool to know the level of engagement with the games. Jennett et al. (2008) suggests that this experience can be determined and measured quantitatively. With a strong understanding of the gradations of immersion and other engaging experiences as described above, the IEQ they developed is based on five elements: cognitive involvement, emotional involvement, real world dissociation, challenge, and control.

The questionnaire is divided into six sections. The first three sections are concerned with tasks which vary attention, namely basic attention, temporal dissociation and transportation. These factors were drawn from their previous work on flow (Csikszentmihalyi, 1998), cognitive absorption (Agarwal and Karahanna, 2000), and presence (Slater and Usoh, 1993), as well as the grounded theory from Brown and Cairns (2004). The other three sections on the other hand are more focused on the immersive experience, asking questions about challenge, emotional involvement, and enjoyment. These aspects were also drawn from the previous study by Brown and Cairns (2004) on the grounded theory of immersion. The questionnaire consists of 31 Likert scale questions which lead to an overall immersion score.

The minimum score of IEQ is 31 and the maximum score is 155. The score could be used as an indicator whether participants engage (between 31- 90), engross (between 90-120) and total immersion (between 120- 155). As a graded experience, the scores will allow us to group gamers according to whether they are experiencing higher or lower amounts of immersion. If the immersion score is lower, the researcher can attempt to ascertain why: perhaps the gamer does not like the game, or perhaps they do not know how to play it and thus were not able to engage. If the gamer enjoyed the game and was able to engage – but still scored low – then perhaps barriers from audio visual equipments on the second level prevented them from becoming fully engrossed. If gamer can overcome the barriers they will experience total immersion which is represent with a high immersion scores.

In this thesis, the overall score of immersion from IEQ is calculated for the statistical analysis. If the scores between conditions show a significant difference, then each of the element of immersion namely Cognitive Involvement, Emotional Involvement, Real World Dissociation, Challenge and Control will be calculated and tested. Any significant difference on any elements will help us to understand which factors that contribute to the significant result of overall immersion experience. This is further expalain in Chapter 3.

2.5 Measuring Immersion

The main technique applied to measure the immersion experience whilst playing digital games in this research is the self-reported technique using psychometric questionnaire (IEQ). This way technique measures and assesses players' subjective emotion and cognition during the gameplay by asking them structured questions after gaming session (Nacke and Lindley, 2010).

Although there are several other techniques available to measure the immersive experience (e.g. psychophysiological tests that objectively measure arousal or valence during a gaming session), psychological questionnaire such as the IEQ provides different psychological explanations compare to what psychophysiological data provides (Grimshaw et al., 2008). Questionnaires are a useful research method to directly quantify the subjective player experience because they are both easy to deploy, and provide a standardised instrument for quantifying the particular aspect of experience under consideration (Adams and Cox, 2008). Additionally, questionnaires allow players to express their subjective experience – albeit within the parameters set by the items of the questionnaire.

2.6 Factors That Influencing Immersion

As discussed, immersion is affected by multiple factors from the players, the game and the environment. Existing research studies on immersion in digital games show that player's preference on the game is crucial to ensure players are able to engage with the games (Brown and Cairns, 2004). In addition, knowing how to control the game also contribute to immersion because if players are struggle with the control they would not be able to engage with the games (Brown and Cairns, 2004). Cairns et al. (2014b) conducted studies on the effect of game controllers on immersion and they found that the naturalness of the game controls influences player's immersion experience whilst playing mobile games. Furthermore, Sanders and Cairns (2010) argue that music has a big impact on player's immersion. They played players' favourite music on the background of the game and tested player's immersion level and found that players are more immersed in the games when they listen to their favourite music whilst playing. Furthermore, Cox et al. (2012) argue that the different levels of challenges in the games affect players immersive experience. Moreover, Thompson et al. (2012) found that immersion is also affected by the size of the touch screen.

All of these research studies show that immersion can be influenced by many factors. By introducing an external factor to players or increasing challenge in the game whilst they are playing digital games could influence their immersive experience. Therefore, in this research the main focus to manipulate immersion is to manipulate the external factors whilst players play digital games.

2.7 Immersion and Time Perception

Research on time perception whilst playing digital games shows a significant effect on player's time perception during the gaming session. In the study conducted by Wood et al. (2007), 99% of the participants reported that they had experienced "time loss" whilst playing video games. In another study, Luthman et al. (2009) gamers claim they "lose track of time"; and in the study of Tobin and Grondin (2009), the time that gamers feel is passing is shorter than the time that passed in reality. While these studies are similar in the sense that they measure the players' time perception, contrasting studies exist; Rau et al. (2006) found that players' abilities to perceive time are altered according to their profiles (but that they are "definitely" not losing track of time).

The statements about players' time perception whilst playing digital games are not completely consistent with each other. This might be due to the different semantic representation of time, especially when different people describe their temporal experience differently (using different term, example, temporal unit, etc) (Friedman, 1990). In his extensive studies, Friedman (1993) argues that there is no single or natural temporal code in human memory that represents time uniformly. However, time is perceived as a chronological order depending on a process of active, repeated construction of the temporal queues memory. Therefore, one person produces time perception differently to another.

In a gaming environment, the player's time perception depends on their experience in the gaming session. Here, immersion is argued to be one of the experiences that could alter the player's time perception (Brown and Cairns, 2004; Jennett et al., 2008; Sanders and Cairns, 2010). The experience will contribute to whether they judge their perception of time to be shorter or longer than the actual playing time.

The confusion on time perception arises when different fields of research conduct studies on time perception from different points of view (Hammond, 2012). For example, neuroscientists argue that different parts of the brain produce different ways for humans to perceive time; and psychologists argue that time perception is a subjective experience. Not only do the different representations of time lead to different results in players' time perception, but the differences in time perception paradigms and the methods to measure time perception are also contributing to produce different results.

James (1890) divides time perception paradigms into two: the prospective paradigm, and the retrospective paradigm, believing that different variables affect these two different senses of time. The prospective paradigm is a judgment as to when a person is aware of the need to estimate time before they experience the time duration, whereas the retrospective paradigm is a judgement as to when a person is unaware of the need to estimate time until the period of time has passed and they later have to estimate the time duration. Zakay and Block (1997) assert that these two terms can also be referred to as experienced duration (prospective) and remembered duration (retrospective). They argue that the former additionally requires attention and that the latter additionally requires memory for estimating the time. Block (1992) find that these two paradigms have different processes where one is more affected compared to the other, depending on the event.

Through an in-depth analysis of these two paradigms, Zakay and Block (1997) found that there was one variable that affected prospective time estimates but not retrospective ones – the processing complexity of an experimental task. For example, an experiment involving a simple task and a complex Stroop task (the name of a colour is printed in a color not denoted by the name) conducted by Zakay and Fallach (1984) shows that as the complexity of the task during the experiment increases, time perception in the prospective paradigm decreases, suggesting that participants have less attention to allocate to the monitoring of time. This is not an issue in the retrospective condition where the task has already been completed.

Research on time perception in digital games uses both retrospective and prospective time perception paradigms. In the online survey conducted by Wood et al. (2007) to investigate time loss amongst gamers. They provided seven closed questions and six open questions asking players to describe their gaming habits, views, experiences, and strategies in relation to time loss whilst gaming; players describing their experience by referring back to the memory of the playing session. In contrast, Luthman et al. (2009) used prospective time estimation by telling their participants to pay attention to time as they will be asked about it at the end of the study.

In addition, there is a study done by Rau et al. (2006) to investigate playing time found that time distortion occur during gaming sessions however they did not specify which paradigm was used in obtaining the data for playing time.

More recently, Sanders and Cairns (2010) have conducted studies to investigate the relationship between immersion and time perception. They manipulated immersion using music and measured time perception both retrospectively and prospectively. They found that music plays a major effect on immersion: immersion increases when players like the background music being played during the gaming session. For time perception, they found no statistically significant difference in the retrospective paradigm, but found a significant underestimation of time in the prospective paradigm, i.e. players underestimate time prospectively when they are immersed in the game.

Further, there is a clear indication from studying time perception that people perceive time differently depending on how they think about time (Hammond, 2012). Unlike other types of perception, there is no physical manifestation of time in the same way as an object that can be seen, touched, or heard. In fact, there is no internal process that corresponds to a timepiece when players are playing digital games (Sanders and Cairns, 2010). However, Block and Zakay (1997) found many theorists of time perception agree that time perception can be explained in terms of cognitive processes or the interactions between cognitive and biological processes.

2.8 Time Perception Paradigms

2.8.1 Retrospective Paradigm

Retrospective time perception paradigm uses memory to judge the duration and no need the players to maintain attention. It requires and depends on memory to retrieve all the contextual information that was encoded in association with event information during a time period (Block and Zakay, 1997). Many arguments arise about the type of memory that involved in this process. Friedman (1990) suggests a "time memory" theory to explain the memory of time of when a particular event occurred. It consist of two models: the strength model and inference model. The strength model explains time memory as a memory trace that persists over time. Friedman (1993) explains that by using this model, we judge the age of the memory, and this tells us when the event happened based on the length of trace. The longer the event is happening, the weaker the trace because of memory decay. In contrast, inference memory uses the information related to the event in order to judge the duration. Information is gathered during an event that will produce an estimation of time regarding the event. These two models are convincing in explaining how we estimate duration from long term memory, rather than the immediate estimation of duration for events that just happened.

Block and Zakay (1997) explain the remembered duration of a time period is affected by the amount of contextual changes stored in memory and available to be retrieved at the time of duration judgement. These include changes in environmental context, mood, and how a person processes the duration. We perceive duration as being longer when we spend time performing multiple tasks (as opposed to just a single task). Also, we estimate a duration as being longer when we are processing complex stimuli and a duration without a segmented period (constant activity). This is because of the varied kinds of processes required to do so (Block and Zakay, 1997) . The retrospective paradigm also allows a person to encode temporal information with the information retrieved from memory (Block and Zakay, 1997).

2.8.2 Prospective Paradigm

The prospective paradigm uses attention to estimate time perception (Block and Zakay, 1997). Duration estimation in this paradigm depends on attention demanding processes that occur concurrently with the non-temporal information (Zakay and Block, 2004). When you are told that you have to estimate time, you become more sensitive to the temporal task. By having another non-temporal task, your attention is divided between two. This influences the accuracy of estimating the time. By having more and more non-temporal tasks, it reduces the capability to accurately estimate time. Therefore, when attention is divided between several tasks at one time, time estimation is affected and the duration judgement become shorter than the actual time.

The attentional gate-model suggests that when attention is distracted from the temporal information, fewer temporal pulses are accumulated and a situation is perceived as shorter (Zakay and Block, 1995). Based on this attentional gate-model, temporal pulses are produced by the pacemaker in the human internal body clock (Zakay and Block, 1995). The pacemaker generates regularly spaced pulses at a fixed rate per second. The attentional-gate is a cognitive mechanism controlled by the allocation of attention to time (Zakay and Block, 1995). The prospective paradigm also allows a person to intentionally encode temporal information as an integral part of the experience (Block and Zakay, 1997).

Based on this model, when more attention is focused on time, the attentional-gate opens wider or more fully (Zakay and Block, 1995), and more temporal pulses can go through the gate. This increases accuracy when estimating time; but when attention is diverted and being focused on the other non-temporal tasks, the gate is closed, and time is perceived shorter because the temporal pulses are not passing through, decreasing accuracy. This model is usually used to explain complex human timing behaviours (Zakay and

Block, 1995).

2.9 Factors That Influence Time Perception

Time perception can be influenced by many factors such as age (Zélanti and Droit-Volet, 2011), physiological factors – body temperature, mood, emotion, etc (Meissner and Wittmann, 2011) – music (Cassidy and MacDonald, 2010), visual stimuli (Droit-Volet et al., 2004), and mental health (Roy et al., 2012); amongst others. Following are the brief explanation on the factors that influence retrospective and prospective time perception.

2.9.1 Factors That Influence Retrospective Time Perception Paradigm

Memory is the important element for retrospective time perception paradigm. In this paradigm, time estimation is made based on the memory. There are several factors that influence retrospective time perception paradigm namely segmentation of events (Zakay et al., 1994), duration length and the number of stimuli (Block and Zakay, 1997). Zakay et al. (1994) argue that one event which consists multiple segments in it for example multiple tasks is perceived longer retrospectively. This is because one task is stored as one temporal cue in the memory storage. Having many tasks would increased the number of temporal cues in the memory which would influence that estimation where time is perceived long retrospectively. In addition, Block and Zakay (1997) add that the greater the number of stimuli of a task consist of higher contextual changes that increase the memory storage size. This influences the retrospective time perception paradigm. Moreover, Block and Zakay (1997) show that a short duration estimation is perceived longer retrospectively because participants are able to recall the contextual changes accurately which makes the time is perceived as longer.

2.9.2 Factors That Influence Prospective Time Perception Paradigm

Different intensities (i.e. speeds) of visual stimuli influence how people perceive time prospectively. Time is perceived to be faster when the visual stimuli is faster, whereas time is perceived to be slower when the visual stimuli is slower (Droit-Volet et al., 2004). The background of a digital game could have an impact on the overall gaming experience, and could also affect the player's time perception.

The prospective paradigm using the production method works very differently indeed. Instead of measuring time based on memory and recalling past events, it requires participants to actively be aware of time. Therefore, any underestimation or overestimation is easier to discuss. We could investigate why participants' estimation of time is not similar to the exact given time. This phenomenon can be described by the Scalar Timing Theory (STT) (Wearden, 1999). This theory suggests that human time perception consists of clock, memory, and decision processes. Further it is also equipped with a pulse generator (automatic) and attentional gate. When attention is focused on a non-temporal task, the gate opens wider and more pulses go through the gate. At this point, time is perceived as quicker. That is why when we are performing a boring task, we often focus on the time and it makes time move slowly. The greater the intensity of a visual stimulus on a background screen, the more interference with the human clock, which indirectly tells the cognitive processes to allow more pulses to go through the gate, and leads to the perception that time is moving more quickly. We were expecting to see this effect in the fast Starfields condition in Study Five, but as time was measured retrospectively, these pulses could not be counted and participants instead had to use their memory to estimate time.

Further, the difficulty of the task also influence prospective time perception paradigm (Hicks et al., 1976). Performing difficult task influence prospective time perception in which participants perceive time as shorter and stop earlier than the actual time. This also can be seen when participants conducting multiple task (Block and Zakay, 1997). Having multiple tasks reduces participant's attention on the temporal task, thus reducing the accuracy of the prospective time perception paradigm.

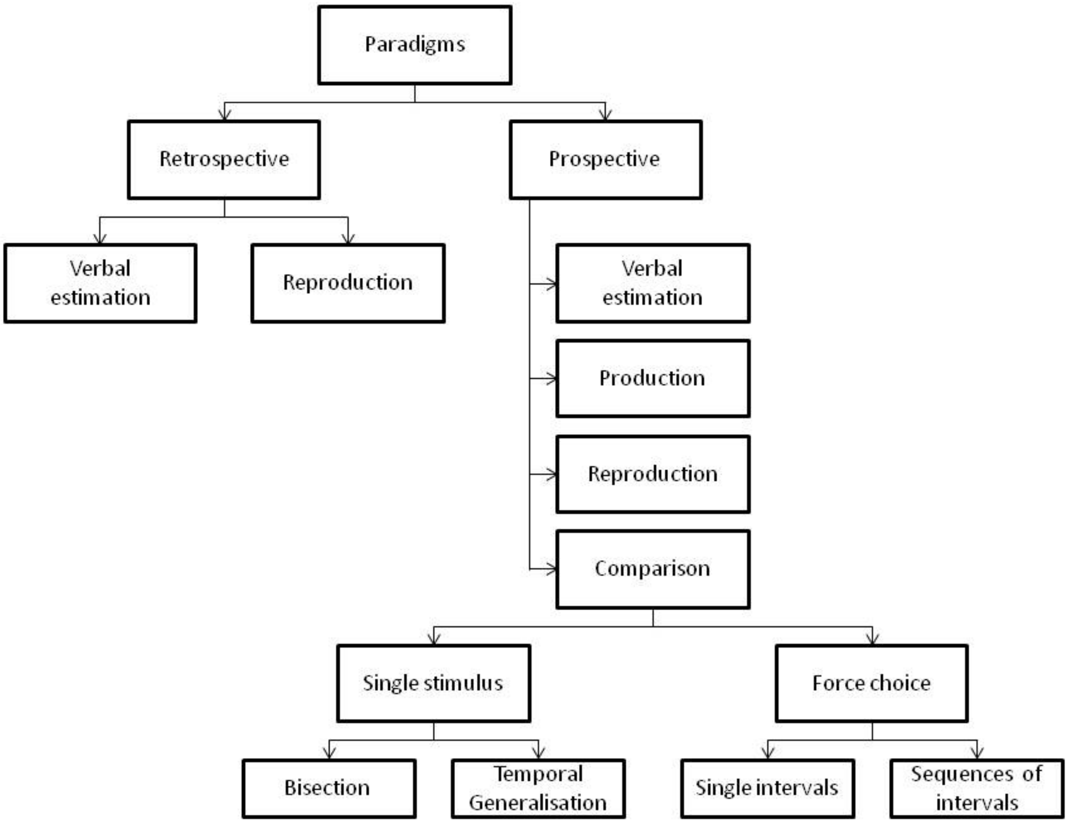
In short, both paradigms use different mechanisms, with the former based on memory and the latter depends mainly on attention to process the temporal information. The confusion of paradigms and methods is still a debate between researchers in the area of human time perception. Similar to researchers in the area of digital games, there is no specific paradigm and method suggested to be used to conduct time perception in the context of digital games. This research thus will focus to investigate further into the methodological aspect in conducting time perception experiments whilst playing digital games.

Without substantial evidence on which paradigm is the best way to measure time perception of gamers, this thesis will cover both of the paradigms. Time perception is measured retrospectively in the first five experiments, with the rest then using the prospective one.

2.10 Methods to Measure Time Perception

There are four different methods to measure time perception, namely:verbal estimation, production, reproduction, and comparison (Grondin, 2010). All of these methods could be used in prospective paradigm but only two methods namely verbal estimation, reproduction can be used in retrospective time perception paradigm. Figure 2.1 shows the diagram for time perception paradigms and methods.

Figure 2.1: Methods Available in Measuring Time Perception in The Different Time Perception Paradigm. Source: Grondin (2010)



Zakay and Block (1998) argue that these methods use different cognitive processes and that the time estimation produced reveals those processes. In the first of the four methods – verbal estimation – a person experiences a target duration which they must then translate into an estimation statement in some temporal units (seconds, minutes, or hours) (Zakay and Block, 1998) . However, the variations in this method are very high. This is because different people have learnt to judge time with different proficiency (Block and Zakay, 2001). On the extreme end, a participant struggling to translate their subjective experience into a numerical estimation of time may simply give a random estimation.

Secondly, the production method requires a person to attempt to delimit an objectively measured duration corresponding to a verbally stated time period (Block et al., 1998). For example, they are asked to say "stop" when they think two minutes have passed has passed. This method requires a translation, but in this case it is in the reverse direction, meaning from an objectively labelled duration to a subjectively experienced duration. The third method is the reproduction method. It does not require verbally stated units Block et al. (1998), but a person experiences the target duration and later they are required to delimit another time period that is the same length. This relies on a comparison of experiences rather than of conventional temporal units.

The fourth method – comparison – is divided into two submethods: single stimulus and force choice. In a single stimulus comparison, a person judges the duration after being introduced with a temporal duration (i.e that duration is a short/long duration). This judgement involves assigning the interval into either a short or long category (Block et al., 1998). The classical way to apply this comparison is called the bisection method: it familiarises a person with the shortest and the longest (standard) interval several times. Then, the person is presented with several different temporal intervals and must categorise them as being closer to one of the two standards. The second way to apply the single stimulus comparison is called temporal generalisation. A person is introduced initially with the midpoint (standard) of the interval several times. Later on, subsequent intervals are introduced and this person needs to indicate "yes" or "no" as to whether the intervals presented are of the same length as the standard (Grondin, 2010).

For the force choice comparison, there are two ways to conduct the duration estimation. First is by a single interval where a person is introduced to two intervals and required to compare whether the second interval is longer or shorter than the first one. Secondly, we can apply sequences of intervals where a person is introduced first with the standard interval and second with the comparison intervals. Later on, being introduced with several intervals and required to compare these intervals with the standard and comparison intervals (Grondin, 2010).

Recall that, time perception for similar event can be produced differently depending on the paradigms. Block and Zakay (1997) argue that some variables only affect one particular paradigm and not another one. Friedman (1990) adds that the variations in the flow of subjective time, how people experience the sense of the chronological past events, human mental model and people hold different views of time also influence human time perception. He adds that the vicissitudes of what occurs, what we notice and what we remember affects our ability to perceive time. There are many variables that influence how we perceive time.

Therefore, the question about which method to be used in researching time perception in digital games is one of the big challenges we must address. We found that some of the methods were not suitable for understanding players' estimation of time whilst playing digital games – this will be discussed more in the experimental chapters of this thesis.

2.11 Measuring Time Perception whilst Immersed in Digital Games

Grondin (2010) argues that the categorisation of temporal experiences is not clearly defined by researchers. It entirely depends on the type of research and the expected outcome from the research. As research in time perception covers multiple areas – including social psychology, experimental psychology, and phenomenological perspectives – many different ways of measuring time have emerged.

Time can easily be measured using any ordinary timing device, such as a watch, clock, or mobile phone. In experiments investigating subjective or experienced time, however, it is somewhat more complicated; in particular, memory processes of gamers are needed for them to describe their experiences related to time retrospectively (Grondin, 2010). Clearly, there is a huge difference between asking players about their playing time after a gaming session, and asking them to measure time perception during the gaming session. Investigating time perception whilst playing digital games using both paradigms will help to build a stronger argument about what is going on.

As this research uses theories from psychology, most literature on time perception is concerned with measuring very short amounts of time (up to 120 seconds) (Droit-Volet et al., 2004). Psychologists are interested in understanding the model of human time perception. Most of the experiments were done using music, light signals, or speech, and the unit of measurement is typically in milliseconds. This type of study is crucial in understanding and developing the human time perception model, but when it come to playing digital games, is completely unrealistic; few gaming sessions are only 120 seconds long!

For time perception research in the context of digital games, Tobin and Grondin (2009) have applied these two paradigms to understand how adolescents perceived long durations during gaming session. Their findings support that these two paradigms can be used for long durations as well. They found that short playing durations were overestimated and the long playing durations were underestimated. The time used was 8 minutes for short and 24 minutes for long sessions.

In term of engagement with digital games, there is no evidence suggesting a minimum amount of time required to become engaged with the game. But as this thesis focuses on the investigation of immersion and time perception using casual/puzzle games, players can engage in a short time because the gameplay of casual/puzzle games is designed to be easy and the rules are straightforward. No prior experience of longer trail needed to understand the gameplay. This type of game could make players bored if they play them for too long (Halim et al., 2010).

2.12 Conclusion

The rich variety of the gaming experience is indeed contribute to the difficulty to identify the exact experience of playing digital games. However, *immersion* has been commonly used by players, designers and reviewers of games to describe the experience of playing digital games. Therefore, this thesis specifically focuses on the investigation of immersion.

One of the said consequences from immersion is players are losing track of time. It is suspected that there is a link between immersion and players' time perception whilst playing digital games which this thesis aims to investigate in details. The literature presented in this chapter is thus a description of my understanding of the digital games, experiences of playing digital games, immersion, immersion and time perception, time perception paradigms and methods to measure time perception.

Several factors that influence immersion and time perception are identified from the literature. As both notions are cognitive processes, the major challenge in this research is to identify variables that manipulate immersion which do not have a direct effect time perception. Conversely, the variables that manipulate time perception which do not have a direct effect on immersion. On the other hand, another challenge that has been identified from the literature is having different time perception paradigm and several methods to measure time perception in the context of digital games.

Therefore, acknowledging all of these challenges, this research first focuses on manipulating immersion to test its effect on time perception where time perception is measured using retrospective paradigm. This is followed by manipulating time perception to test its effect on immersion where time perception is measured prospectively. Further analysis is conducted using meta-analysis to test the single effect on time perception when time is manipulated. Finally, a grounded theory is conducted to understand how players perceive time whilst playing digital games.

3. CHAPTER THREE: MANIPULATING IMMERSION

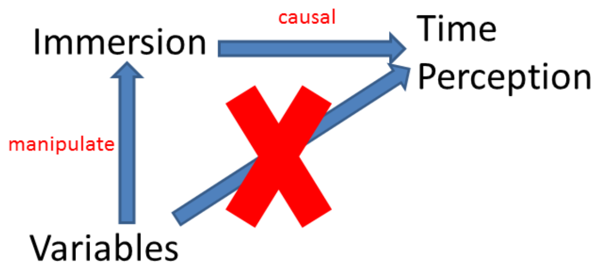
The research question this thesis investigates is very specific: "does immersion influence time perception whilst playing digital games". With this question in mind, this chapter describes the first four experiments intended to manipulate immersion to see the effect on time perception. The initial results from these four experiments suggest a dissociation between immersion and time perception. However, it is just tentative. It is assumed that perhaps the retrospective time perception paradigm is not suitable to be used in measuring time perception in the context of digital games. Thus, there were not effects on time perception in all studies.

One experiment that manipulate time perception is conducted to test the retrospective time perception paradigm after these four initial investigations. Although this chapter is designed to discuss the manipulation of immersion to test its relationship with player's time perception, this one paticular study which manipulate time perception is added in this chapter is because of all of the studies presented in this chapter are applying retrospective time perception paradigm to measure time perception whilst playing digital games.

The primary aim is to test whether changes in immersion have significant effects on players' time perception. To proceed, we have to consider which independent variables that we can use for all of these five experiments. We have to ensure that the manipulations only affect immersion without also directly manipulating time perception. Both notions are cognitive processes and the manipulation of immersion could also directly manipulate time perception. If this is not controlled properly, the results produced will be difficult to be interpreted or may be unreliable. Figure 3.1 illustrates the interaction between variables and the causal link between immersion and time perception.

Little is known as to how to do this since research focusing on immersion and time perception is relatively new. Unlike research on time perception specifically in the context of digital games, research on immersion is not new in the area of Games User Research as seen in 2.2.3. Jennett (2010) argue that immersion can be manipulated by manipulating the barriers to immersion from the players (i.e. preferences, expertise), the games, and the environment. Indeed, players are less immersed whilst playing digital games

Figure 3.1: The Variables to Manipulate Immersion and Causal Link between Immersion and Time Perception



when barriers available from the game and the players are increased. When these barriers are introduced to players, they have to invest their attention to overcome them, thus reducing their attention on the game and resulting in a reduced immersive experience (Brown and Cairns, 2004).

Not only that, we also need to consider which time perception paradigm and method should be applied in the experiments to measure players' time perception. Though there is lack of literature on time perception in the context of digital games, there are multiple general ways of measuring time that could be applied based on research from psychology. The multiple methods available however are confusing because different paradigms and method produces different result. Up to today, there is no accepted unified methods proposed to measure player's time perception whilst playing digital games.

Studies conducted by Sanders and Cairns (2010) suggest that the model of human time perception developed from by psychology researchers can be used to investigate the effect of immersion on players' time perception (example of studies on time perception using this model can be seen from James (1890); Gilliland et al. (1946); Block and Zakay (1997); Wearden and Lejeune (2008); Grondin (2010)'s works).

Recall, Sanders and Cairns (2010) ran two studies to investigate the effect of immersion on time perception using these paradigms. They also found that players underestimate time when they are immersed in the games. However, this is only seen in the prospective time perception paradigm; not retrospective. One of the major drawbacks from their study is that music also has an effect on time perception (Kellaris and Kent, 1992), reminding us that the key problem in conducting experiments on immersion and time perception is the methodological dilemma. That is to say, the challenge of identifying variables for use in the experiments that only manipulate immersion and not directly on time perception.

Acknowledging the problems of multiple paradigms and methods to measure time perception, this research starts its investigation by following previous research studies. The first part of this research focuses on manipulating immersion whilst playing digital games. We identified two factors from players to be manipulated, namely the player's motivation to play (Study One) and the player's cognitive processes (Study Two). One factor from the game platform (Study Three). Another one factor from the environment namely surroundings lighting (Study Four). For Study Five, moving Starfields on the background screen is used to manipulate time perception. Immersion level is measured using the Immersive Experience Questionnaire (IEQ) because of reasons as described in the literature review chapter (Jennett et al., 2008).

For all five experiments, time perception is measured retrospectively (Grondin, 2010). Attention is the main element for immersion (Jennett, 2010) and it also the core function to estimate time prospectively (Block and Zakay, 2001). Although there is no clear evidence that immersion and time perception are sharing the same resources (especially attention), we argue that using the prospective paradigm whilst manipulating immersion could confound the results. If results show that time perception is affected, it is difficult to explain whether the significant effect on time perception is caused by immersion or because of the manipulation variables. In contrast, the retrospective paradigm uses memory as the core function to estimate time (Block and Zakay, 2001). Therefore, if any changes on immersion scores significantly affect time perception, we could conclude that perhaps there is an association between immersion and time perception, as the variables to manipulate immersion are being controlled in a way so as not to influence time perception.

In addition, many research studies on time perception whilst playing digital games were conducted by asking participants to retrospectively describe their experiences during playing. These studies implicitly used retrospective time perception to understand players' time perception during gaming session (for example (Rau et al., 2006; Wood et al., 2007; Tobin et al., 2010)).

Alongside the main aim to investigate the effect of immersion and time perception, all the experiments are also trying to overcome the methodological dilemma. The results from all the experiments suggest an indication that there is dissociation between immersion and time perception. However, the retrospective time perception paradigm is worrying. Because the duration estimation using this paradigm usually tend to produce verbal estimation which is less accurate and also producing a 5 minute effect (participants tend to round their estimate to the nearest 10 or 5 minutes). It may be a problem of measurement rather than manipulation that influences the results.

3.1 Study One: Want to Play (WTP) vs. Have to Play (HTP) (Retrospective Paradigm)

One of the factors that influences immersion is the player (Jennett, 2010). Indeed, the first barrier that reduces the immersion level is related to player's preference towards the games (Brown and Cairns, 2004). Brown and Cairns (2004) argue that if a player does not like the game, they will not enter the first stage of immersion which is engagement. On this premise, our first study focuses on manipulating the player. This manipulation is represented by player's motivation to play the game. The motivation is reduced by limiting their ability to choose their time slot during the experiment to play digital game. Hopefully by limiting this ability to choose the time slot would make them feel they have to play the game.

The player's motivation is a subjective topic. Przybylski et al. (2009) represent the motivation to play digital games as high levels of basic psychological need satisfaction. "Psychological need satisfaction" is a term developed from self-determination theory (Przybylski et al., 2009) which means that one's psychological need satisfaction would foster either harmonious passion or obsessive passion for playing digital games. These two type of passions are however come from player's intrinsic motivation. Harmonious passion occurs when the player really wants to play the game, whereas obsessive passion occurs when someone is told to play. When gamers want to play digital games, for example, the basic psychological need satisfaction increases, thus it helps to increase the harmonious engagement with the playing activity. On the other hand, low levels of need satisfaction would promote obsessive passion for games and contribute to the feeling that game play is something one feels compelled to or has to do. These two are important because they determine someone's passion to play digital games.

It is very hard to manipulate players' motivation to play digital games. This is because intrinsic motivation amongst the participants is different and it entirely depends on personal issues (Przybylski et al., 2009). They argue that when players want to play the game, this influences to create positive experience from playing digital games. Olson (2010) conducted a study on motivation for digital game play among children and revealed that motivation affects children's emotions about electronic game use. She suggests that it is important to see how motivation influences children's decision as something that they want to do when they are bored. It shows that when they are bored, children are becoming more motivated to play the game as they have got nothing to do. Similar phenomena apply to adult players too; they play digital games because they want to and no one forces them to play (McGonigal, 2011).

Several factors influence player's motivation to play digital games. Yee

(2006) found three major components that motivate players, namely: achievement, social component, and immersion. In contrast, Cairns et al. (2014a) argue that players are not playing digital games to be immersed but they are immersed when they play digital games. It seems to be that immersion is not the motivating factor to gets players to start to playing digital games, but it is rather a motivation for players to keep playing digital games. Hence, on that basis from the literature it is argued that a player's motivation does have an influence on their immersion. Therefore, it is assumed that by limiting participant's freedom to choose when to play reduces their motivation to play as if they have to play the game. In terms of time perception, only intrinsically motivated players are argued to experience time passing more quickly (Fielding et al., 1992). This is only when they have a high harmonious passion – which is an intrinsic motivation.

To manipulate player's intrinsic motivation is however a very difficult task. To increase player's intrinsic motivation in the laboratory setting is challenging. Participants know they are participating in the study, is is hard to justify if they really want to play the game. Hence, to introduce a "have to play" condition, this study manipulates player's ability to choose the time slot to play digital games is hope to reduce player's motivation to play (rather than their intrinsict motivation). This is because they are assigned with a specific time slot for them to come and play the game – they have to come and play the game. However, it is assumed that it would not affect player's time perception because player's intrinsic motivation is not being manipulated. The manipulation focuses on the factor external to intrinsic motivation.

To ensure that the variable "player's motivation" only affects immersion and not time perception, this study is focusing only on removing the player's ability to choose when to play. By doing this, we argue that the experimental design will only affect player's preference and not their intrinsic motivation. In the "have to play" condition, the ability to choose when to play play is reduced by limiting players choice to play at any time by assigning participants a specific slot to play digital games. The given slot might not be suited to the player's preference, thus influence their immersion level. In addition, when participants have the freedom to choose the time slot to play, this increases their motivation to play which then affects them to experience time is moving quickly.

3.1.1 Aim and Hypothesis

The aim of this study is to evaluate the effect of player's motivation on game immersion. The particular focus is characterised by the phrases "want to play" (WTP), which refers to the condition where participants have the freedom to choose when to play, and "have to play" (HTP), which refers to the condition where the player's freedom to choose the time to play is removed. Immersion is hypothesised to be higher when players WTP compared when they HTP digital games.

On the other hand, if time perception is associated with immersion, time perception is hypothesised to show a difference between both conditions if immersion scores are significant difference. Although at the time of design, it was not clear whether participants would underestimate or overestimate the time during which they were immersed in the games, but our main aim was to test if changes on immersion will directly influence time perception in some way, i.e. show a significant difference between conditions.

3.1.2 Design

As the changes in each participant from one condition to the other are of interest, and to reduce the error variance associated with individual differences, the experiment used a within subject design. Participants were randomly allocated into two groups, and were counter-balanced for gender and the order of play. Each participant was allocated randomly to being in the WTP condition first, followed by the HTP condition (or vice versa).

The independent variable was the ability to choose the time slot to play digital games. The WTP condition was created by allowing participants to play their favourite game at their preferred times. Whereas, the HTP was created by specifically assigning participants a specific slot to come and play their favourite games. In the WTP condition, participants were given a period of five days to choose from, and they could come in on any day and at any time during that period. In contrast, in the HTP condition, participants were assigned to a specific time slot, assigned by the experimenter. The gaps between each session ranging from 7 to 9 days. The primary dependent variable was the immersion scores and the secondary dependent variable was participant's time perception.

3.1.3 Participants

The total number of participants in this experiment was 19 (16 male and 3 female). Most of them are students from the Department of Computer Science, University of York. Their age range was between 18 and 40 years old with a mean age of 26.37 (SD=5.15). Participants were screened prior to the experiment. As the manipulation is the player's preferred slot to play digital games, all of the other preferences on the games need to be controlled. Therefore, in this study, the player's experience with the game is important. To ensure that their preference on the game is controlled, it is essential to use their favourite games in the experiments. The information about participants' favourite games was gathered by asking them to fill up a preliminary questionnaire. This questionnaire consisted of questions about the amount of time spent playing games before, favourite game genres, and which game they would like to play in the experiment. After the process of selecting participants was completed, all the games that participants wanted to play during their session were purchased. Instead of asking participants to bring their favourite games to the home lab, the games were purchased because of the needs for the research group at the department to have a collection of games for future studies. It is crucial to use participant's favourite games because it is pointless to manipulate player's preference on the slot to play if the games used in the experiment are not their favourite games. All participants spent an average of 1 to 3 hours playing digital games in every session, several times a week. All of them received a £10 Amazon voucher at the end of the experiment.

3.1.4 Materials

The experiment was conducted in the living room of the Home Lab in the Department of Computer Science, University of York. The consoles used were Nintendo Wii, PlayStation 3, PlayStation 2, and Xbox. The decision of which platform to use was made by the participant before the experiment started. This was done by asking all potential participants to fill in a preliminary questionnaire to gather all the information regarding their preferred games and consoles.

Table 3.1 lists all the games chosen by the participants for the experiment:

The screen size for the monitor used in this experiment was 21", and the distance from the couch to the cabinet was 1.5 m. Participants played their preferred game for both conditions, however, they had to start from the beginning in their second condition. No participants were allowed to save their game level. This was done to ensure both sessions have the similar gameplay. Having different gameplay would be the confound for the experiment.

The home environment was monitored to ensure optimum conditions, i.e. a temperature between 20°C to 25°C, and consistent lighting levels during the experiment. The environment inside the room was well lit and all the blinds were closed – including on the glass door. Further to this, participants were required to switch off all their electronic devices and to keep them together with their watch in a box prepared before the experiment. The box then was kept on the coffee table next to the sofa during the running of the experiment (to avoid distraction). The duration for them to play in both

Table 3.1: Games and Consoles Used in the Experiment.

PlayStation 2	PlayStation 3	Xbox	Nintendo Wii
Devil May Cry 3	Uncharted 3	Gears of Wars	Legend of Zelda: Skyward Sword
Resident Evil 3	Assassin's Creed: Brotherhood	Assassin's Creed	Mario Galaxy 2
Onimusha 2	F1 2011	Call of Duty	Tennis
FIFA 12	Need for Speed	The Elder Scroll IV: Oblivion	Brain Training/ Touchmaster
Gran Turismo 4	FIFA 12	Batman Arkham Asylum	Resident Evil
		Guitar Hero	Mario Kart Wii
		Call of Duty-Modern Warfare 3	Tennis
		Street Fighter	Wii Sport Resort

Figure 3.2: The Living Room in the Home Lab at the Department of Computer Science, University of York, UK. Photo Credited to: John Houlihan

conditions was 17 minutes. The stopwatch function from the Blackberry Bold 9700 was used to measure the playing time.

Demographic details were gathered using a paper demographic questionnaire covering factual matters such as age, gender, occupation, and participants' gaming history including frequency of play, average playing duration, and the amount of years they have been playing. Immersion was measured using the IEQ (Jennett et al., 2008).

For the first session in both conditions, an extra question was added at the end of the questionnaire asking players to estimate the duration of playing time by choosing one out of 60 boxes. In contrast, in the second session for both conditions, at the end of the questionnaire participants had to compare the playing duration as either shorter, longer or similar to the first session using a 5-point Likert scale (minimum 1 which represents very much shorter; maximum 5 represents very much longer; and 3 represents similar).

3.1.5 Procedure

Participants were randomly divided into two groups. Participants in group 1 were allocated a specific date and time for their session in the first week of the experiment. They were required to come and play the game on the given slot. Otherwise, they would be discarded from the analysis. Participants in group 2 were told that they could come and play their favourite game at any time from 9am to 8pm from Monday to Friday in the second week. After completing the first session, participants in group 1 were told that for their second session, they could come and play their favourite game at any time from 9am to 8pm from Monday to Friday in third week. In contrast, participants in group 2 were allocated a specific date and time to play in fourth week. During this session they had to come and play their favourite game on the given slot. Otherwise, their data would be discarded.

The experiments ran for a month with one group and one condition for every week. Having discussed and received a consent form for each session, participants were introduced to the game platform and their preferred game. Once the experimenter was confident that participants understood the task and instructions, they were allowed to start playing it. Their playing time was measured from the moment they were told: "the experiment starts now". Gaming sessions lasted for 17 minutes (1020 seconds). No tutorial time was needed, since every participant was very familiar with the game and its gameplay, allowing them to engage easily without having to concentrate on settings and controls (Brown and Cairns, 2004). Participants were told to stop playing after 17 minutes (1020 seconds), and then were required to complete the paper IEQ and demographic questionnaires. They were debriefed about the aim of the experiment after they completed both sessions.

3.1.6 Results

To see if there is any effect of the motivation on immersion, the total immersion score was calculated from the IEQ. Table 3.2 shows the mean and standard deviation for the total immersion score in both conditions. Whereas Table 3.3 shows the mean and standard deviation for time perception (first session) and time comparison (second session).

Table 3.2: Mean and (Standard Deviation) for Immersion Scores and Time Perception between Conditions

	Want to play	Have to play
Immersion	116.47 (11.98)	118.63 (13.28)
Time Perception (seconds)	1060.00 (307.41)	912.00 (231.17)

Table 3.3: Mean and (Standard Deviation) for Time Perception and Time Comparison between Conditions Measured in Seconds

Time perception in the first session	Time comparison in the second session
982.11 (272.92)	1.79 (1.03)

Using a paired samples t-test, the immersion scores were tested further to investigate if the difference was significant. Time perception for the first session was tested using an independent t-test. The results show no significant difference in immersion scores between WTP and HTP, $t(18) = -0.483, p = 0.635$. Moreover, the effect size for immersion is small, *Cohen's d*= 0.07. Figure 3.3 shows a box plot for immersion scores in both conditions. There is no *prior* need to exclude the outliers given that the results was similar (not significant) when they were excluded.

Similar to immersion scores, there was no significant difference in time perception between the WTP and HTP, $t(17) = 1.194, p = 0.249$. The effect size for time perception is medium, *Cohen's d*= 0.54. Figure 3.4 shows the box plot for time perception in both conditions.

Interestingly, on average all participants were significantly underestimating playing time in their first session, $t(18) = -3.480, p = 0.003$. This underestimation was tested using a one sample t-test with a test value of 17 minutes (1020 seconds). We also analysed whether participants feel that the second session was shorter or longer using a one paired sample t-test with a test

Figure 3.3: The Box Plot for Immersion Scores between Conditions

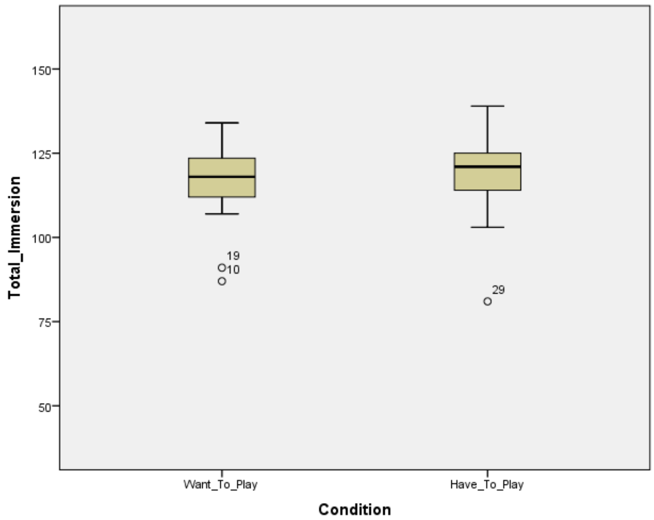
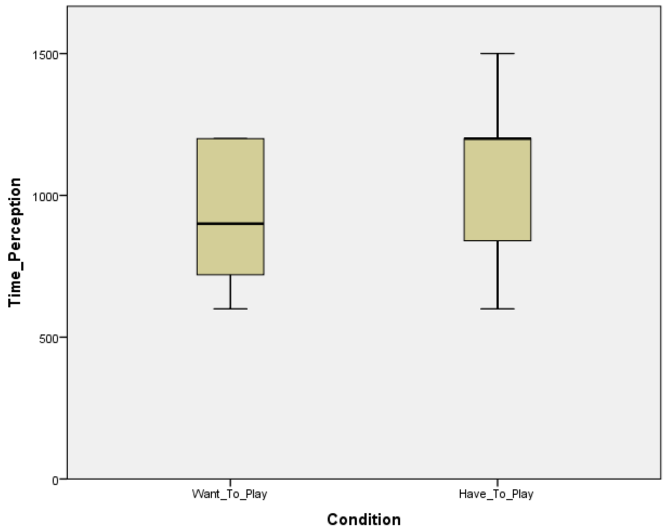


Figure 3.4: The Box Plot for Time Perception between Conditions



value= 3 (represents similar duration) and shows non-significant results with $t(18) = -0.046, p = 0.964$.

3.1.7 Discussion

The results reject the hypothesis. There is no significant effect of players' motivation (based on their prefered time slot to play) on the level of immersion whilst playing digital game. The results suggest the same for time perception: no significant effect of players' motivation on time perception. However, the results shows a strongly significant underestimation of time perception when players play in the first session. This may be due to participant's verbal estimation close to around 15 minutes (900 seconds). Yarmey (2000) argue that participant round up their retrospective time perception to the near 10 or 5 minutes. They could estimate time perception based on the gameplay.

This study was not able to manipulate immersion. Firstly, having the ability to choose the slot to play digital games during the experiment may be not similar to player's intrinsic motivation which has an impact on immersion. By limiting player's freedom choose the slot and assigned them to come to play on a specific day and time is suspected did not create the HTP condition. It can be assumed that in both conditions participants feel that they have to come and play because they may feel that they are obligated to complete the experiments. It could be that, players feel that they have to play in both conditions.

Motivation is very subjective and it is not manipulated easily. It is different from one person to the other. One of the major factors that influences motivation is emotion (Buck, 1988). Giving participants the opportunity to come at any time should be able to motivate them to play, but we could not control the emotional levels at the time of the experiment of participants which has a direct effect on motivation (Buck, 1988). This is one of the variability that might has an effect on the results. It could be that participants just had a tough day and decided to come and play their game; but having a rough day in the department could influence their emotions and directly affect their motivation. In addition, participants allocated to slots at the end of the day may be more tired – fatigue could also influence player performance. In (Mousseau, 2004)'s dissertation, she found that fatigue reduces attention allocation and reducing performance in the game. As for this study, we did not consider participants' levels of fatigue before the experiment, which may have influenced the manipulation variable.

On the other hand, by giving participants the opportunity to choose to their favourite game on their preferred console could introduce noise the experiment. As stated, playing digital games is all about the experience (Jennett et al., 2008). Different games consist of different actions. The tasks and aims of each games are different. Some of them require a narrative element to enhance their experience, whereas some of the games do not require this and are more straight forward. For comparison, *Elder Scrolls Oblivion* game consists of an interesting narrative that players follow, compared to *Wii Sport Resort*, where player just choose a sport and start playing. The controls are also not similar – another factor that the experiment did not control. It could be that the different types of games, genre, and platforms contributed to the inconsistent results.

For the results on time perception, it suggests that most of participants underestimating time in the first session. We suspect that participants used their verbal estimation on duration to play close to 15 minute. People are able to estimate time with practice (Zakay and Block, 2004), and 5, 10, 15, 20, etc minutes are often used in daily life which might influenced participant to choose these amount of duration. Also, it appears that people tend to round their estimations to the nearest 5 minutes (Yarmey, 2000). We call this rounding behaviour the “5 minutes effect”.

In addition, the gap from the first session to the second session was too long. The gap was between 7 to 9 days and therefore this led participant to having similar experiences in term of immersion. This influenced how the participant behaved during the experiment. One thing that we did not record was when the participants last played the game. During the debriefing session, two of the participant told us that they had to try and recall everything about the game again. The first session was mostly a reintroduction session where participants were trying to get to grips with the controls, the storyline, and other factors of the games. Perhaps this influences their immersion experience. Whereas in the second session they are getting used to it but they have to repeat it again.

Future work could ensure that the game chosen is not a game that participants had mastered before – but was not a completely new game either. One of the participants complained that he liked to play *Call of Duty* and that he is expert at it, but he never played it on a console, and he requested to play this game on console during the experiment. Playing the same game on different platforms produces different experience. This somehow contributed to a less immersive experience. When gamers are not familiar with the controls they cannot get into the first level of engagement (Brown and Cairns, 2004).

All in all, this study did not successfully show that motivation – when participants were given the freedom to choose the slot to play – influences immersion. Also, this experiment did not show the association between immersion and time perception. The variability in the study was substantial with hindsight that the experiment was properly controlled but a lot of aspect about the methodology on investigating immersion and time perception were learned from this study. This is useful for future experiments. The creation of the motivation is not easy to be replicated and manipulated in the control experiment. It suggests that the it is crucial to identify the variable that can be controlled in the experiment. Further, we argue that, a better manipulation is needed to manipulate immersion whilst playing digital games.

3.2 Study Two: Suppress Thoughts (Retrospective Paradigm)

The manipulation of the player's motivation to play the game did not work; in particular, it did not create the "want to play" condition. Further, there was indisputably variability that could influence the results in Study One. Thus, it makes it difficult to conclude whether the potential results produced were because of the manipulation or because of the variability. Hence, this research is continued by focusing on another manipulation on players.

Immersion is a cognitive sense that is influenced by cognitive processes (Jennett, 2010). Cox et al. (2012) found that cognitive processes during the gameplay can be manipulated by increasing the level of challenge in the game. In this study, we are still focusing on manipulating player's cognitive processes in order to increase their immersion scores. However, the manipulation needs to be narrowed down to reduce the noise that was observed in in Study One. Hence, this experiment manipulates players' cognitive processes before they play the game, rather than during the gameplay.

The specific mechanisms that cause immersion are not yet identified. It is cognitive engagement that allows gamers to experience the sense of "being in the game" (Jennett et al., 2008). How this cognitive engagement works and how it increases immersion is still not fully understood. As cognitive processes are important for immersion, increasing the difficulty of the cognitive task will affect player's cognitive processes thus it could reduce the immersion. However, to do this during the gaming session will again contribute to the huge noise and confounds in the experiment.

Cognitive processes can be manipulated by increasing the difficulty of the task. (Kahneman, 2003) argue that we use two types of cognitive processes, namely: System One and System Two. In psychology, these two systems are referred to as *Dual Process Theory* (Kahneman, 2003). System One is automatic and unconscious. It is effortless and could be based on intuition. It is associative but requires more time to learn. In contrast, System Two is a rule based system. It is controlled by situation, and is flexible in order to ensure it is usable when needed. System Two also require more effort. This theory has been used widely in the area of consumer psychology, e.g. for understanding consumers' decision making processes (Kahneman, 2003).

In his book, Kahneman suggests that System Two is a single resource within the brain such that whenever we are engaged in effortful activities, this resource is used. This means that if the energy for this resource is depleted, then System Two works less well. This phenomenon is called ego depletion and has been studied in a substantial body of work by Baumeister and his group (Baumeister et al., 2000). In their studies, they used the task of answering arithmetic questions as a tool to expend resources in the cognitive processes. When more resources are expended and used this will produce a condition called "ego depletion". When someone is in this state, they become less able to function effectively, e.g. by regulating itself or exerting volition. Its effect is rather to conserve remaining resources – rather than full exhaustion – but it is still possible that one experiences exhaustion. This will increase the self's optimal functions and does not to heavily rely on habit, routine, and automatic processes.

Hence, the manipulation for this study focuses on increasing participant's effortful cognitive activities, producing a big ego depletion. A big ego depletion causes cognitive processes – especially System Two – to be exhausted. As playing digital games requires more resources from our dual process theory, experiencing a big ego depletion could affect participants' immersion in the game. For time perception, it is argued that time is perceived as longer prospectively when completing effortful activities that people are not enjoying and it should not affect retrospectively time perception (Block and Zakay, 2001). In addition, in this study the focus on time perception is during the gaming activity and not during their first task. Therefore, the manipulation should not affect player's time perception.

3.2.1 Aims and Hypothesis

The aim of this experiment is to investigate the difference in immersion scores when people have first been asked to do an effortful task that would require System Two to be engaged and would result in ego depletion. The hypothesis is that participants experience less immersion when they perform an effortful task before a gaming session. Therefore, if time perception is affected by immersion, the difference in immersion changes time perception too. The hypothesis for time perception is time is perceived shorter during the gaming activity compare to performing effortful task before.

3.2.2 Design

The experiment was a between subject design. The independent variable is the activity to be done before the game playing session. In the first condition, the task was to sit quietly for five minutes listening to classical music. Mozart music, available from `www.youtube.com` was chosen because of the so-called Mozart effect (Thompson et al., 2001), i.e. that listening to Mozart music may improve the cognitive processes. The other two conditions are: first to answer moderately difficult arithmetic question (3 digit numbers multiplied by 3 digit numbers), and secondly, the "suppress thoughts" condition, in which participants are told not to think about a white bear, which should suppress thoughts more than the maths condition. This is because, it requires a high level of self-control not to think of the subject that being suppress (Wegner et al., 1987)

The primary dependent variable was the immersion scores, and the secondary dependent variable was time perception. The hypothesis was that immersion will be higher in the control music condition than both the other conditions, in which it should be less. For time perception, playing time is expected to be perceived shorter compare to sitting and listening to music. Whereas playing time is perceived longer compare to answering arithmetic questions and suppress thoughts condition.

3.2.3 Participants

Participants were found by opportunity sampling, and were recruited from the Ron Cooke Hub, University of York. There were 30 participants, of which 24 were men and 6 women. The mean age of the participants was 25.88 (SD: 5.25) with the youngest being 19 years old and oldest 45 years old. Most of the participants rated themselves as playing games more than one hour per week. The most common game played was a casual game on mobile phones (i.e facebook games), and the most preferred genre of games was first person shooters. Only 15 of the participants had previously played *Mario Kart Wii*.

3.2.4 Materials

It can be very easy to choose a game that is not enjoyable and therefore leads to low immersion. Based on previous studies, *Mario Kart Wii* seemed like a good choice: it has broad appeal (Mario Kart Wii has sold a whopping 31.9 million units around the world in 2011 [1]), is easily learnt, and provides a good gaming experience. In addition to the game, the questionnaire was printed out on paper for the participants to read. The questionnaire consisted of several demographic questions followed by the IEQ. In this study, participants did not need to estimate time, but they had to answer a question asking them the compare whether the playing session is shorter, similar or longer than their first task.

3.2.5 Procedure

The experiment was conducted in the living room of the Home Lab, in the Department of Computer Science, University of York.

[1] http://www.nintendolife.com/news/2012/01/mario_kart_wii_races_past_30_million_sales_milestone

Participants were welcomed and given the informed consent form to understand, discuss, and signed. For first condition, participants were asked to take a seat and wait (for five minutes, but they are not informed about this time duration) in the dining room of the Home Lab. During this time, if they were in the listening to music condition, experimenter left the room whilst Mozart music was playing in the background of that room. For the math problem condition, they were given moderately difficult multiplication problems to solve on paper and the other group of participants, in the suppress thoughts condition, they were told to write down their thoughts on a piece of paper while trying to avoid thinking about a white bear.

Pretesting indicated that both tasks were perceived as equal in difficulty and unpleasantness but the suppress thoughts condition should involve more self-regulation and therefore cause a greater ego depletion and thus a greater effect on immersion. After working on the assigned manipulation task for 5 minutes, the experimenter stopped participants.

After the first session completed, participants were taken to play *Mario Kart Wii* in a different room. After playing for 7 minutes, the experimenter stopped the player and asked them to complete all the questionnaires. The participants were then debriefed as to the goals of the study.

3.2.6 Results

Data collected was transcribed on a single spreadsheet. Table 3.4 summarises the means and standard deviations for the immersion scores and time comparison for the two different conditions.

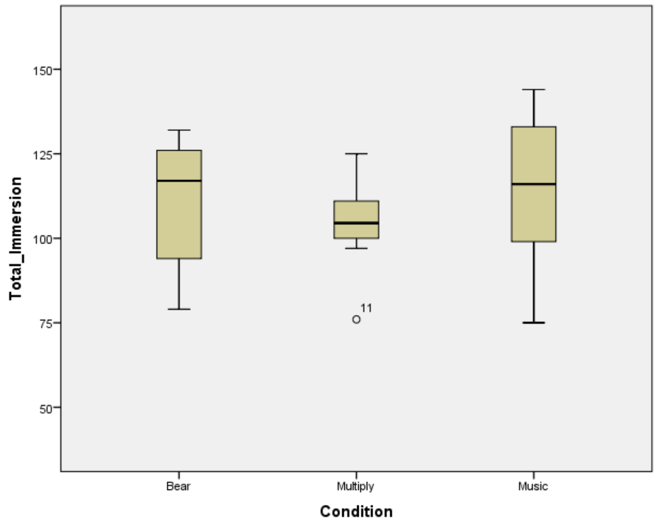
Table 3.4: Mean and (Standard Deviation) for Immersion Scores and Time Comparison between Conditions

Condition	Immersion	Time Comparison
Music	114.30 (21.72)	3.4 (0.70)
Arithmetic test	104.00(12.73)	3.4 (0.70)
Suppress Thoughts	109.50(20.32)	2.8 (1.32)

The result was tested using ANOVA test suggesting no significant difference on immersion levels, $F(2, 27) = 0.761, p = 0.477$, $\eta_p^2 = 0.050$, suggesting small effect. Figure 3.5 shows the box plot for immersion scores across conditions. There is not reason to exclude the outlier for the analysis given the results without it was similar (not significant).

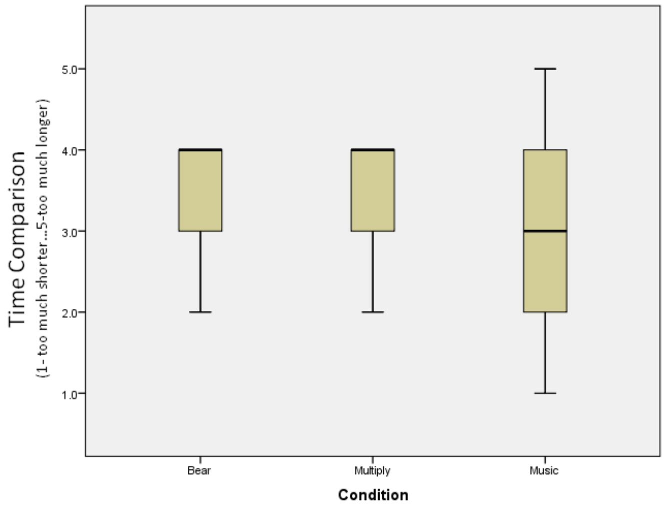
Similar to time comparison, there was no significant difference between conditions, $F(2, 27) = 1.328, p = 0.282$, $\eta_p^2 = 0.090$, suggest that the effect

Figure 3.5: The Box Plot of Immersion Score between Conditions



was small. Figure 3.6 shows the box plot for time comparison between conditions.

Figure 3.6: The Box Plot of Time Perception between Conditions



One sample t-test with test value = 3 was conducted to test whether participants estimated that the first session was longer or shorter compared to their playing time. The result, $t(29) = 1.140, p = 0.264$ suggests that in all three conditions participants did not significantly feel that the first session was any different in length.

3.2.7 Discussion

The results do not support our hypothesis. Participants' immersion levels did not decrease, although System Two was being used effortfully. Performing a difficult cognitive task should use more resources in the System 2 and reduce the player's cognitive resource to concentrate, thus potentially reducing immersion. Similar to time perception, there was no significant difference between conditions. It is still unclear whether immersion influences time perception in digital games.

In the suppress though condition requiring participants to *not to think about white bear*. This task was supposed to be a challenging task because the thought to be suppressed tends to rebound after suppression is discontinued from the low self-control strategy (Wegner et al., 1987). This means that participants in this condition need a high self-control to not to think about something that we are told to. Usually at one point, we will reach the rebound that causes us to think about it. In this experiment, participants were left in a fully furnished living room with some academic poster on the wall. The suppress thought task become a secondary task since the layout of the dining room is full of furniture, photo frames of the scenery, and academic posters, allowing them to distract their attention from the thought to suppress. In fact, all of them in the condition told me that they were reading the posters during the task. They were also questioning the information in the posters. This strategy seems to allow them to increase their self-control on the thought to be suppressed.

On the other hand, the results are affected by the unfortunate randomisation of participants. The randomisation of participants in suppress thought groups unfortunately allocated the more experienced gamers, who love to play Mario Kart, and enjoy the game. All of them were really competitive; some were really skilled at the game. The expertise affects how participants treat the game – those with experience knew what to do. As Brown and Cairns (2004) argue that players experience high immersion when they like the game and know its controls, their immersion scores were higher than hypothesised.

The experiment manipulated players' cognitive processes in the first task to investigate its effect on immersion. However, with the lack of literature on the cognitive processes in the context of immersion, the results suggest perhaps that cognitive processes in the first task are different from the cognitive processes whilst playing the games. Little has been done to prove that there is a link between cognitive processes in the context of immersion and cognitive processes in suppressed thoughts. More should be done to establish or refute this link.

It is challenging to identify the variables that manipulate immersion only without a priori manipulation on time perception. The findings from Study One and Study Two suggest that manipulating players could have a huge noise and high variability, because the manipulation is not something that we can control. These are methodological explorations, and at this point we have learned the challenges. Therefore, to proceed with this research, we decided not to focus on the manipulating the player but rather the surroundings. This will give us more complete control of the experiment.

3.3 Study Three: Mixed Reality Game vs. Desktop Game (Retrospective Paradigm)

We have learnt that to manipulate players' motivation by limiting the freedom to choose the slot to play, and to manipulate players' cognitive processes consist of huge source of variability. Further, it was difficult to manipulate players and control the the manipulation in the laboratory experiments. It is challenging to isolate the variable to only manipulate immersion without a priori manipulation on time perception.

Therefore, in this study, we are now focusing on manipulating the gaming environment. This gives us full control of the manipulation in the lab. Our aim is still similar to those of the previous two studies. We want to manipulate immersion and test its effect on players' time perception. If immersion does influence time perception, any changes in immersion levels will significantly affect time perception. We start to manipulate the environment by manipulating the platform of the games, using both a PC and iPad, and mixed reality games. We describe briefly mixed reality games before presenting the experiment.

Mixed reality (MR) is a combination of augmented reality (AR), where artificial objects are added to the real world environment using AR mediated tools, and augmented virtuality (AV), where physical world objects are added into a fully immersive virtual environment (Thomas, 2012). Their play experience is not fully contained by a virtual or physical world (Bonsignore et al., 2012). It can be played indoors or outdoors, using either head-mounted displays, handheld displays, or projector-based displays. Recently, Thomas (2012) claims have been made that the use of handheld displays on the mobile devices is an exciting direction for mixed reality games. This is because the pervasive nature of mobile devices perfectly fits the gameplay of mixed reality games.

Run Zombie, Run! is an example of such a game. It is played on the iPhone, iPad or on another compatible smartphone device (Lammes, 2011). The game requires gamers to carry their mobile phone around whilst chasing or avoiding zombies. The background in this game is the real environment.

When we consider studies of the experience of playing digital games, there has been substantial research in a wide range of areas, including the role of aesthetic factors (Anderson and Bushman, 2001), and even narrative ones (Qin et al., 2009) on the gaming experience. The similarity of these studies is that all of them were focused on the manipulation of the game, investigating its effect on player's immersive experience. On the same premise, the argument is that by changing the background of the game (virtual environment vs. the real environment) would affect a player's immersion whilst they are playing the game. Therefore, this study is conducted using mixed reality games (real environment as the background) vs. desktop games (virtual environment as the background).

Clearly, mixed reality games integrate the real environment into the gameplay. It increases awareness of the player's surroundings. Studies conducted by Jennett et al. (2008) suggest that being increasingly immersed in a game would decrease one's ability to re-engage with the real world – so what would happen to immersion if the real world surroundings are now part of the game? Arguably, immersion could increase, because the whole world is now part of the game, and so players literally are in the game. On the other hand, it might decrease, because the action in the real world distances people from the "virtual" actions in the game.

Real world dissociation is one of the elements of immersion (Jennett et al., 2008). Playing digital games with a virtual background on any gaming platform should disassociate the player from the real environment. In this study we try to provoke the player's immersion by integrating the real world surroundings into their gaming session. We suspect that by adding the real environment into the gaming session, immersion will reduce.

For time perception, the only possible chance that playing mixed reality games would influence time perception is the awareness of the surroundings could influence the temporal cues in the memory (Block and Zakay, 2001). If each movement in the lab increases the temporal stamp in the memory, we would be able to test this later (Block and Zakay, 1997).Therefore, having a high awareness of the surrounding in the mixed reality games couldould influence participants to overestimate the time because the temporal cues are higher than sitting on PC game. However, it is argued that this manipulation would not influence time perception because having the awareness of the surroundings is not similar with having more task to increases the temporal stamps in the memory.

Also, if time perception is significantly different – but not immersion – then we could argue that there is perhaps a dissociation between immersion and time perception. We believe that the manipulation in this study will have less variability because the manipulation is something that we can control. In comparison to the previous studies, we could not control the manipulation on the players. Also, we learnt that giving check boxes for intervals of one minute did not push participant to try to think more precisely about their playing time. Thus, in this experiment, we provide participants intervals of 30 seconds, which we hope to reduce the so-called 5 minute effect.

3.3.1 Aim and Hypothesis

The aim of this study is to investigate whether any changes in immersion will alter players' time perception. The hypothesis is that immersion levels will be higher in the desktop environment compared to the pervasive environment. The hypothesis for time perception is participants overestimate time perception in the mixed reality condition compare to those in the PC condition because the high awareness of the surroundings increases the contextual changes in the memory.

3.3.2 Design

The experiment was a within-subjects design. The independent variable was the game's environment which is divided in two conditions: the experimental group plays games in the pervasive environment, whereas the control group plays games in the desktop environment. The primary dependent variable was the immersion score (IEQ score), and the other dependent variable was the participants' time perception for the duration of their gaming session.

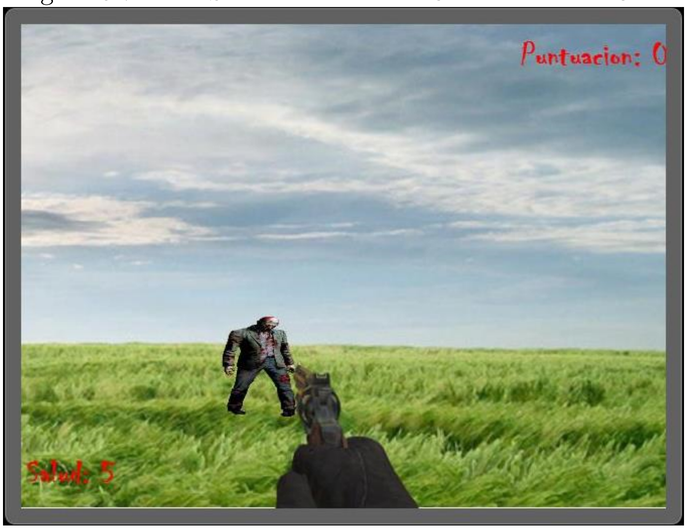
3.3.3 Participants

The total number of participants was 29 (12 were female and 17 were male), all of them from the Universidad Politecnica de San Luis Potosi, Mexico. All of them were recruited by opportunity sampling around the campus, and were undergraduate students at the university. The age ranged from 18 to 32 years old with the mean age of 21.76 (SD= 2.94). All of them had experience playing digital games both on desktops and iPads. On average, they played digital games at least once a week. All of them were counterbalanced and assigned randomly to any condition first.

3.3.4 Materials

The devices used were a first-generation Apple iPad and a desktop computer. The screen size of the iPad was 250mm (diagonal), with a resolution of 1024 by 768 pixels. The monitor size used with the desktop computer was 21" (resolution 1366 x 768). The game used for this study was specially developed by two undergraduate students namely Alejandro Alonso and Ricardo Abel Martinez Vivanco from the Department of Information Technologies and Telematics, Universidad Politecnica de San Luis Potosi, San Luis Potosi, Mexico as a part of their summer project. It ran as a native app on the iPad and standalone platform on the desktop (rather than inside a browser). The game was called "*Catcha-Zombie*". In this game, zombies run across the screen and the player has to shoot them. On the iPad, this achieved by touching them on the screen; on the desktop, this is achieved by using a mouse click. Figure 3.7 is the screenshot for the game on desktop.

Figure 3.7: The Screenshot for the Catcha-Zombie Game



The background of the game for the iPad was the real environment in the lab. Participants had to move around with the iPad for the zombies to appear, whereas in the desktop environment, the background was created virtually, and participants had to use the arrow buttons to move around. This genre of game was chosen due to the simple nature of its gameplay, requiring no prior gaming knowledge or experience: it was intended to be just as easy for the first-time gamer to understand and pick-up as it would be for life-long gaming enthusiasts.

A stopwatch from a mobile phone was used to measure the time taken to play the game. The Immersive Experience Questionnaire (IEQ), consisting of 31 questions, was translated into Spanish by the lead researcher in Human Computer Interaction, Dr. Eduardo H. Calvillo Gámez. Eduardo is an Assistant Professor at the Department of Information Technologies and Telematics, Universidad Politecnica de San Luis Potosi, San Luis Potosi, Mexico. This was done because the medium used at the university was Spanish, therefore to avoid participants from struggling to answer the questionnaires in English, it was translated in Spanish. This translation was checked by the language lecturer at the university. It was uploaded as a Google form for participants to fill it online after they had played the game. There was also a short demographic questionnaire covering factual matters such as age, gender, occupation, and participants' gaming history, including frequency of play, average playing duration, and experience in playing games on an iPad. Time perception was measured using an open answer question retrospectively. They did not have any prior knowledge of the need to measure time before they play the game.

Great care was taken to ensure that the environment the game was being played in was the same for every participant, with each participant playing the game in the same room. The blinds in the lab were shut to avoid distraction from natural lighting and people walking by in the corridor. The experiment was conducted in the User Experience Lab, Centro de Nuevas Tecnologias (CNT) Building, Universidad Politecnica de San Luis Potosi, Mexico. The lab was set up as a living room with a complete set of furniture. A desktop computer was place at one corner in the lab.

3.3.5 Procedure

Participants were given a consent form, which they discussed and signed. Then, they were asked to sit in a chair with the desktop computer on the table in front of them. A brief explanation and demonstration of how to play the game followed. Afterwards, the experimenter left the room to leave the participant alone in the room with the game. They were not made aware of the requirement to estimate time.

In the first session, participants were asked to play the game on the desktop or iPad, and the next day, to return and play the game on the other device. To avoid any bias and learning effect, the order of play was fully counter-balanced. Once the experimenter left the room, the timer started. After 7 minutes, the experimenter returned to the room and asked the participant to fill in the IEQ and demographic questionnaires online via the Google form. In this study, an extra question about time perception was asked at the beginning of the questionnaire asking players to estimate the duration of their playing time by ticking one of the check boxes. One box represents 30 seconds. The minimun value was 30 seconds and the maximum value was 30 minutes 0 second.

3.3.6 Results

To see if there was any effect from the type of game background (virtual or mixed reality) on immersion, the total immersion score was calculated from the IEQ. Table 3.5 shows the mean (and standard deviation) for the immersion scores, time perception, and immersion components in both conditions

Using a paired samples t-test, the results were tested further to investigate if the difference was significant. The test shows that there was a signific-

Table 3.5: Mean and (Standard Deviation) for Immersion and Its Components between Conditions

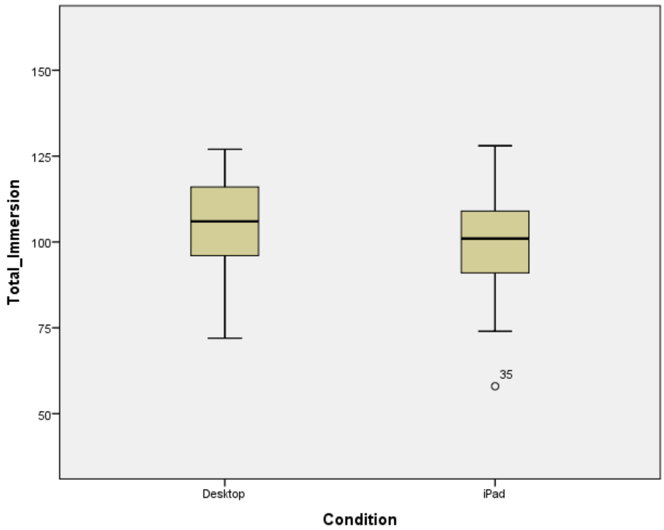
Components	iPad	Desktop
Immersion, $t(28) = -2.104, p = 0.043$	98.97 (15.14)	104.14 (14.05)
Time perception (seconds), $t(28) = -1.951, p = 0.061$	504.83 (300.97)	411.72 (182.64)
Real World Dissociation, $t(28) = -1.051, p = 0.302$	19.48 (5.12)	20.62 (4.75)
Emotional Involvement, $t(28) = -2.087, p = 0.046$	18.03 (4.09)	19.62 (4.17)
Cognitive Involvement, $t(28) = -2.221, p = 0.035$	32.48 (5.02)	34.41 (4.77)
Challenge, $t(28) = 0.112, p = 0.911$	12.86 (2.83)	12.79 (2.80)
Control, $t(28) = -1.026, p = 0.314$	16.10 (2.82)	16.69 (3.19)

ant difference in the immersion scores for the iPad and desktop conditions, $t(28) = -2.104, p = 0.043$. Using *Cohen's d*= 0.395, the effect size was calculated indicating a medium effect across conditions. Figure 3.8 shows the box plot of immersion scores in both conditions. There is no *a priori* reason to exclude the outlier because it does not affect significance. Therefore, it is included in our analysis. As this was a within participants design, we also checked for a difference in immersion between the first and second conditions as done by between subject test and there was no effect, $t(28) = 0.664$, $p = 0.183$.

Since the overall immersion scores are significantly different between conditions, the other components were therefore further tested to see where the difference in immersion might be strongest. The tests show that there was only a significant difference between the conditions in Cognitive Involvement, $t(28) = -2.221, p = 0.035$ and Emotional Involvement, $t(28) = -2.087, p = 0.046$. There were no significant effects on Real World Dissociation, $t(28) = -1.051, p = 0.302$, Challenge, $t(28) = 0.112, p = 0.911$, and Control, $t(28) = -1.026, p = 0.314$

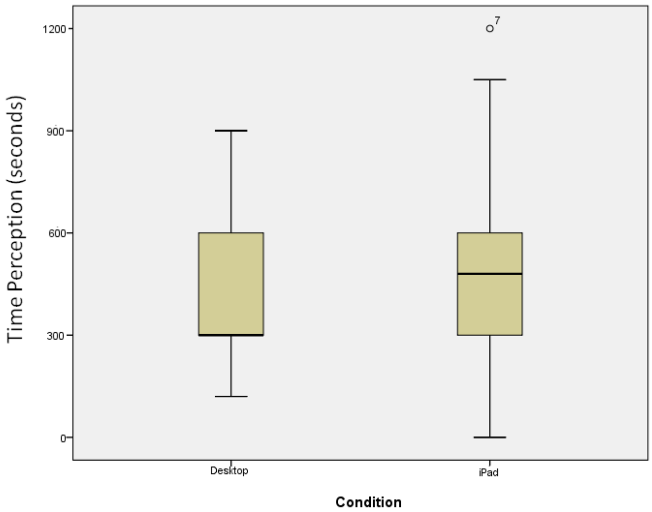
Time perception was marginally significant $t(28) = -1.951, p = 0.061$, between conditions. Using *Cohen's d*= 0.37 shows that the effect for time perception was small. Figure 3.9 shows the box plot for time perception in

Figure 3.8: The Box Plot of Immersion Scores between Conditions



both conditions.

Figure 3.9: The Box Plot of Time Perception between Conditions



To test whether the overestimation in the mixed reality group was significant, the result of time perception was tested using a one-sample t-test with the test value = 420. There was no significant overestimation in the mixed reality condition $t(28) = 1.518, p = 0.140$.

3.3.7 Discussion

The results support our hypothesis that immersion is lower in the MR game in comparison to the desktop game. The effect is quite modest but clear. What is interesting is that the difference in immersion is not due to a difference in the real world dissociation component. Thus, players are not particularly feeling that they are not in the game world as an immediate consequence of playing in the pervasive style. Instead, immersion seems to be reduced in the levels of emotional and cognitive involvement that players feel in the pervasive condition.

However, there is marginally significant effect on players' time perception. Retrospective paradigm uses memory to refer back to the gaming duration. It stores the memory into several event slots. The more events that happen at one time, the more temporal cues that are generated and stored the memory (Block and Zakay, 1997). The results show that participants who play the mixed reality game overestimate time compared to those in the desktop condition. This could be that they were aware of their surroundings whilst playing the game, which generates more events to be stored. However, the statistical test shows that the overestimation was not significant. We argue that the duration of 7 minutes is too short to produce more temporal stamps. If they stored many stamps, then at the moment they look back to their playing time, they will process all of these stamps as many events, and should significantly overestimate time. This is because playing the mixed reality game requires participants to move around the lab; they are doing more than one single activity during the gaming session. Block and Zakay (2001) add that most traditional experimental designs on time perception use dual-task activity to manipulate the experimental condition. They found that those who are performing more tasks overestimate time retrospectively.

Similarly, this experiment also faced the same challenges from previous studies on the experimental manipulation. The variable in this study is isolated but we are still unsure as to whether it has an effect on time perception. Although we tested overestimation, and it shows that participants did not overestimate time, we are not yet certain whether the manipulation has an effect on time or not because the variation in gameplay is so different between the two platforms. We have tried to control all of the possible confounds, but it is still possible that the differences in immersion levels are due to the different game environments. Pervasive gaming brings the real environment into the game, and here, even required the participants to walk around and tap the iPad (as opposed to the desktop version where gamers sit and click); one could argue that this difference in input style (touch input and mouse input) might have led to the difference in immersion levels. From the results however, it does not seem that players were experiencing a difference in immersion due to the control component of immersion which the style of the input plays important roles for control (moving around and moving the mouse) in the games. Therefore, we argue that the different control mechanisms in both conditions did not influence the results.

Furthermore, different amounts of physical activity were needed to control and play the game in the pervasive environment. Thus, participants could have been getting tired holding the iPad whilst touching the screen to kill the zombies. This may have reduced their general level of engagement and immersion (Brown and Cairns, 2004). We are not able to justify if the difference of immersion levels is due to the high visibility of the environment whilst playing on the iPad. Also it is hard to justify whether there was fatigue experienced by the participants. However, we note that the gameplay period was quite short, and thus unlikely to cause fatigue – but this cannot be ruled out.

Mixed reality games increase the visibility of the surroundings and makes the real world more visible. When participants moved around with the iPad, they saw everything in their surroundings which increased their awareness of what was happening around them. The clear visibility and better awareness of the surroundings decreased their attention on the game. They are perhaps attending to the world around them as they play and unconsciously not noticing this (otherwise Real World Dissociation (RWD) would differ); it is taking attention away from the game and hence reducing the sense of immersion. Considering the argument that immersion is only influenced by the dimensions in the games Calleja (2011), this study provides an insight that immersion could also be affected by the surroundings.

3.4 Study Four: Surrounding Lighting (Retrospective Paradigm)

Results from the first three studies suggest the investigations have started to show a successful manipulation on immersion whilst playing digital games when the variable is controlled properly. Although Study Three successfully manipulated immersion by using the mixed reality games, the study however did not control variables from the controller, such as input style, gameplay, and screen size. It is difficult to design studies comparing mixed reality games and PC games without having different controls, gameplay, and the display sizes.

The important lesson learnt from Study Three is that immersion can be manipulated by manipulating the surrounding environment. Indeed, Brown and Cairns (2004) found that players conduct a ritual of controlling the surroundings before they start to play digital games. For example, dim the room and setting the level of the audio. Based on this and the results from Study Three, it seems that the surrounding environment influences immersion.

Based on findings from Study Three, this study is designed to manipulate the environment which is entirely external to the games and the gamers. By manipulating the environment, this study is able to control further variables. Given that players are adjusting the lighting level in the room before they start playing digital games (Brown and Cairns, 2004), we use this as the variable to manipulate immersion. The manipulation focuses only on the brightness of the room.

This is done by manipulating players' awareness of their surroundings in a way that it won't alter how they play the game. We therefore use the different lighting levels to change the visibility and their awareness of their surroundings. This was done by adjusting the lighting level in the room in which players were playing the game. After all, it may not be just a ritual, but as a means of increasing the immersive experience whilst playing.

Brightness is one of the primary visual qualities that describe visual perception (Purves, 2008). Furthermore, it is also used to describe our visual expression of light and dark elicited by different light intensity. Indeed, most of the available information in our surroundings is perceived through our eyes, including both bright and dark conditions (Hartmann, 1963). In a bright condition, we perceive something in sharp and clear view with lots of detailed information that makes it easy for us to recognise and orientate objects. In contrast, these processes are reduced in the dark condition because our visual input is broader, blurry, and lacks colour information.

Veitch et al. (2005) believe the effects of light indicate great variety and complexity of its impact beyond the phenomena of vision. These include on one side the effect on mood and behaviour, and the other, physiological effects on autonomic arousal and hormones. The connection between environmental conditions, darkness and brightness, and visual perception style over conceptual level, together form a mental link between brightness, construal level, and psychological effect.

Mehrabian and Russell (1974) found bright areas with darker surroundings to be unpleasant and a cause of visual discomfort. This is due to the excessive amount of light that causes glaring from the light source. At the same time, they argue that human activity increases as the light intensity increases. This explains why most people are actively working at day time and sleeping at night time. Similarly, Ekrias et al. (2008) argue that lighting in the surroundings helps to increase awareness, especially to drivers whilst driving at night.

Research on lighting was previously focused on visibility and the visual comfort (Veitch et al., 2005). In entertainment especially in the theatre and cinema, many studies on surrounding lightings were focused on the cinematographic effect – stage lightings, lightings in the cinema, and so on. It mostly concerns the ideal amount of light on the stage to produce a better stage effect (Wilson-Bokowiec, 2010). Studies by Knez (1995) proved that lighting plays an important role in affecting the mood of humans. However, in his studies, this effect depends on the gender and age (Knez and Kers, 2000). Younger males generally have a positive mood in dim conditions. In contrast, younger female tend to be in a negative mood in dim conditions.

Considering this and the results from previous study on the effect of mixed reality games (i.e. that having a high awareness of the surroundings reduces immersion level), we present a study that changes the surrounding lighting from dim to bright to increase the awareness of the surroundings and reduce immersion. This can be done by keeping all of the other variables constant – especially the players and the game. With regards to time perception, to best of our knowledge, there is no specific research on the effect of the lighting level in the room on time perception. We argue that by changing the brightness in the room, we would not increase the number of time stamps in the players' memory, because lighting level is not an activity that could produce a temporal event.

3.4.1 Aims and Hypothesis

This study aims to investigate the effect of different lighting levels in the room on immersion in a digital game. The manipulation involves of varying the lighting levels from dim, neutral to bright. This study is based on the idea that lighting levels affect the visibility of the surroundings and influence the immersive experience of players. The hypothesis for this study is that immersion levels decrease as illumination in the room is increased. That is to say, gamers are expected to be less immersed in a bright room.

3.4.2 Design

The experiment was a between subject design. Participants were randomly allocated into three different conditions, balanced to give ten participants in each condition. The independent variable was the lighting condition of the room that participants were playing the game in, with three different conditions (dim, neutral, and bright). The dependent variable was the immersion score in each condition as measured by the IEQ score (Jennett et al., 2008). Participants were also asked to write down their estimation of the time spent in the session in minutes.

3.4.3 Participants

The total number of participants in this experiment was 30. Most of them were students from the Department of Computer Science, University of York, except for one participant who was a visiting research student in the department. Their age ranged between 18 and 40 years old with a mean age of 25.52 (SD=5.57). All of the participants were male, in order to reduce the possibility of participants becoming uncomfortable about sitting in a dark room with a male observer. All participants had previous experience with digital games, spending an average of 1 to 3 hours playing digital games in every session. All of them received a £10 Amazon voucher at the end of the experiment.

3.4.4 Materials

The experiment was conducted in the living room, of the home lab, at the Department of Computer Science, University of York. The platform was a Nintendo Wii and the game used on this platform was Super Mario Galaxy 2. This game was chosen because it requires little time to learn and people can play it with different levels of expertise. It is suitable for this research because participants can easily understand how to control the character and enjoy playing it during the experiment. The display used in this experiment was a 21" flat screen monitor and the distance from which the participants sat was 1.5m.

A light meter was used to measure the lighting level in the room. It has specifications of a maximum range of 400,000 lux with the ± 5% accuracy, and a maximum resolution of 0.01Lux/Fc. The bulbs used in this experiment were tungsten bulbs, and to increase the illumination, additional desk lamps were added during the experiment. All the bulbs were switched on 45 minutes before the experiment to stabilise the illuminant.

The experiment was conducted in the evening after 16:45 during winter, when the outside environment was completely dark. All the windows in the room were covered with blinds to avoid distraction, especially from street lights. The temperature was measured and controlled to be between 20°C to 24°C to provide a comfortable environment for participants, and to ensure that the atmosphere was similar to a comfortable home environment.

The stopwatch function on a Blackberry Bold 9700 was used to measure the playing time. Demographic details were collected: age, gender, and occupation. Furthermore, details about participants' gaming histories was collected, including frequency of play, average playing duration, and the number of years they had been playing. Immersion was measured using the IEQ (Jennett et al., 2008). One question on time estimation was added at the beginning of the questionnaire.

3.4.5 Procedure

The illumination of the living room was measured before each experiment started. This was to ensure the amount of light was constant for each condition: the dim condition (mean of illuminance was 9.39 Lux, SD=0.50), neutral condition (mean of illuminance was 311.81 Lux, SD= 9.26), and bright condition (mean of illuminance was 397.37 Lux, SD= 8.31).

There were no clocks in the room and participants removed watches and cell phones (to avoid distractions). Having discussed and received a consent form for each session, participants were introduced to the platform and the game. Once we were confident that the participant understood the tasks and the instructions, they were allowed to start playing the game; first as a tutorial. The tutorial session begins when the game starts, until Mario flies to the first galaxy. At that point, the participants were informed that the experiment was starting.

The time taken for the tutorial was different between participants. The mean time taken for the tutorial was 6m 53s ($SD = 1.67 minutes$). The playing duration then lasted for 20 minutes. Participants were required to stop playing after 20 minutes, then were asked to complete the immersion and demographic questionnaires. However, in this experiment, they were also required to estimate the time they spent playing, by ticking one of checkboxes (30 second intervals) before filling in the IEQ.

3.4.6 Results

To confirm that the experimental manipulation was having a significant effect on immersion and time perception, the immersion score and time perception were compared in each condition. Table 3.6 summarises the means and standard deviations for the immersion scores, time perception, and all components of immersion in the IEQ for the three different conditions.

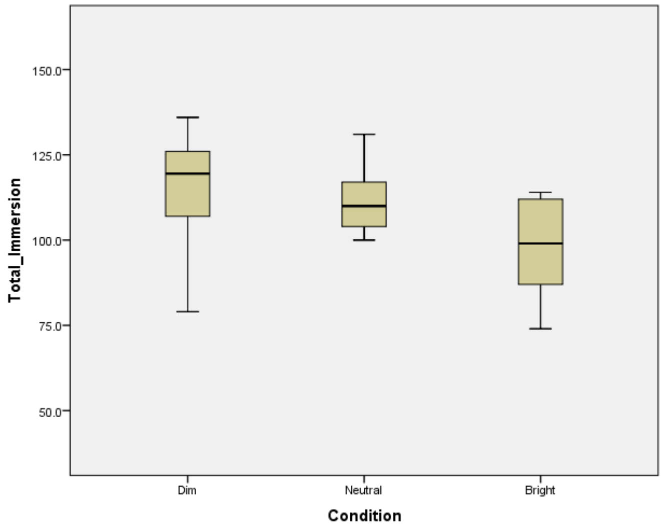
Table 3.6: Mean and (Standard Deviation) for Immersion and Its Components across Conditions

Components	**Dim**	**Neutral**	**Bright**
Immersion, $t(27) = 2.821$, $p = 0.009$, $\eta^2_p = 0.235$	113.30 (18.46)	109.80 (9.09)	95.00 (14.41)
Time perception (seconds), $t(27) = 1.172$, $p = 0.325$, $\eta^2_p = 0.027$	1746.00 (658.76)	1800.00 (509.90)	1950.00 (430.12)
Real World Dissociation, $t(27) = 2.002$, $p = 0.055$	23.80 (4.16)	22.90 (4.23)	20.00 (4.35)
Emotional Involvement, $t(27) = 2.514$, $p = 0.018$	20.80 (5.73)	19.60 (2.63)	15.90 (4.15)
Cognitive Involvement, $t(27) = 2.687$, $p = 0.012$	37.40 (4.97)	36.50 (4.93)	31.20 (5.55)
Challenge, $t(27) = 0.132$, $p = 0.719$	13.50 (3.06)	12.20 (1.99)	11.70 (3.13)
Control, $t(27) = 1.024$, $p = 0.321$	17.80 (3.33)	18.60 (2.32)	16.20 (3.12)

As hypothesised, the mean for immersion score decreases as the level of illumination increases. A contrast was used to test if the change in means supports the directional experimental hypothesis. The contrast was highly significant, $t(27) = 2.821$, $p = 0.009$, $\eta^2_p = 0.235$, suggesting the effect size was calculated indicating small effect across conditions. This means that the hypothesis is supported by the difference in immersion means between the three conditions. (It is worth nothing that ANOVA confirms the difference in conditions, $F(2, 27) = 4.486$, $p = 0.021$, but obviously less significantly because the ANOVA is not explicitly testing the directional hypothesis). Figure 3.10 shows a box plot of the relationship between lighting effect and immersion level.

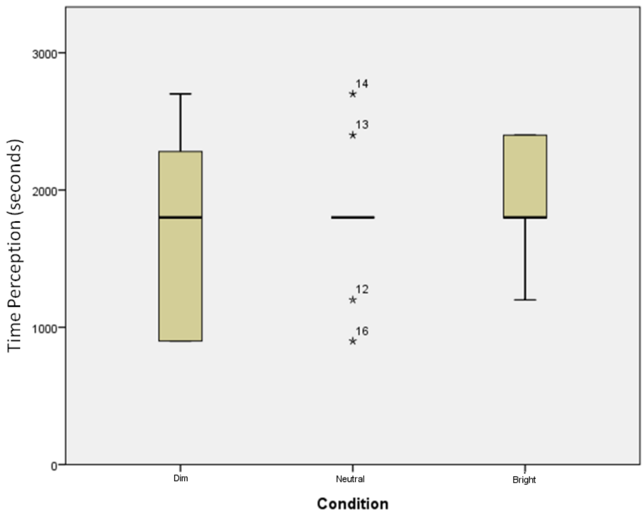
The relationship to components of immersion – in particular Real World Dissociation in the IEQ – was tested using a contrast test, which showed that it is approaching significance, $t(27) = 2.002$, $p = 0.055$. As this is not significant though, similar to Study Three, the other components of immersion were also analysed using contrasts. Again, only Emotional Involvement $t(27) = 2.514$, $p = 0.018$ and Cognitive Involvement $t(27) = 2.687$, $p = 0.012$ show significant support for the hypothesised change in immersion with lighting level. On the other hand, no differences were shown for Challenge $t(27) = 0.132$, $p = 0.719$ and Control $t(27) = 1.024$, $p = 0.321$

Figure 3.10: The Box Plot for Immersion Scores across Conditions



On the other hand, there is no significant difference for time perception between the conditions $t(27) = 1.172$, $p = 0.325$, $\eta_p^2 = 0.027$ suggesting the effect size was small across conditions. Figure 3.11 shows the box plot for time perception across conditions.

Figure 3.11: The Box Plot for Time Perception across Conditions



3.4.7 Discussion

This study shows a strong significant effect of lighting on immersion scores. It supports the hypothesis that lighting level of the surroundings affects the immersion experience of playing digital games. It shows a directional pattern, where immersion scores decrease as lighting level increases. Again, though, this was not strongly manifested through a difference in the level of real world dissociation; it was seen that emotional and cognitive involvement does follow the same trend as immersion overall.

This suggests that lighting really does influence players' experience of playing games. They were not in control of the surroundings at all in this experiment, so there was not the opportunity for the ritualistic behaviour before playing that as described by (Brown and Cairns, 2004). It seems then that in low light conditions, players are better able to become involved in the game and this must clearly be due to a loss of the sense of surroundings, even if players are not wholly aware of this dissociation from their surroundings.

This finding has some consistency with results in other contexts of awareness from surrounding lighting, for example, in Ekrias et al. (2008), drivers' vision is argued to be better when they receive sufficient light on the road. It helps them to be aware of their surrounding and be aware of what could happen while they drive. This seems to apply to gamers, as when they could see their surroundings, they are becoming more aware and thus less immersed in the game.

It may be that in very bright conditions, the increased level of illumination was too artificially bright and that this is what reduced the players' immersion. However, though the room was somewhat unusually bright for a living room, participants were required to play the game in exactly the same way in all conditions, so it could be expected that the opportunity for immersion over the 20 minute playing period was certainly there, and that the bright surroundings were not glaring or uncomfortable – nor preventing them from seeing the screen clearly. It seems that it really was awareness of the surroundings that was influencing their ability to become immersed.

One of the issues in this study is that it was conducted only with male participants. We can only conclude here that the level of brightness has a significant effect of mood among males. Males find themselves more relaxed and happier in dim conditions (Knez and Kers, 2000). The result could be different if we consider female participants and how they become immersed in different level of brightness. Therefore, we suggest that future studies into this effect to include female participants.

Time perception did not show any significant difference during the experiment. In this experiment, we controlled all of other possible variables/confounds that may have influenced the manipulation of immersion and time perception. We argue that the manipulation was not influencing time perception. All of the participants experienced the same type of gameplay, the same type of controllers, and played from the same position (a sofa in the Home Lab). They were not experience different gameplay from one condition to the other that might influenced their time perception. In addition, during the gaming session, they did not have many movements, or performing other non-gaming related activities that could be used as the temporal cues or sequence of events stored in the memory to be referred later to estimate time. Therefore, it is assumed that having the same gaming session for all the condition causing them not to have different time perception estimation.

On the other hand, the gap to recall memory of the playing time was not too long. Participants were first asked to estimate time before they proceed to the IEQ. Therefore, the memory of the playing time was fresh and that was not a factor that influenced the process to estimate time perception retrospectively. Perhaps, although the brightness was different between condition, the gameplay was the same given no different temporal cues in the memory.

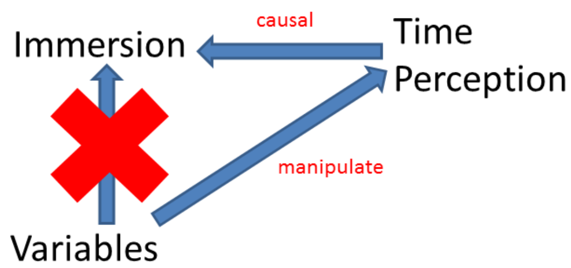
Based on the results from this study, we strongly argue that the manipulation of immersion did work. We controlled all the possible variables and confounds that might influence time perception. Accordingly, we suspect that there is dissociation between immersion and time perception, i.e. immersion does not influence players' time perception. The only concern that we have still is the problem of measurement. We are not confident that the retrospective time perception paradigm is suitable to estimate time perception whilst gaming. The process to recall the duration does not show how the estimation is given. Did participants rely on a specific method to build their estimation, or were they rather completely using their verbal estimation which is an estimation made by players. Although we provide checkboxes denoting possible durations, we do not know whether they produce the duration not based on their verbal estimation. Hence, the next study aims to address this issue.

3.5 Study Five: Visual Stimuli (Retrospective Paradigm)

The initial findings shows that there is dissociation between immersion and time perception but the measurement style is questionable. The retrospective paradigm is not a convincing way to ensure that participants do not only rely on their verbal estimation (a person experiences a target duration which they must then translate into an estimation "statement in some temporal units). Results from Study Four suggest that the manipulation of immersion work. Also, the results show that the manipulation did not indirectly manipulate time perception during the experiment. Therefore, we suspect that there is dissociation between immersion and time perception.

If it is true that there is no association between immersion and time perception, then changes on time perception should not affect immersion. Figure 3.12 illustrates the interaction between variables and the causal link between immersion and time perception. Also, it is suspected that the retrospective paradigm is not suitable to be applied in this research.

Figure 3.12: The Variables to Manipulate Time Perception and Causal Link between Time Perception and Immersion



With this study, we start to focus the investigation of this thesis on the hypothesised dissociation between immersion and time perception. While – unlike the rest of the chapter – this study will focus on manipulating time perception (instead of immersion), we present it here because it also uses the retrospective time perception paradigm. In particular, as we are not convinced that the paradigm is the right one for measuring players' time perception, this study will manipulate time perception – using variables known to influence it – and measure it retrospectively to test the paradigm.

One of the variables that influences time perception is visual stimuli (i.e. the different speed/intensity of moving object). We argue that in this study, time perception will be significantly different between conditions (high speed/intensity vs slow speed/intensity of moving Starfields). Visual stimuli are identified as strongly influencing human time perception. Droit-Volet et al. (2004) conducted studies to investigate the effect of visual stimuli on time perception. They found that a higher intensity of the visual stimuli significantly influences time perception: time is perceived as shorter for the faster stimuli. Indeed, Wearden and Lejeune (2008) explain that human time perception is affected by the number of pulses produced by the pacemaker in our body. They argue that the production of pulses can be influenced by the visual stimuli, where the faster the stimuli is, the more pulses that will be generated by the pacemaker.

With this idea, we manipulate time by changing a visual stimuli on the display – moving Starfields – and measuring time perception retrospectively to see if the manipulation work but time perception could not be estimated prospectively. It is assumed that by introducing the Starfields on the background would not influence immersion because the Starfields are not a part of the game. Players would have similar gaming experience because the gameplay is the same.

3.5.1 Aim and Hypothesis

The aim of this study is to investigate the dissociation between immersion and time perception by manipulating time perception to test its effect on immersion. Furthermore, we aim to test the retrospective paradigm for measuring time perception when playing digital games. The hypothesis is that time is perceived faster in the fast moving stars condition and that immersion will not be statistically influenced.

3.5.2 Design

The design for the experiment was a between subject one. The independent variable was the speed of the moving Starfields, see Figure 3.13 on the screen background; fast Starfields and slow Starfields. The primary dependent variable was immersion, whereas the secondary dependent variable was participants' time perception. Time perception was measured retrospectively by providing options of a small interval (30 seconds) for them to choose from. Immersion is measured using the IEQ.

3.5.3 Participants

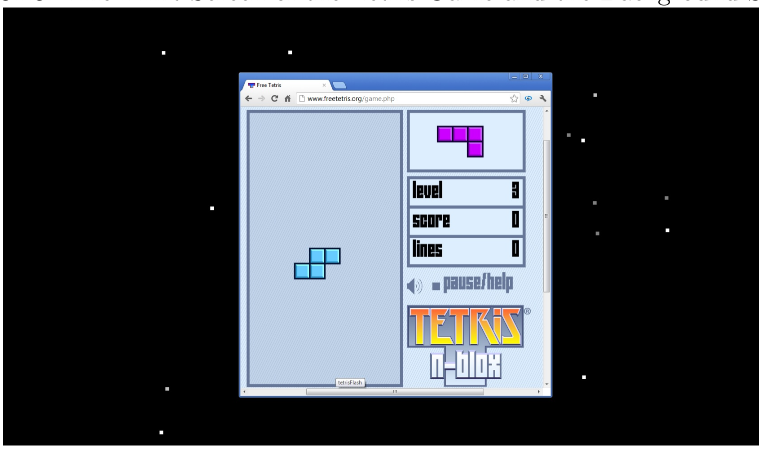
Participants were recruited by opportunity sample around the Department of Computer Science, University of York. There were 32 participants, of which 22 were men and 10 women. The average age of the participants was 21.5 (standard deviation 3.25) with the youngest being 19 and oldest 29.

Most of the participants rated themselves as playing games at least 1 hour several times a week. The most common genre of game played was strategy.

3.5.4 Materials

The moving stars (Starfields) Java source code was retrieved from `http://javadom.com/tutorial/example/StarField.java.txt`. It was modified using the Eclipse IDE to change the number of stars produced each second. The speed of the moving stars was manipulated by reducing the default number of stars generated. The default was 50 stars generated per second. For the slow condition, the number of stars generated was reduced to 30 stars per second, whereas to increase the speed, the number was increased to 210 stars per second.

Figure 3.13: The Print Screen of the Tetris Game and the Background Starfields



The game used was an online version of *Tetris* available from `http://www.freetetris.org/`. Each participant played Level 3 on a desktop computer with a 21" screen with resolution of 1920x1080 pixels. The game was controlled using a typical Microsoft keyboard. The moving stars were set up to be the background screen, with the game adjusted to be in the middle of the screen. In this study we used desktop games because it would be difficult (or even impossible) to modify console games in a way that adds Starfields to the background.

The experiment took place in the living room of the Home Lab in the Department of Computer Science, University of York. To ensure that the surroundings were constant, the blind in the room was shut and all the light was switched on. Participants were also given a headset and the volume from the game was set up at 80%. A smartphone was used to measure the playing time. Immersion levels and time perception were measured from the Immersive Experience Questionnaire (IEQ) (Jennett et al., 2008). Demographic details were measured covering age, gender, occupation, and participants' gaming history, including frequency of play, average playing duration and the amount of years they had been playing.

3.5.5 Procedure

Participants were welcomed and given the informed consent form to fill in, which was discussed and signed. Then, the instructions of the experiment were explained to them. They were also instructed to switch off their mobile and to take off their watch to be kept in a box. The box with their belongings was placed on the table next to them. This was to avoid distraction during the experiment.

They were introduced to the game and given a few minutes to spend on a tutorial. After the participant confirmed that they were confident about the controls and aim of the game, they were told to start playing. The stopwatch from the smartphone was started simultaneously. They were asked to play for 7 minutes 30 seconds (although they were not informed about this time duration).

In the control condition, participants were asked to play the game with the slower stars moving on the screen background, whereas in the experimental condition, participants were playing with the faster stars. After playing for 7 minutes and 30 seconds, the experimenter stopped the player and asked them to complete the IEQ portion of the questionnaire, and asked them to estimate how long they thought they had been playing. The participants were then debriefed as to the goals of the study.

3.5.6 Results

To confirm that the experimental manipulation was having a significant effect on immersion and time perception, immersion score and time perception were compared in each condition. Table 3.7 summarises the means and standard deviations for the immersion scores and time comparison for the two different conditions.

Table 3.7: Mean and (Standard Deviation) for Immersion Scores and Time Perception between Conditions

	Slow Starfields	Fast Starfields
Immersion	103.56 (14.83)	95.75 (17.38)
Time Perception (seconds)	390.94 (96.04)	395.63 (131.21)

Figure 3.14: The Box Plot for Immersion Scores between Conditions

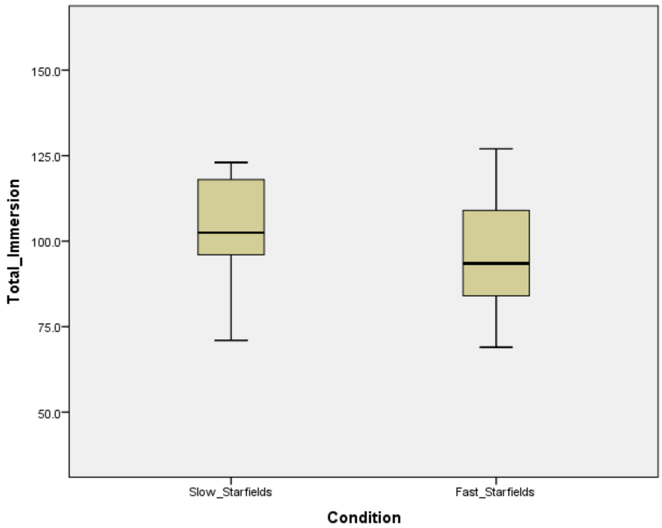
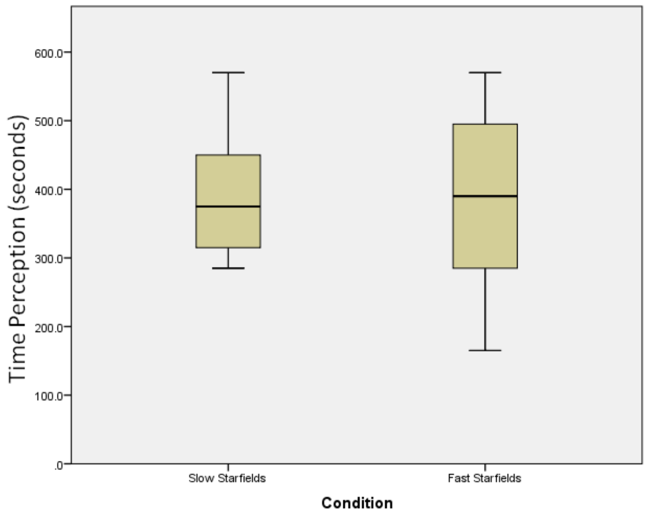


Figure 3.15: The Box Plot for Time Perception between Conditions



Immersion was tested using a t-test, $t(30) = 1.368, p = 0.182$. Using *Cohen's d*= 0.483 shows a medium effect for immersion between conditions. Figure 3.14 shows the box plot for immersion scores between conditions. Similar to time perception, the t-test show no significant difference between conditions, $t(30) = -0.115, p = 0.909$. Using *Cohen's d*= 0.041 shows a small effect for time perception between conditions. Figure 3.15 shows the box plot for time perception between conditions. Players were underestimating time in both conditions, but the one-sample t-test done for each group with test value 450 seconds show no significant underestimation.

3.5.7 Discussion

The aim of the experiment was to investigate the dissociation between immersion and time perception by manipulating time perception whilst playing digital games. Alongside this aim, the study was designed to test the retrospective time perception paradigm as a method for measuring time in digital games. The results do not support our hypothesis: time was not perceived faster in the fast Starfields condition, and retrospective time perception was not able to measure it.

In addition, there was no difference for immersion levels between the two conditions. Again, we are having the same problem as in Study One and Study Two. We are not able to identify whether the manipulation on time perception did not work or its measurement (retrospective paradigm) could not capture time perception properly.

Participants played the game with moving stars on the background screen, which are not a standard feature of the game. Indeed, the moving stars do not change the gameplay. Playing the game with either the stars move faster or slower did not affect players' immersive experience. Based on the findings from Study Four, awareness of the surroundings influences immersion. But when we introduce the moving stars as the background screen, we argue that participants integrate the background as an aesthetic factor of the game. The moving Starfieds were completely external to the game, and it did not directly require participants to interact and engage with the background.

The different speed and intensity of the moving stars on the background screen was expected to change participants' time perception (Droit-Volet et al., 2004). From previous studies in psychology, looking at different intensities of visual stimuli affects the time perception of humans. By applying this and asking participants to estimate the time they have spent playing the game, we found that the means of the time estimation for both conditions were nearly correct to the actual correct time (13th box from 20 options available to choose). When we asked participants to estimate the time they had to estimate retrospectively: they estimate it by ticking the one in the middle (as an effect of verbal estimation). Other than that, by giving a set range of responses, participants were choosing the option in the middle. They seemed to think that the amount should not exceed than the maximum range, and that it should also be more than the minimum. It can be assumed that, they choose the option (check box) in the middle. This middle value was quite to correct to the actual playing time. Furthermore, previous studies on time perception use a very short interval of time (usually in millisecond) (Grondin, 2010). Long intervals, such as 7 minutes, does influence how participants estimate time perception which leads to verbal estimation.

This study specifically show that retrospective time perception paradigm could be problematic in measuring time perception. We therefore will repeat the exactly same experiment for Study Six in the next chapter because we suspect the manipulation should work, but that the retrospective time perception could not estimate it properly. This next study is using prospective time perception to measure time. Before we continue to the next chapter, we summarise and discuss the findings from this chapter.

3.6 General Discussion

3.6.1 Manipulation of Immersion

From these studies, we found that immersion is not only dependent on the games and the gamers, but also on external factors as well. This is important, as both the SCI-model (Ermi and Mayra, 2005) and player involvement model (Calleja, 2011) define immersion as a factor in games or the movement of attention between their various dimensions. Our findings contribute to the literature evidence that the players' surroundings are also important factors in creating a more immersive experience. We note that this idea has clearly been adopted by Microsoft in their product *IllumiRoom* (Jones et al., 2013), a system that augments the area surrounding a television with projected visualisations that serve to improve the gamer's experience.

The results of Study Four strongly suggested that surrounding lighting influences immersion. This finding is useful to help identify factors that influence a player's involvement with a game. It is also very helpful for justifying how immersion can be explained from the current theories. However, with these findings, it is clear that rather than categorise immersion into different group or to treat it as a representation of the movement of attention, it is more natural to treat it as a graded experience (Brown and Cairns, 2004).

3.6.2 Methodological Challenges of Studying Immersion and Time Perception

After all five studies, we argue that it is challenging to identify the ideal method for studying immersion and time perception in digital games. A major challenge is measuring time perception in the context of digital games; shortcomings of the retrospective time perception paradigm, for example, might explain why we could not detect any changes in time perception.

The retrospective paradigm uses memory to produce duration estimation (Block and Zakay, 2001). We argue that participants were struggling to come up with the estimation because it is very difficult for them to translate the subjective time on their experience into the objective measure in seconds or in minutes. As Friedman (1990) believes that the semantic issues in describing time makes it difficult for people to give an exact estimate.

In the experimental situation, we also suspect that participants provide the time estimation without thinking of it hard and give the answer because the questionnaire required them to provide it. Therefore, we could not control how participant recall the estimation and make the judgement. Participants could also experience the lost of the temporal information because the question about time was asked at the end of the experiment. The gap between the task and the question about their time estimation plays a major effect, this was the concern in Study One, the longer the gap between the task and the need to estimate time, the larger the information decay and the less accurate the estimation is (Brown, 1958).

The retrospective paradigm does not allow us to understand *how* players perceive time whilst gaming. This is because they were not aware of the task to measure time until after the gaming sessions had taken place. Hence, it is not clear which strategy they used to produce their time estimation, but we strongly believe that most were using random estimation. This is because the amount of contextual changes during the gaming session for condition in the studies which encoded in the memory storage for the duration that need to be estimated could be similar. Less is known whether playing a same digital games with lights on have different contextual changes when play in the dim room.

Not only this, but the duration for playing digital games is also a challenge for designing the experiments. Grondin (2010) in his review on time perception research argues that most research on time perception in psychology uses small time intervals (usually in milliseconds); indeed, Wearden and Lejeune (2008) state that the maximum interval used in research on psychological time perception was 120 milliseconds (2 minutes). Little research has been conducted that investigates time perception with much longer intervals. Even recently, one contribution on time perception used small intervals, and revealed that digital games induce more influence player's subjective experience, rather than cognitive controlled, processing of time (Rivero et al., 2013). But again, gamers – especially experienced ones – play longer than this small interval. It is very challenging to decide on which duration is appropriate to research on time perception in the context of digital games.

In addition, the variability amongst participant is substantial. In the retrospective paradigm, there are no techniques or methods to ensure that participants would not think about time. For example, in the retrospective paradigm it is important that all participants are not aware of the task to measure time, but the study could not stop participants wondering how long the experiment might take. They could have had a quick think about how long it would take and this will flip the retrospective paradigm to involve awareness of time.

This thesis argues that the retrospective paradigm is not suitable for researching time in the context of gaming. This is because it is difficult for participant to translate their subjective experience of time into objective statement on paper, it leads to "5 minutes effect", it is difficult to control on how participants behave on time and the most suitable gaming duration is unknown. Therefore, we continue the investigation by changing the paradigm to prospective, as now we can study how participants perceive and think of time.

3.6.3 Dissociation between Immersion and Time Perception

The results from all of the studies conducted in this chapter suggest that there is a dissociation between immersion and time perception. Immersion was significantly manipulated in two of the studies, however, there was no significant effect on time perception.

The main concern to emphasise at this stage is the measurement problem. We are confident that the manipulations on immersion were done properly by controlling the variability and reducing any possibility of indirect effect on time perception. However, we are not confident that retrospective paradigm was the suitable one to choose for measuring time perception in the context of digital games. Therefore, to confirm this dissociation, further investigations will focus on identifying the variables that manipulate time perception to test its effect on immersion. By doing this, we can confirm the dissociation.

4. CHAPTER FOUR

The results presented in Chapter Three indicate that there is dissociation between immersion and time perception during a gaming session. Two studies successfully manipulated immersion scores using different gaming platforms: a mixed reality game versus a desktop one (Study Three), and changes to surrounding lighting – dim, neutral and bright room (Study Four). However, there were no clear effects on players' time perception. The variables used to manipulate immersion in these studies were mainly focused on manipulating only the external factors to the player, and the gaming platforms, whilst controlling other confounding variables that could influence time perception.

The manipulation and the measurement of immersion in Chapter Three were designed properly, giving a high level of confidence on the successful manipulation of immersion. However, the concern now is on the measurement technique to measure a player's time perception. All studies in Chapter Three used the retrospective time perception paradigm because the factor being manipulate was immersion. To ensure the manipulation did not directly affect time perception, retrospective paradigm was used because it uses memory to estimate time. In addition, many research studies to understand player's time perception whilst playing digital game were mostly conducted retrospectively. However, Sanders and Cairns (2010) argue that time perception is significantly being underestimated when players are immersed in the game only when time is measured prospectively, and not retrospectively.

To test whether the retrospective time perception paradigm is suitable to be used in this research, Study Five was conducted by manipulating time perception, measuring the immersion scores and time perception retrospectively. The results suggest that there was no significant difference in immersion scores and time perception for both conditions. These results suggest that the retrospective time perception could not capture the players' time perception accurately during their gaming sessions; this being an issue that must be addressed if we are to proceed to answer the research question of this thesis.

One of the problems encountered using retrospective time perception paradigm is the random estimation given by participants in estimating their time perception. In addition, the 5 minutes effect also contributes to the challenges in producing accurate responses. Moreover, the strength of the accuracy on time perception estimation using the retrospective time perception paradigm is strongly influenced by the physical intensity of the stimulus/activity that evoked the additional information of the durations (Block and Zakay, 2008). Therefore, the more tasks done at once, the longer will the duration of completing them all be evaluated retrospectively. This is because each task will be labelled as one temporal stamp in memory, and time is perceived as longer when there are more such stamps in memory. All the experiments conducted in Chapter Three, the gaming activity for a period between 7 minutes to 20 minutes does not have much variety of tasks, perhaps meaning fewer temporal stamps in memory for participants to recall.

If the indication on the dissociation between immersion and time perception is true, as shown from experiments in Chapter Three, then this can be further tested by manipulating time perception. The dissociation between immersion and time perception will show that any changes to time perception will not affect immersion scores. Based on this premise, the next six studies focus on manipulating time perception to test its relationship with immersion.

For all six experiments in this chapter, the manipulation of time perception will be based on some of the factors described in Section 2.9.2. All the six studies use the prospective time perception paradigm with production method (participants produce the duration that they were told about without referring to timing devices). This is because prospective time perception paradigm uses attention to estimate time(Block and Zakay, 1997). Immersion also needs a high level of attention to be invested in the games as to maintain the immersive experience (Jennett, 2010). Although, there is no evidence that immersion and time perception use the same attentional resources, if the dissociation between them exist, any changes on time perception would not significantly influence immersion. In addition, the prospective time perception paradigm is expected to reduce all the problems encountered during previous experiments with the retrospective time perception paradigm, such as verbal estimation, losing the temporal information of the time, and the gap between the gaming activity and the task to measure time.

This research argues that the manipulation of time perception in Study Five should be working to show a significant difference on time perception, but the retrospective time perception paradigm appears to be unsuitable to measure it. Therefore, to confirm that the manipulation of time perception does work, and that retrospective time perception paradigm was the problem, Study Six is designed to repeat Study Five but with time perception measured using the production method prospectively. The results from

Study Six show that the moving Starfields on the background screen of the games does influence time perception, but there were no effect on immersion. This result further indicates evidence of the dissociation between immersion and time perception.

Based on the findings from Study Six, Study Seven is designed to integrate different speeds of visual stimuli as a part of the gameplay. Study Seven uses different speed levels of the *Tetris* game (level 1 vs. level 10). Study Eight is designed to further test the results from Study Seven by manipulating time perception by changing the pace of the game. All the results from Study Six, Study Seven and Study Eight suggest strong indication of dissociation between immersion and time perception. To confirm this, Study Nine, Study Ten and Study Eleven are designed to further manipulate time perception to test its effect on immersion. Study Nine focuses on a traditional manipulation of time perception by introducing secondary activities (answering arithmetic questions) during the gaming session. The final two experiments are focused on the manipulation of the cognitive load by using the N-back test; Study Ten uses 1N, 2N and 3N back test whereas Study Eleven further investigates the manipulation of time perception using 2N and 4N-back tests. The aim is to gather more evidence to support the previous findings that there is dissociation between immersion and time perception whilst playing digital games.

4.1 Study Six: Visual Stimuli (Prospective Paradigm)

Study Five was conducted to manipulate players' time perception to test its effect on immersion. The manipulation was done by changing the intensity/speed of moving Starfields on the background screen. Time perception was measured using the retrospective time perception paradigm and the results suggest no significant difference for players' time perception and immersion in the slow Starfields and the fast Starfields conditions.

This study re-runs Study Five to confirm that the manipulation on time perception works but that the retrospective time perception paradigm is not suitable for measurement. Further, if there is a dissociation between immersion and time perception as indicated from previous studies, the significant difference on players' time perception would not have any significant effect on immersion.

4.1.1 Aim and Hypothesis

The aim of this study is to confirm the dissociation between immersion and time perception and to affirm that the retrospective paradigm is not suitable for measuring time perception in the context of digital games. The hypothesis is that time is perceived to be quicker when participants play digital games with the high speed Starfields condition in the background of the screen. When time is being perceived to move quickly, participants will stop earlier than the actual time (underestimate). In addition, immersion is hypothesised to have no significant effect between conditions.

4.1.2 Design

The experiment was a between subject design. The independent variable was the speed of the moving Starfields on the background screen. The primary dependent variable was immersion level, and the secondary dependent variable was the player's time perception. Immersion level was measured by the IEQ (Jennett et al., 2008), whereas time perception was measured using the production method prospectively (participants are aware of the task to measure time and they have to stop playing after a certain amount of time as told by the experimenter).

4.1.3 Participants

Participants were randomly recruited from students and staff at the University of York. There were 20 participants, of which 13 were men and 7 women. The average age of the participants was 21.6 years old (standard deviation 4.68) with the youngest being 19 years old and oldest 45. Most of the participants rated themselves as playing games at least 60 minutes several times a week. The most common games played were puzzle games.

4.1.4 Materials

The materials used in this study were the same as those in Study Five.

4.1.5 Procedure

Participants were welcomed and given the informed consent form to fill. After discussing it, and confirming that the instructions were understood, the participants signed the form as agreeing to voluntarily participate in the experiment. After that, they were also instructed to switch off their mobile and to take off their watch. Both of these items were kept in a box to avoid any distraction during the experiment. This box was placed on the table next to them.

When they were comfortable to start, they were introduced to the games and were given a few minutes as a tutorial before the experiment started. When they felt confident on what they had to do and were ready for the experiment, the experimenter informed them about the task that they had to do. In the slow condition, participants were asked to play the game with a slower moving Starfields on the background screen whereas in the fast condition, participants were playing with a fast moving Starfields on the background screen. They were told to play the game for 7 minutes and 30 seconds, and that when they felt they had reached 7 minutes and 30 seconds, they were required to stop playing and immediately press the reception bell next to the keyboard. When they were ready to start, the experimenter reminded them again that they had to stop playing when they felt they had reached 7 minutes and 30 seconds. Once they understood, the experimenter informed them that they could start playing now and simultaneously start timing them using the stopwatch from the iPhone 4s. The experimenter then left the room to allow the participant play the game. When the participant felt they had reached 7 minutes and 30 seconds, they stopped playing and pressed the bell; the experimenter then immediately stopping the stopwatch and recording the produced playing duration. After that, the experimenter came back into the room to ask participants to complete the IEQ. They were also asked to fill the demographic questionnaire. Participants were then debriefed about the goals of the study. They were given some chocolates as a token of appreciation for their participation.

4.1.6 Results

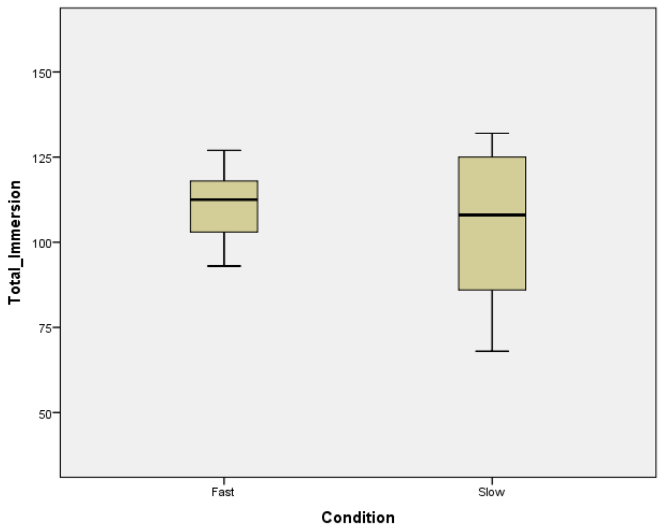
The data was transcribed into a single spreadsheet. Table 4.1 summarises the mean and (standard deviation) for the immersion scores and players' produced time perception between conditions.

Table 4.1: Mean and (Standard Deviation) for Immersion Scores and Time Perception between Conditions

	Slow Starfields	Fast Starfields
Immersion	106.70 (21.56)	111.20 (10.26)
Time Perception	529.90 (246.79)	335.40 (106.34)

To confirm that the difference on time perception between conditions was statistically significant, the data is tested using the independent t-test. There is no significant difference on immersion scores between conditions $t(18) = -0.596, p = 0.56$. Using *Cohen's d*= 0.326 showing a small effect on immersion scores. Figure 4.1 shows the box plot for immersion scores in both conditions.

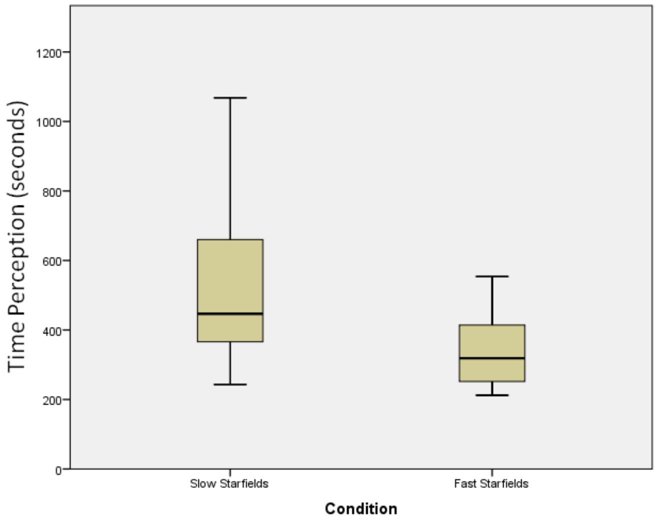
Figure 4.1: The Box Plot for Immersion Scores between Conditions



Further, a similar test was done to test whether time perception was showing a significant difference between conditions. The test shows that there is a significant difference on time perception between conditions $t(18) = 2.289, p = 0.034$. The effect size for time perception was calculated using *Cohen's d*= 1.024 showing a large effect size. Figure 4.2 shows the box plot for time perception in both conditions.

From the results, the time perception that participants supposed to pro-

Figure 4.2: The Box Plot for Time Perception between Conditions



duced prospectively was 7 minutes and 30 seconds (450 seconds) means they have to stop playing when they feel they have reach that time. A one-sample t-test with the test value of 450 is conducted to test whether the overestimation of time in the slow Starfields is significant, and whether the underestimation of time in the fast Starfields is significant.

The results show a strongly significant underestimation of time perception in the fast Starfields condition $t(9) = -3.408, p = 0.008$ whereas no significant overestimation of time perception in the slow Starfields condition $t(9) = 1.024, p = 0.333$.

4.1.7 Discussion

The results confirm that the different intensities/speed of the visual stimulus influenced time perception. Participants strongly perceived that time was moving quicker in the fast Starfields condition, causing them to stop earlier that the actual time. In contrast, those in the slow Starfields overestimated time perception (but it was not significant). The effects size on the difference in time perception between conditions suggests that the manipulation of time perception works and can be measured using the prospective paradigm.

The results also support our hypothesis that there is dissociation between immersion and time perception, and that the prospective time perception paradigm is a more suitable paradigm to be used in measuring time perception in the context of digital games.

Unlike for immersion, the difference between conditions was not significant, indicating that our hypothesis on the dissociation between immersion and time perception is true. The speed/intensity of the Starfields background influenced time perception, but not immersion. This may be caused by immersion being selective (Jennett, 2010). In this study, the Starfields are designed to move in the background of the games which allow players to ignore them and keep playing. Therefore, the different intensity/speed of the visual stimulus does not influence their immersion because they do not have to attend to it. However, the visual stimulus might have an influence on immersion if players have to pay attention to it as part of the game. As Jennett (2010) argues, if you call your daughter's name whilst she is playing digital games, she might ignore you despite hearing it because she wants to be immersed in the game.

Supposedly, when the intensity of the visual stimuli increase, more stimuli were added to the cognitive processes. This additional stimuli overlap with the cognitive task set of the gameplay (Karle et al., 2010). Although players do not attend to the visual stimuli, having it on the background screen affects players indirectly. The most obvious key fact from this study is time perception can be manipulated by using different speed/intensity of the visual stimuli.

One drawback of this experiment is that the manipulation was done externally to the game components. What would happen to time perception and immersion scores if the speed/intensity of the visual stimulus was part of the game?

4.2 Study Seven: Game Speed (Prospective Paradigm)

All of the evidence is indicating that there is dissociation between immersion and time perception. It is argued that the retrospective paradigm is problematic in measuring time perception in the context of digital games because recalling time perception from previous gaming session produces high verbal estimation. This does not happen in the prospective time perception paradigm.

The manipulation of time perception shows that it is strongly influenced by the different speed/intensity of the visual stimuli. However, this result was produced by manipulating external factors to the games. Does it has the same effect if the one game is being played with a different speed? That is to say, when the intensity itself becomes part of the gameplay? It could be that when the game has a different speed, the substantial stimuli of the different speed/intensity would not only overlap with the gameplay but it is rather a part of the gameplay (Karle et al., 2010). Therefore, when different speed/intensity is a part of the game, perhaps will influence immersion and time perception because players are not able to ignore it.

Using a similar game to Study Six, this study is designed to manipulate time using different speeds in two conditions: Tetris level 1 and Tetris level 10. Unlike Study Six, this study was done during a practical class of the *Human Aspects of Computer Science (HACS)*. HACS is a first year undergraduate compulsory course which focuses on understanding research in HCI.

There were a total of 104 first year computer science undergraduates for the 2012/2013 academic year. These students were divided into two practical groups. During this practical session, they will learn on how to plan, design, run and analysis HCI experiments. Before they start to plan and design their own study, they will be introduced to one study in the lab. They have to take part as the experimenter and the participants in the study. This study was conducted during their practical. Details of the procedure is described in the procedure section.

4.2.1 Aim and Hypothesis

The aim and the hypothesis for this experiment were similar to those of the previous study. The hypothesis is that time is perceived more quickly with the higher intensity of the visual stimulus in the in-games components (speed of the game). When time is being perceived to move quickly, participants will stop earlier than the actual time (underestimate). However, the hypothesis for immersion is there is no significant effect on immersion. This adds to the evidence of the dissociation between both notions.

4.2.2 Design

The experiment was a between subject design. Those in the experimenter group will run the experiment simultaneously whilst their paired colleague will be the participant. The independent variable in this study was the speed of the *Tetris* game (level 1 and level 10). The primary dependent variable was the immersion score, and the secondary dependent variable was the time perception.

4.2.3 Participants

A total of 104 undergraduate students were involved in the study, all from the *Human Aspects of Computer Science* module (HACS) at the Department of Computer Science, University of York. They were divided into two practical groups. In each group, they were paired together –one experimenters and one participants – producing 52 pairs of people all together. Their ages ranged from 19 to 27 years old (mean age: 19.25), with 6 of them female and the rest being male. All of them played digital games before. Most of them played digital games several times a week, for at least for an hour per session. Their favourite games varied from puzzle games to massively-multiplayer role playing games.

4.2.4 Materials

The game used was *Tetris*, available from `http://www.freetetris.org/`, i.e. the same game used in Study Five and Study Six. As this research is collecting the evidence of the dissociation between immersion and time perception, using different games would be a huge confound in drawing conclusions from the results.

The study was conducted in one of the undergraduate computer labs at the Department. There were 80 computers available in the lab. Each computer was using a resolution of 1680 x 1050 on a 21 monitor.. A standard Microsoft keyboard and mouse were provided for playing the game, and headphones were made available so the participants could hear the sound effects of the game.

A set of a consent forms and instruction sheets were prepared so that the students in the experimenter group could read what the experiment was and how to run it. This set of instruction includes a brief description for them to handle the participant to ensure that they do not know the aim and the objective of the experiment.

The Immersive Experience Questionnaire (IEQ) developed by Jennett et al. (2008) was used in order to measure how immersed the participants were in the game while they were playing. As suggested in Study Six, we applied the production method in the prospective time perception paradigm for measuring players' time perception. Demographic details were gathered using a demographic questionnaire covering factual matters such as age, gender, occupation, and participants' gaming history including frequency of play, average playing duration, and the amount of years they have been playing. A smartphone (one per experimenter – their own smartphone) was used to measure the elapsed time.

4.2.5 Procedure

Firstly, all the first year students were randomly assigned to work in pairs (52 pairs in total from both practical groups). After they found their pair to work with, and settled down in front of the PC (there were 80 PCs in the lab), all of them were welcomed by the module leader and were given the informed consent form to fill. They were told to decide which one of them will be the experimenter and which will be the participant.

Once they decided, all the experimenters were given a set of instructions, consent forms, and questionnaires. The set was given alternately to ensure no two similar conditions were next to each other. These experimenters were then asked to read and understand the instructions. Once they understood the instruction, they were told to follow them and start asking the participant to read, understand and agree to participate in the experiment. The experimenters were required to get the participant to sign the consent form. Whilst their participant was reading and signing the consent form, the experimenter was required to set up the game with the specific level for the experiment.

After their participant returned the consent form to them, they were next required to explain to their participant what they had to do during the experiment. They were also asked to instruct their participant to switch off their mobile and to take off their watch (to be kept in their bag). This was to avoid distractions during the experiment.

Then, the experimenter introduced their participants to the game, and gave them a few minutes as a tutorial before the experiment started. After the participant confirmed that they were confident about what they had to do, and that they were ready for the experiment, their partner then told them to start playing the game for 7 minutes and 30 second. The stopwatch from the smartphone with the experimenter was started simultaneously. Participants were informed at the beginning that they had to play the game for 7 minutes and 30 seconds. When they felt they had played for 7 minutes and 30 seconds, they should stop playing and say "I am done" to inform the experimenter. When the participants said that, experimenters immediately jotted down the actual playing time.

In the slow condition, participants were asked to play the game with level 1 Tetris, whereas in the fast condition, participants were playing with level 10 Tetris. During the gaming session, when participants lost or had no more moves (the blocks stack straight to the top), they were told to start again until they felt they had reached the time. The experimenter took note of the score if they lost to sum all of it later.

Then they were asked to complete the IEQ portion of the questionnaire and were also asked to fill out the demographic questionnaire. Participants were then debriefed as to the goals of the study at the end of the practical.

4.2.6 Results

To see whether the experimental manipulation was having a significant effect on immersion and time perception, the immersion score and time perception were compared in each condition. Table 4.2 summarises the means and (standard deviations) for the immersion scores and their components, as well as game scores, and time perception for both conditions.

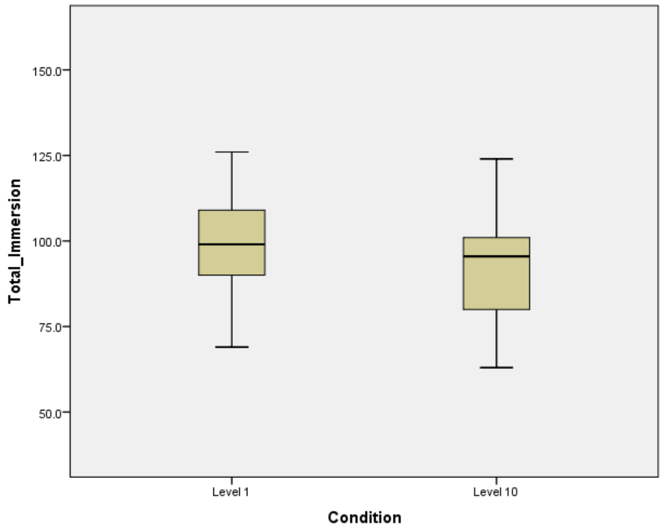
Table 4.2: Mean and (Standard Deviation) for Immersion Scores and Its Components, Time Perception and Game Scores between Conditions

Components	Tetris Level 1	Tetris Level 10
Immersion	99.81 (13.91)	91.73 (14.38)
Time Perception (s)	356.04 (99.24)	376.73 (140.80)
Game Scores	5457.62 (3584.10)	7826.03 (4696.70)
Cognitive Involvement	33.12 (4.66)	29.50 (5.72)
Emotional Involvement	15.62 (4.05)	14.15 (4.73)
Real World Dissociation	22.12 (5.72)	20.35 (5.39)
Challenge	12.31 (2.07)	13.31 (2.06)
Control	16.65 (3.06)	14.42 (2.83)

There was a significant different in immersion level $t(50) = 2.059, p = 0.045$ with the medium effect size of, *Cohen's d* d=0.571. Out of five elements of immersion, only two components, namely Cognitive Involvement, $t(50) = 2.500, p = 0.016$ and Control $t(50) = 2.729, p = 0.009$

were strongly significantly different. No significant difference for other elements, Emotional Involvement $t(50) = 1.197, p = 0.237$, Real World Dissociation $t(50) = 1.148, p = 0.256$, but Challenge was approaching significant $t(50) = -1.747, p = 0.087$. Figure 4.3 shows the box plot for immersion scores between conditions.

Figure 4.3: The Box Plot for Immersion Scores between Conditions



In contrast, there was no significant difference in time perception $t(50) = -0.613, p = 0.543$ with a small effect size, *Cohen's d*= 0.17. Figure 4.4 shows the box plot for time perception between conditions. Although the differences between them were not significant, participants in both conditions were significantly underestimating time. Using one sample t-test, participant in the slow Tetris show a statistically strong underestimation $t(25) = -4.828, p<0.01$ and those in the fast Tetris also significantly underestimate time $t(25) = -2.653, p = 0.014$

Further, to test whether the different levels of speed influenced performance, there was a marginal significant effect on the game scores $t(50) = -1.798, p = 0.078$ Figure 4.5 shows the box plot for game scores between conditions. There is no need to remove the outlier because the results were similar it was removed.

4.2.7 Discussion

The results do not support the hypothesis. The manipulation of time perception show a significant difference on immersion scores but not on participants' time perception between conditions. This suggests additional evid-

Figure 4.4: The Box Plot for Time Perception between Conditions

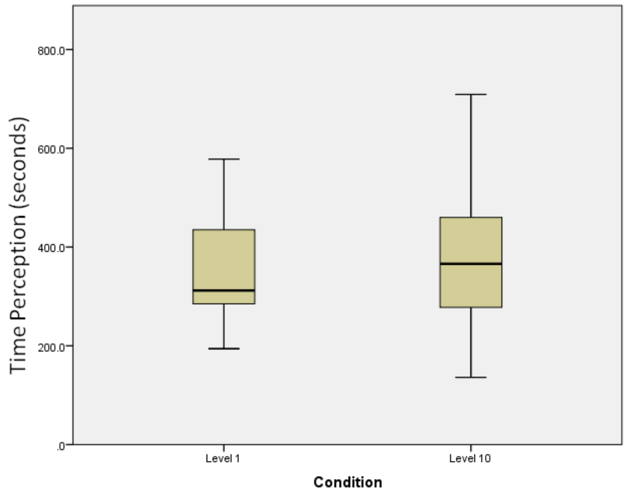
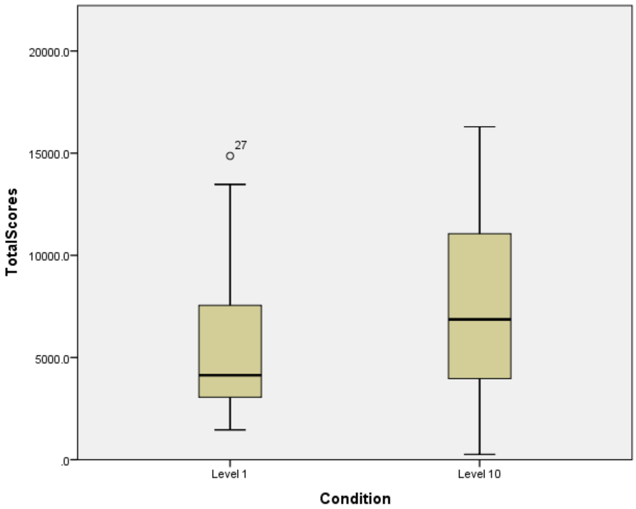


Figure 4.5: The Box Plot for Game Scores between Conditions



ence that there is dissociation between immersion and time perception whilst playing digital games.

In Study Six, the manipulation of time perception was done externally to the game. The result showed that a fast speed (or high intensity) of visual stimuli influenced time perception, but when the intensity is a part of the game, a substantial stimulus is added to the cognitive processes on the gameplay which affect the overall gaming experience (Karle et al., 2010). This can be seen as participants' cognitive involvements were significantly different between conditions. Cognitive involvement is significantly higher in level one Tetris compared to level 10. This may be due to the ability of participants to plan the step to place the block properly in Tetris level 1. This also can be seen with the game scores where those in Level 1 score marginally significantly higher than those in Level 10. Having the slow blocks fall down allows the cognitive processes to process the strategy better in Level 1 than those in Level 10. Thus, it helps to increase immersion.

In addition, the controls for Level 10 were extremely hard to master, preventing participants from reaching a high immersive experience. The blocks fall very quickly, causing them to lose the game many times. The separation of the visual stimuli from the gameplay (on the background) works well in manipulating time perception but when high intensity/speed of the game is a part of the gameplay, it changes the overall effect of the stimuli on the gaming experience, and not immersion. This could be because they invest all the attention on the gaming activity as opposed to the temporal task (produced time estimation). This shows that there is dissociation between immersion and time perception.

This phenomenon fits into what researchers call time perception illusion (Eagleman, 2008). As an example, people claim that they feel that time moves slowly if they are the victim in the accident. However, people who watch it from the external surroundings feel that it happens very quickly. Similar to this study, the difference in time perception was not significant between conditions due to the in-game manipulation. The manipulation of the different speed of the Tetris blocks changes the gameplay. It is faster in level 10 compare to level 1. The different intensity is now the game, not the background on the games as in Study Six.

Interestingly, in both conditions, participants stopped earlier than the actual time. It can be understood if those in the slow Tetris underestimate time, since this would be similar to Sanders and Cairns (2010)'s findings that players who experiencing high immersion underestimate time prospectively. However, in this study, those in fast Tetris condition were experiencing less immersion but still they stopped not significantly later than those in the slow tetris. One possible explanation for this is the environment where the experiments took place was in the computer lab. Possibly by running this experiment in the computer lab setting, participants were influenced by their surroundings. In the lab, they can see that other participants stopped playing, which could influence them to stop playing too.

To confirm the results from this study, the next one is designed to only change the pace of the game whilst keeping other elements the same. If a higher pace produces less immersion and there is no significant difference in time perception, the evidence to support that there is a dissociation between immersion and time perception becomes stronger.

4.3 Study Eight: Game Pace (Prospective Paradigm)

Study Six and Study Seven produced inconsistent patterns of results. The hypothesis that different speeds/intensities of games will influence time perception, as opposed to the external visual stimuli, was rejected. In contrast, immersion scores were significantly affected: those participants in the fast Tetris condition experienced significantly lower immersion than those in the slow Tetris condition. Interestingly, the results support our argument that there is dissociation between immersion and time perception, in which the differences in one notion do not influence the other.

From the results in Study Seven, participants struggled to play the game in the fast Tetris condition. This can be seen from the control element in the immersion questionnaire, where participants in the fast Tetris condition had significantly lower control than participant in the slow Tetris condition.

The results also show that participants marginally significantly experience higher challenge in the fast Tetris condition. This supports Brown and Cairns (2004)'s arguments that knowing how to control and having full control of the game increases immersion whilst playing digital games. Also, game challenge has a significant impact on immersion too. However, playing Tetris on the highest level simply can increase the score –more blocks are available – compare to slow level.

Unlike time perception, all participants in Study Seven underestimated time (they stopped earlier) no matter whether they experience high or low immersion. As discussed, one possible factor that contribute to this is by running the experiments in the computer lab setting. Having considered all of the possible factors that could influence the results in Study Seven (control, lab setting, etc), this study continues to manipulate time perception by changing the pace of the game. This study was derived by me but run by one of the MSc HCIT student, Xiaolong Yin (Bruce) for his MSc dissertation. All the arguments and ideas were mine, but the implementation of the experiment was done by Bruce.

After a long discussion of possible topics for Bruce's dissertation, he was very interested to further investigate the effect of different pace in digital games on immersion and time perception.

Considering the result from Study Seven, to ensure that the control of the game would not influence participants' immersive experience in this study, all the participants recruited liked to play rhythm games (like *Guitar Hero*, but using a keyboard) and they are expert at it. This limits the issue with the control of the game where expert players know how to control the game. It is important to isolate as many factors as possible to ensure that we can reduce the possible confounds in the experiment. Hence, this study focuses on changing the pace of the game. All of the other aspects of the game are controlled (same music, same duration, same controls), but different is only the number of plates falling with the rhythm. A faster pace involves more plates falling than in a medium pace.

4.3.1 Aim and Hypothesis

The study aims to test the dissociation between immersion and time perception in digital games by manipulating time perception. The hypothesis is that participants underestimate time when they play the game with the faster pace compared to those who play with the medium pace, and that there will be no difference in immersion scores.

4.3.2 Design

The experiment was a between subjects design. The independent variable was the pace of the game (medium vs. fast), the primary dependent variable was the immersion score, and the secondary dependent variable was the player's time perception.

4.3.3 Participants

20 participants were recruited around the University of York, UK. During the recruitment process, they were introduced to the *OSU!* game, a rhythm games (like *Guitar Hero*, and they were asked whether they have played the game before. If they answer yes, they will be given a preliminary questionnaire to measure how much they like it, and rate their expertise with the game. This was done by asking 6 questions (5 point Likert scale) for liking and the expert rating. Only those who scored 15 or more were recruited. This was to ensure that they liked the game and knew how to control the game which to avoid confounds. Their age ranged from 18 to 26 with (mean age: 22.05 SD: 2.43). All of them played games several times a week for more than one hour per session. They were given chocolates for their participation.

4.3.4 Materials

The game used was the *OSU!* game available free from `http://osu.ppy.sh/`. The game was developed by a small team in Japan. It is a rhythm-based game like *Guitar Hero*, but being played on PC and using a keyboard to control it. One of the advantages of the *OSU!* game is that almost all the gameplay in the game can be modified by users. It gives player the freedom to choose the songs from their own playlist and modify the levels, which means it is very suitable for this study we can manipulated the gameplay.

The *OSU!* gameplay is easy and straightforward. Players just need to hit the keyboard every time the “beat notes (a plate/disk shape objects) falls off the platform. Players need to press the specific buttons on the keyboard when these disks fall down from the top of the screen and touch the line in the bottom of the screen.

In this study, four buttons on the keyboard are used (buttons D, F, J, K). For example, when a disk shaped object falls from the left pipe and touches the line on the bottom, players should press D. These disk shaped objects come in two types. The first one is a small rectangle and the second one is a long cylinder shaped object with a specific length. When the former disk falls on the line at the bottom of the screen, player should just press the button once. For the latter, players should hold the button until the cylinder disappear.

All of these disk shape objects fall with the rhythm of the song. The game will show a “missed” warning message if player did not press the button at the right time, but the game will go on no matter how well or badly the player performs. The song used in this experiment is called “Beethoven Virus”. It lasted for 283 seconds gameplay. Figure 4.6 shows a screenshot of the game.

Figure 4.6: Screenshot For The OSU! Game

The design of the experiment is as follows:

1. Level Medium Pace: total of 404 disk shape objects
2. Level Fast Pace: total of 595 disk shape objects

On average, participants needed to hit more than two disk shape objects per second in the Fast pace condition. To measure how well they performed in the game, the scores were also recorded. A stopwatch from a mobile phone was used to measure time. Immersion scores were measured using the IEQ, and time perception was measured using the production method prospectively.

4.3.5 Procedure

The study was run individually in a computer lab at the Department of Computer Science, University of York. Participants were welcomed, and the experiment briefly explained. At that time, they were presented with an informed consent form for them to read, understand, and sign. Later, they were briefly told what they should do during the experiment. Once they understood and agreed to be a participant in this study, they were brought to the PC for the experiment, located at one corner of the lab.

Once they felt comfortable, they were introduced to the games and explained again on how to use the controls of the game. They were given one minute for a trial. Although they liked and were experts at the game, they still had to go through the trial to ensure that they were familiar with the controls. Since the length of the music is too short, participants were stopped exactly after one minute during the trial and asked whether they needed more time. If they do, we restarted the game for trial and stop it again after a minute. This is to avoid that they know about the duration of the games based on the length of the music.

When they were comfortable with the game, they were given a pair of headphones. The volume was adjusted to a comfortable level. Participants were told to stop playing when they felt they had reached three minutes, by saying: "I am done". The important thing was that they should stop when they felt 3 minutes had elapsed. They also were told that they should focus on the game more than estimating the time and try to get high scores. Participants were then randomly given one of the two levels (medium or fast). After they said "I am done", the elapsed time was recorded immediately, as well as the scores. They were asked to fill out the immersion and demographic questionnaires. At the end of the experiment, participants were debriefed about the study.

4.3.6 Results

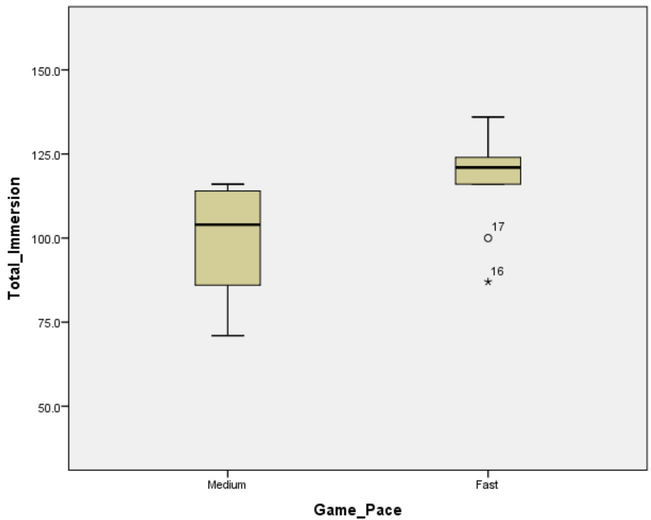
The mean and (standard deviation) for immersion scores and their elements, time perception, and game scores are summarised in the Table 4.3 below:

Table 4.3: Mean and (Standard Deviation) for Immersion Scores and Its Components, Time Perception and Game Scores between Conditions

Components	Medium Level	Fast Level
Immersion	96.30 (10.06)	104.60 (9.83)
Time Perception (s)	160.60 (37.05)	189.80 (51.68)
Game Scores	16489.20 (8859.86)	22586.80 (15905.39)
Cognitive Involvement	28.40 (4.99)	34.80 (5.57)
Emotional Involvement	19.60 (4.03)	21.50 (3.63)
Real World Dissociation	20.10 (1.52)	19.70 (2.63)
Challenge	11.90 (1.20)	10.10 (1.60)
Control	16.30 (2.31)	18.50 (1.84)

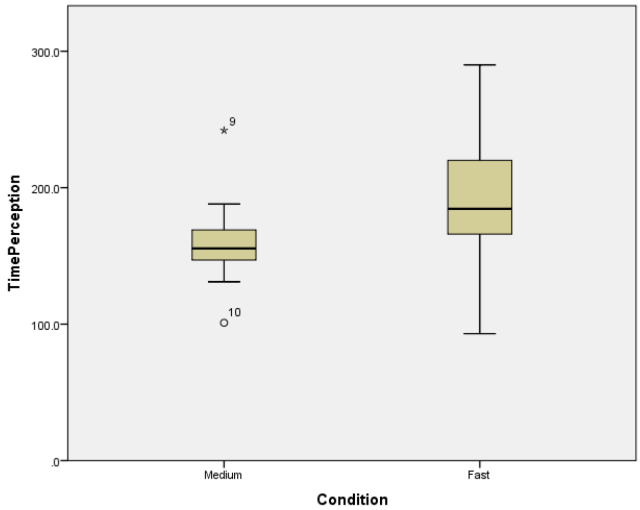
Using the independent t-test, the results show that participants in the fast pace condition were significantly more immersed than those in the medium pace condition $t(18) = -2.790, p = 0.012$. There was a strong effect size, *Cohen's d*= 0.835. Further analysis on the immersion components suggests that only Cognitive Involvement $t(18) = 0.008, p = 0.015$, Challenge $t(18) = 2.240, p = 0.011$ and Control $t(18) = -1.266, p = 0.034$ were significantly different between conditions, whereas Emotional Involvement $t(18) = 0.050, p = 0.283$ and Real World Dissociation $t(18) = 2.641, p = 0.683$ were not significantly different between conditions. Figure 4.7 shows the box plot for immersion scores between conditions. Analysis without the outliers did not change the statistical significance of immersion scores.

Figure 4.7: The Box Plot for Immersion between Conditions



In contrast, there was no significant difference in time perception between conditions $t(18) = -1.452, p = 0.164$. There was a medium effect size, *Cohen's d*$= 0.649$. Further, although those in the medium pace condition underestimated time, the underestimation was not significant. The test was done using one-sample t-test with the test value of 180 $t(9) = -1.656, p = 0.132$. Similar to those in the fast condition $t(9) = 0.600, p = 0.563$, no significant overestimation of time perception. Figure 4.8 shows the box plot for immersion scores between conditions. Analysis without the outliers did not change the statistical significance of time perception scores.

Figure 4.8: The Box Plot for Time Perception between Conditions



Interestingly, the game scores are not significantly difference between conditions $t(18) = -1.059, p = 0.304$

4.3.7 Discussion

The results do not support our hypothesis that high intensity of the gameplay alters players' time perception, however, it influences immersion scores between conditions. This adds to the evidence that there is dissociation between immersion and time perception whilst playing digital games.

Similar to Study Seven, the experimental manipulation influences the players' cognitive involvement and controls, but in this study, it influenced the challenge in the game. As expected, participants experienced higher cognitive involvement and more difficult controls in the fast condition. Interestingly, those in the medium condition experienced higher challenge than those in the fast condition. The challenge is however is not affected because the games scores between conditions were not significantly different to suggest that challenge in one condition is harder than the other.

In this study, all participants were expert gamers for this type of game genre. They also liked this game. Therefore, this rejects any argument about types of gamers and their preference on the game, that might have been the real confounds in Study Seven.

The aim was to manipulate time perception using different intensities/speeds of the games to see whether any changes in time perception influenced immersion. Unlike in Study Six, time perception was manipulated external to the game and the manipulation was successful. However when the manipulation is being integrated as a part of the gameplay, it does not influence time perception but rather immersion.

As Jennett (2010) argue, immersion is a selective attention. Any stimuli external to the game can be chosen to be ignored whilst gaming. But when this stimulus is a part of the gameplay, players have to attend to it, which clearly will influence their immersion scores. This is because players have no other options to ignore it because it is a part of the game.

For time perception, it seems that immersion does not alter time perception. As explained about the time perception illusion (Eagleman, 2008), when you are experiencing the activity you feel time moves differently compared to people who observe. It is possible that during a gaming session, players unconsciously decide whether they would like to attend more to the gaming or to the temporal activity. In a specific playing session, players have to ability to decide how long they want to play, therefore they do not focus on time. For example, whilst waiting for the bus, the information says the bus will arrive in 10 minutes, and a passenger decides to play a digital game in which they become immersed. Suddenly the bus arrives: it is not the immersion that causes them to experience that time has flown, but that they completely ignore the temporal event/counting the time until the bus arrives.

There were no effects on the performance between conditions perhaps because of the variability amongst participants. Their expertise in the game could be the reason why there is no difference in game scores.

So far, although time perception is being manipulated, players are still able to be immersed without affecting their time perception. To note, as up to now all the manipulations of time perception were done by integrating the manipulation in the games. It is assumed that when the manipulation is part of the game, the task to estimate time becomes irrelevant for the gaming session. Hence, players able to select not to focus on it. However, because they were told that have to produce the estimation, the stop after producing the duration. Because of they did ignore the task to measure time, they did not estimate time perception differently between condition.This allows participant to focus on the games and instead ignore about time.

What would happen if we enforced them to do multiple tasks (additional tasks) whilst playing digital games? This clearly will divide their attention between the games and to the additional task. At the same time they have to estimate time. Dual task activity is one of the classic time perception experiments. To find more evidence that there is dissociation between immersion and time perception, introducing an additional task whilst playing digital games and at the same time measuring time could give more insight. To test further any changes in time perception on immersion, this research continues to manipulate time by using this classic experiment on time perception – adding an additional task.

4.4 Study Nine: Multitasks (Prospective Paradigm)

Study Six, Study Seven and Study Eight were conducted by informing participants to keep track of time by producing a temporal interval during a gaming session. Now, we explore a classic experiment in time perception: introducing another additional non-temporal task whilst measuring time perception during a gaming session. Brown (1997) argues that the attentional gate for producing time estimation can be interfered when performing multiple tasks which causing the temporal production to become longer (bigger time difference between time estimation and the actual time). This longer duration can be measured using the difference in time from how long they played to how long they were meant to play.

On the premise that attention is important for duration estimation in the prospective time perception paradigm, it is clear that by manipulating attention, we should be able to see a different value of time estimation at the end of a task. The classic experiment of this manipulation is using a dual task strategy. In previous studies, a non-temporal task (playing digital games) was given, whilst at the same time, participants were required to estimate the elapsed time. Interestingly, when the manipulation of time perception was a part of the gameplay, the results produced were not similar to the literature. Participants did not perceive time quicker but instead the manipulation affected their immersion scores.

Therefore, this study focuses on introducing an additional task during the gaming session, whilst still estimating time. Judging time duration accurately is a difficult task. It requires a high level of attention and information processing by an individual, and any distraction will lead to a greater error in estimating time accurately. The concept of attention when trying to estimate time involves "alertness, vigilance and selectivity" (Von Sturmer et al., 1968). This therefore can mean that shared attention – due to carrying out one or more additional tasks – means a lesser ability to judge the time duration accurately. Thus playing a game and carrying out a secondary temporal task and having to perform another additional task should reduce the attention of the gamer to the actual duration of time; more so than a gamer that is just playing the same game without the additional task.

By introducing another task while still having to estimate time, the overall complexity of the experiment increases, helping to test whether players are attending to the temporal task, the games, or the additional task. If they are attending to temporal task, the estimation would be accurate, whereas if they are attending more so to the games, then time perception will be significantly different. As shown in Study Eight, if players pay all of their attention to the games and ignore the need to estimate time, then immersion increases.

The results from this study add further evidence as to whether immersion is associated or not with time perception during gameplay. It should be noted that while the experiment was derived by me, it was run by first-year computer science students in the Department of Computer Science, University of York, as part of their *Human Aspect of Computer Science (HACS)* module. The results were published in Nordin et al. (2013).)

4.4.1 Aim and Hypothesis

This study aims to test the dissociation between immersion and time perception whilst playing digital games. The results produced in the previous studies did not appear to be consistent with the literature. Therefore, in this study, one additional task is added to manipulate time perception to test its effect on immersion. The hypothesis is that participants who have to perform an additional task whilst playing will stop earlier (i.e. underestimate more) than those who do not have to. Furthermore, we hypothesise that there will be no difference in immersion scores (i.e. supporting the dissociation).

4.4.2 Design

The experiment was a between subject design with two conditions. The independent variable was whether the participant had an additional task (answering arithmetic questions) or not. The primary dependent variable was the immersion score, whereas the secondary dependent variable was the player's time perception.

4.4.3 Participants

In total, 19 students (11 females, 8 males) aged 18-20 (mean= 18.3) were randomly recruited to participate in the study. All of them were students from the Heslington East Campus, at the University of York. All of them were familiar with digital games and typically played several hours a week.

4.4.4 Materials

To reduce any confounds from the game, we once again used *Tetris* (available from `www.freetetris.org`), a game with simple controls and one that is familiar to most players (all but one had played a version of it before).

In order to ensure that the experiment was run in the same way, an experimenter's script was prepared, in which the details of the experiment were given in a step-by-step format. Along with this, a video was created that contained both the distraction questions (arithmetic questions) for the experimenter to verbally asks the participants. The video included a timer on the screen, so that the experimenter could easily write down the time that the participant stopped playing.

A consent form were discussed so that the participant could find out what the experiment was about, why they were taking part, and to give permission for us to use their data in our experiment. The Immersive Experience Questionnaire (IEQ) developed by Jennett et al. (2008) was used in order to measure how immersed the participants were.

Demographic details were gathered using a demographic questionnaire covering factual matters such as age, gender, occupation, and participants' gaming history, including frequency of play, average playing duration, and the amount of years they have been playing. Since some participants would be asked arithmetic questions (mix of summations of and differences between numbers of three digits, e.g. 125+321, 432-216), a results form was used to mark down the answers to the questions, how many were correct, and the *scores/levels* they managed to reach on the game. In order for all this data to be compiled into one big spreadsheet, Google Docs was used for the experimenters to fill in all the data after an experiment had finished.

The game was run on computers provided for us to use in a software lab, at the Department of Computer Science, University of York. Each computer was using a resolution of 1680 x 1050 on a 21" monitor. Standard Microsoft keyboards and mouse were provided for playing the game, and headphones were given so the participants could hear the sound effects of the game.

4.4.5 Procedure

Participants were split into two groups: no additional task and with additional task. They were asked to fill in a consent form. Next, they were asked whether they wanted a trial run with the Tetris game before starting the experiment, i.e. to become familiar with the controls.

Participants in the no additional task group played the game and were asked to stop when they felt that 7 minutes had passed, whereas participants with an additional task group did the same, but were asked the arithmetic questions at the same time. The questions were asked continuously from the beginning of the experiment until they stop. The experimenters recorded their Tetris scores and results of the arithmetic questions.

Once participants had stopped playing, the time was recorded and they were given the IEQ to fill in. Once this was completed, they were asked if they had any further questions, before being debriefed about the aims of the experiment. Participants were also given some chocolates for participating.

4.4.6 Results

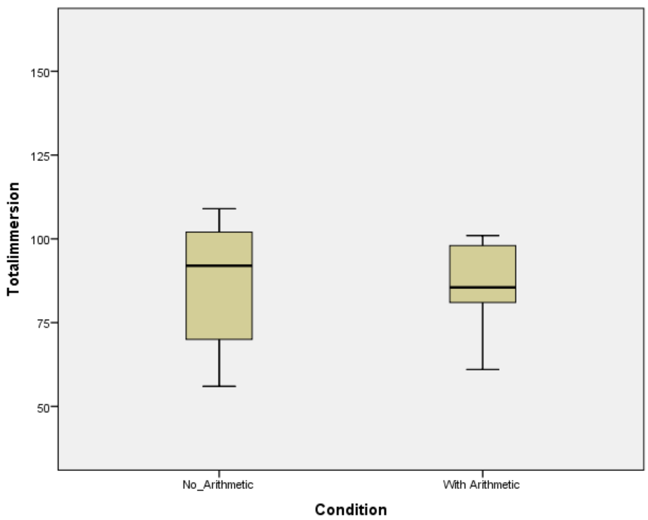
Table 4.4 shows the mean (and standard deviation) of immersion scores, time difference, and game scores for both conditions.

Table 4.4: Mean and (Standard Deviation) for Immersion Scores, Time Perception and Game Scores between Conditions

	No arithmetic question	With arithmetic question
Immersion	87.11 (19.52)	85.90 (11.77)
Time Perception (s)	372.11 (76.80)	317.10 (112.11)
Game Scores	11306.56 (8910.02)	2564.00 (2343.56)

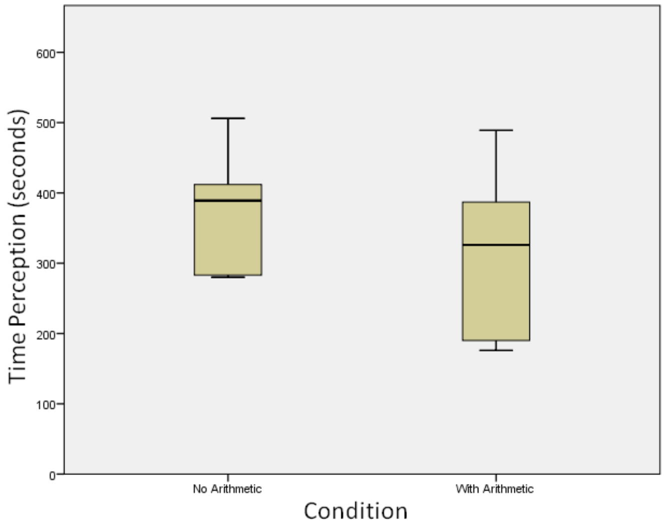
The results were tested further to find out whether the differences between conditions were significant. There was no significant difference for both immersion scores $t(17) = 4.329, p = 0.870$. The effect was small, *Cohen's* $d = 0.075$. Figure 4.9 shows the box plot for immersion scores between conditions.

Figure 4.9: The Box Plot for Immersion Scores between Conditions



Similarly, there were no significant difference of time perception, $t(17) = 1.662, p = 0.234$. The effect was a medium effect, *Cohen's* $d = 0.572$. Figure 4.10 shows the box plot for time perception between conditions.

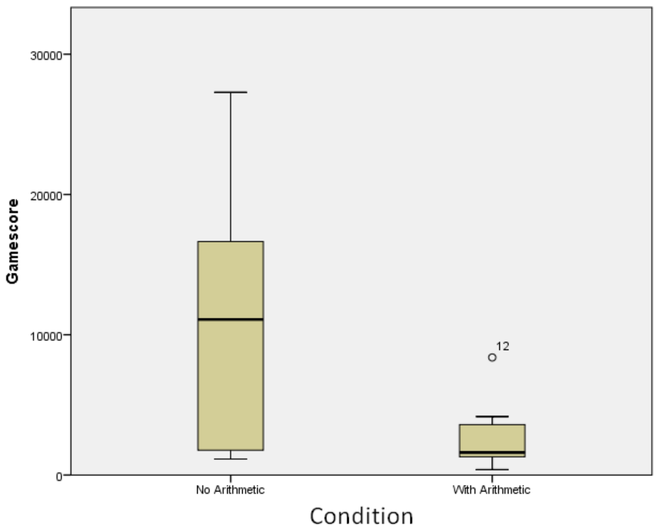
Figure 4.10: The Box Plot for Time Perception between Conditions



The minimum error rate (correct answer / number of questions asked) for the answer given by participants was 0.45 and the maximum was 1.00 ($mean = 0.78, SD = 0.20$).

However, the game scores were significantly lower for participants with an additional task group $t(17) = 10.813, p = 0.008$. Figure 4.11 shows the box plot for game scores between conditions.

Figure 4.11: The Box Plot for Game Scores between Conditions



Further analysis was done using a one-sample t-test with test value 420 seconds (7 minutes) to investigate the underestimation of time in both conditions. The results show that participants with the additional arithmetic task were significantly underestimating time $t(9) = -2.902, p = 0.018$. On the other hand, participants who play digital games without the arithmetic task condition were only just approaching significant underestimation $t(8) = -1.871, p = 0.098$.

4.4.7 Discussion

The results did not support the hypothesis that participants underestimate time when an additional task was introduced during the gaming session. Similar to immersion, there was no significant different on immersion scores between conditions. However, participants performed badly in the games when they had to do an additional task.

Since attention is divided into several tasks – playing the game, producing time perception, and (for some) answering arithmetic questions – the performance of participants was affected. This can be seen from the game scores. Clearly, players need to invest a lot of attention on the game to get a high score. When they were given a secondary task (producing time perception), they need to split their attention between the two. Having an additional task to these distracts the players even more.

Participants in the condition with the additional task were required to attend to the task of answering the arithmetic questions. They could not just ignore it and attend to either the game (increasing immersion) or the temporal task, leading to poorer performances. Furthermore, Faulkner et al. (2007) argue that performance is poorer with multitasking. This is due to a reduced ability to maintain the attention while simultaneously making decisions that draw on memory and visual-spatial resources.

Surprisingly, there was no different between immersion scores across the conditions. A possible explanation is that participants were treating the task of answering arithmetic questions as "part of the game", which perhaps made the whole activity more engaging. Similar for time perception, the more attention that is invested in estimating the duration, the more accurate the estimation of time (Block and Zakay, 1997). However, in this study, participant's attention (in the condition with an additional arithmetic task) was forced to attend to answering the arithmetic question. Although there was no significant difference in time difference between conditions, the results suggest that participants in both conditions were underestimating time, i.e. they stopped playing before 7 minutes. This is because they could not focus all of their attention on estimating the time. When attention on the temporal task needs to be split with other non-temporal tasks, it affects participants to perceive time as moving faster (Block and Zakay, 1997). Therefore, it causes participants to stop earlier than the actual time. Unlike when all the attention is invested on the temporal task, more precise estimation would be produced.

The additional task forces the participant's attention to answer the arithmetic question whilst playing the game and estimating time. This reduces the attention on the need to estimate the time. Therefore, their underestimation was significant compared to those who do not have to answer the arithmetic questions. They could not focus on producing more accurate time estimations. When one is distracted from monitoring the time, it contributes to the difficulty of measuring time and influences them to stop earlier before the correct time. It can be assumed that, they are not stopping after the correct time because when participants switch their attention to non-temporal task then they switched back to the temporal task, they lose the track then they feel they have play for long and hence they decided to stop earlier.

The results from this study could be the tentative and more evidence are needed to show that there is dissociation between immersion and time perception. The results from this study suggest that there is dissociation between immersion and time perception. Participants are losing track of time not because of immersion but it seems that during the gaming session they invest their attention on the game rather than on time. If there is no need for players to attend to temporal activity, they will invest all of their attention into the game. When players are told to answer arithmetic questions whilst playing and estimating time, they were significantly underestimate time but immersion was not affected.

Based on this premise, the next study aims to introduce a different additional task whilst playing digital games and estimating time. If the results are consistent, we can conclude that there is no association between immersion and time perception, i.e. immersion does not influence time perception, but a player's decision to invest their attention on either the game or the temporal task influences their perception of time.

4.5 Study Ten: Cognitive Loads 3N-Back Test (Prospective Paradigm)

The results from all nine studies conducted suggest strong evidence that there is dissociation between immersion and time perception. In addition, Study Nine shows that although an additional task was added for participants to perform in addition to playing and estimating time, there was no effect on immersion and time perception. But the additional task significantly influenced players' performances, and caused them to strongly underestimate time compared to those without an additional task.

Having an additional task (answering arithmetic questions) increases the demand for cognitive processes. Results from Study Nine suggest that participants in the study were able to prioritise the relevant information and ignore the unrelated activity during gaming session. de Fockert et al. (2001) argue that the prioritisation of the relevant information depends on the mental process that is loaded, which influences the working memory in the control of selective attention. The availability of working memory maintains the stimulus-processing priorities to direct the attention to be focused on the relevant (rather than irrelevant) stimuli, and minimising the interruption of any irrelevant distractors.

This next study focuses on further investigating whether players can ignore irrelevant tasks to maintain immersion, and whether having to do additional activities influences their time perception. This will add further evidence supporting that there is dissociation between immersion and time perception. It adds to the findings that immersion is a selective attention, where players are able to ignore irrelevant tasks to maintain immersion but not time perception.

To test this, the study manipulated players' working memory using the memory load task, which is the ability to retain important information whilst comprehending, thinking, and acting during an activity (Conway et al., 2007). Previous research shows that working memory influences selective attention (de Fockert et al., 2001). Therefore, working memory was manipulated with the expectation of influencing immersion.

The memory load can be done by using the N-back test (Lavie et al., 2004). Participants are required to memorised a letter from a set of randomised letters. One set of randomised letters contains letters from A-Z and in between them there is one anchor (a bell sound) introduced in this set of alphabets. Depending on the condition, participants are required to remember one letter before this anchor – it could be the first (1N), second (2N), third (3N) letter before the anchor. Everytime they hear the anchor, they should say the letter that they have to remember.

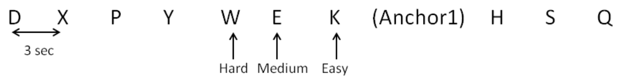
4.5.1 Aim and Hypothesis

The aim of this study is to further support the dissociation between immersion and time perception. This will be achieved by manipulating working memory by using a memory load activity. The hypothesis is that performing a memory load activity will influence time perception, but not affect immersion.

4.5.2 Design

The experiment was a between subject design. The independent variable was the level of difficulty of the memory load task: easy (last letter before the anchor), medium (second to last letter before the anchor), and hard (third to last letter before the anchor). The primary dependent variable was the immersion score, and the secondary dependent variable was the time perception. Figure 4.12 illustrates the memory task used in this study.

Figure 4.12: The Representation of the Letters from the Set of Alphabets and the Anchor



4.5.3 Participants

Participants were recruited by an opportunity sample around the University of York campus. There were 30 participants, of which 18 were men and 12 women. The average age of the participants was 24.78 years old (standard deviation 5.67) with the youngest being 19 years old and oldest 35 years old. Most of the participants rated themselves as playing games at least 60 minutes a week. The most common game played was Counter Strike and games on the Facebook.

4.5.4 Materials

Instead of using *Tetris* again, this study used an online puzzle game called *Bejeweled 2*, available from `http://www.popcap.com/games/bejeweled2/online`. The decision to change the game was made because at the time, the integrated Facebook puzzle game *Candy Crush* was very popular[1], and its

[1] `http://www.theguardian.com/technology/2013/dec/17/apple-app-charts-2013-minecraft-candy-crush-saga`

gameplay is very similar. Hence, using *Bejeweled 2* would fit in to the current demand and interests of the participants. This game is used instead of *Candy Crush* game itself because to avoid expert players on Candy Crush (those who achieved high scores) feel bored with the game used in the experiment when we ask them to play from the first level.

The classic game mode was chosen for all participants, which allowed the participants to take as much time as they needed to complete a level (other modes involve a time limit). They were playing the game on a desktop computer with a screen resolution of $1920x1080$ pixels, and a normal mouse to play the game.

The experiment took place in an empty meeting room. To ensure that the surroundings were constant, the blinds in the room were shut and all the lights switched on. The game sound was played on the external speaker at 30% volume. A smartphone was used to measure the playing time. Time perception was measured prospectively using the production method. Participants were told that they have to play the game for 7 minutes and identify the letter based on their condition at the (last letter, second last or third last from the anchor) same time. They were told to stop playing the game when they felt that they have reached 7 minutes by pressing the reception bell on the table next to the keyboard.

Immersion levels and time perception were measured using the Immersive Experience Questionnaire (IEQ) (Jennett et al., 2008). Demographic details were measured covering age, gender, occupation, and participants' gaming history, including frequency of play, average playing duration, and the amount of years they had been playing.

4.5.5 Procedures

Participants were welcomed and given the informed consent form to fill. After they discussed and signed the form, the instructions of the experiment were explained to them. They were also instructed to switch off their mobile and to take off their watch, putting them in a box next to the table to avoid distractions during the experiment.

They were introduced to the games and their memory load task. They were given a few minutes to play the game as a tutorial before the experiment started. This ensures that participants familiar with the game and its control. This was to ensure they were understood which letter they had to mention based on their condition. The letters for the tutorial were different from the experiment to avoid a learning effect.

After the participant confirmed that they were confident about what they had to do, and that they were ready for the experiment, the experimenter told them to start playing the game. They were told to play for 7 minutes, recall the letter every time they hear the bell, and press the reception bell when they felt that they have reached 7 minutes. The stopwatch from the smartphone and the recorded audio of the alphabets were started simultaneously.

After they pressed the bell, the experimenter immediately stopped the stopwatch, recorded the elapsed time, and stopped the audio for the letter. Participants were then asked to complete the questionnaires. Participants were then debriefed as to the goals of the study.

4.5.6 Results

The data was transcribed into a single spreadsheet. The mean and standard deviation for the five elements of immersion, total immersion score, number of letters said by the participants, and the errors participants made with the letters were calculated and presented in the Table 4.5 below.

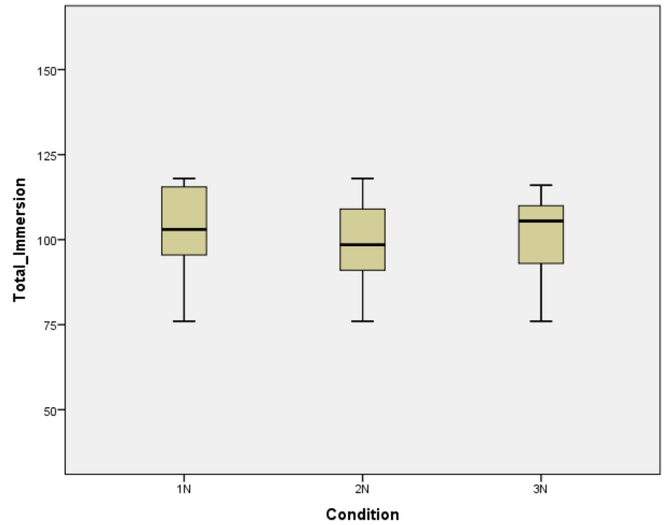
Table 4.5: Mean and (Standard Deviation) for Immersion Scores, Time Perception, Number of Letters, Errors, Error Rate and Game Level across Conditions

	Easy Condition (1N)	**Medium Condition (2N)**	**Difficult Condition (3N)**
Immersion Scores	100.80 (14.05)	98.80 (13.56)	101.00 (12.78)
Time Perception	365.90 (126.09)	336.10 (134.43)	491.70 (206.80)
No of letters Mentioned	5.10 (2.13)	5.00 (2.11)	7.40 (3.34)
Errors rate	0.06 (0.11)	0.33 (0.28)	0.45 (0.26)
Game Level	3.40 (1.27)	3.30 (0.949)	3.50 (1.51)

An ANOVA test was used and showed that there was no significant difference in immersion scores between conditions, $F(2, 27) = 0.81, p = 0.922$, $\eta_p^2 = 0.140$, suggesting small effect. Figure 4.13 shows the box plot for immersion scores between conditions.

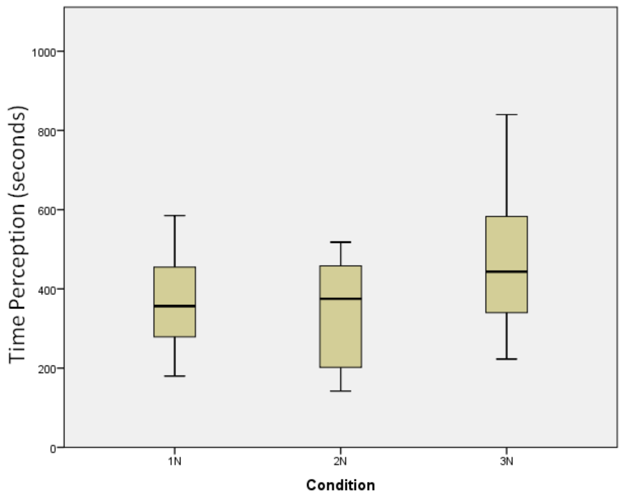
Using the same test, the result for time perception shows that time perception was approaching significance, $F(2, 27) = 2.667, p = 0.088$, $\eta_p^2 = 0.162$, suggesting small effect. Figure 4.14 shows the box plot for time perception between conditions. The one sample t-test was used with the value = 420 to test whether the underestimation or the overestimation was significant. The underestimation in the easy condition was not significant, $t(9) = -1.357, p =$

Figure 4.13: The Box Plot for Immersion Scores across Conditions



0.208, whereas the underestimation in the medium condition was marginally significant, $t(9) = -1.974, p = 0.080$. Moreover, the overestimation in the hard condition was not significant, $t(9) = 1.096, p = 0.301$.

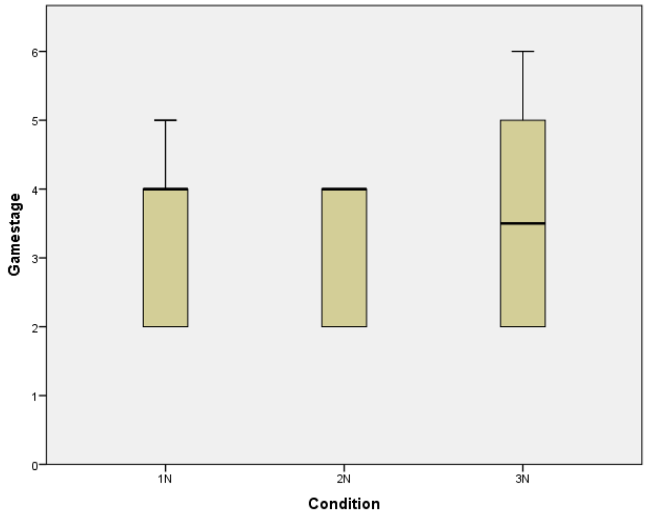
Figure 4.14: The Box Plot for Time Perception across Conditions



The performance of participants was not significantly different across conditions, $F(2, 27) = 0.063, p = 0.939$, $\eta_{\text{p}}^2 = 0.018$, suggesting small effect size. Figure 4.15 shows the box plot for game level between conditions.

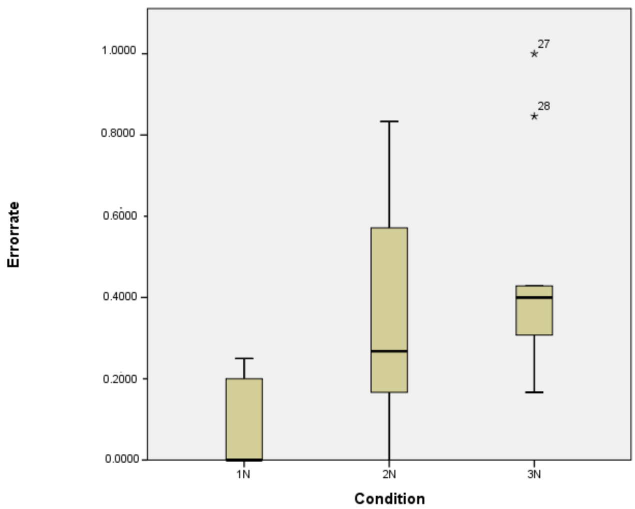
By contrast, the error rates of participants was highly significant between

Figure 4.15: The Box Plot for Game Level across Conditions



conditions, $F(2,27) = 5.889, p = 0.003$, $\eta_p^2 = 0.352$ showing small effect. To test the interaction, a post-hoc test using Tukey test was performed on the data. Only the interactions between 1N and 2N, $F(2,27) = -0.263, p = 0.042$ was significant whereas the interaction between 1N and 3N, $F(2,27) = -0.386, p = 0.002$ was strongly significant. However, there was no significant interaction between 2N and 3N, $F(2,27) = -0.1226, p = 0.469$. The number of letters participant said during the study was not significantly different between conditions, $F(2,27) = 2.745, p = 0.082$. We removed the outlier and found that there was no difference in the results.

Figure 4.16: The Box Plot for Error Rate Made across Conditions



4.5.7 Discussion

The results do not support our hypothesis that the memory load test would influence time perception, but as we expected, having a memory load task did not affect immersion level.

In contrast to Study Nine, this study was done by manipulating participants' working memory, requiring them to remember a letter – whilst playing and estimating time – rather than working on finding the answers to the arithmetic questions. The results support that players are able to ignore the additional task (memory load) to maintain immersion in the game.

The results on error rate suggest that those in the hard (3N) condition made more errors than those in the easy (1N) condition. Similar to those in medium (2N) condition, they made more errors than those in easy (1N) condition but not between medium (2N) and hard (3N). This suggests that the manipulation worked in term of task difficulty. Interestingly, their game performance was not affected. Participants managed to finish the game at the same level. They were able to keep their attention on playing the game despite the memory load being introduced during the gaming session, but their ability to perceive time is affected (with marginal effect).

This finding again adds the evidence that there is dissociation between immersion and time perception whilst playing digital games. During the gaming session, players are able to ignore the irrelevant task to the gaming session. Clearly in this experiment, participants have to perform three different tasks at one time, which influences their time perception because the magnitude of prospective duration decreases when participants perform multiple tasks (Block and Zakay, 2008).

The findings suggests that players are able to prioritise the need of concurrent cognitive activities and ignore unrelated cognitive process (which in this case can be seen from the finding that their immersion scores were not significantly different between conditions). Having a high working memory on the games should have an influence immersion because participants are not able to ignore the memory load tasks given to them. However, as immersion is a selective attention, they manage to prioritise to which task they should attend to which causing the non-significant results on their immersion levels.

Therefore, the next study will again be using memory load, but will design it to be with two groups (2N and 4N). This is because the 1N back test was too easy given that the error rate made in this group is low. Having 2N and 4N is necessary given that 2N is medium difficult and 4N is hard. To test whether they can ignore the unrelated task to gaming activity participants will be instructed to get high scores (game oriented) or to estimate time accurately (time oriented). This will give them an obligation to either focus on the game or on time which will influence immersion and time perception. Thus, if there is no interaction between both, we can gather more evidence for the dissociation between immersion and time perception.

4.6 Study Eleven: Memory Load (Prospective Paradigm)

From Study Ten, it is clear that the different level of difficulties between 1N and 3N back tests were strongly significant. It supports the evidence that to remember the letter is more difficult in the 3N condition compared to 1N condition. Although the difficulty level is high, there was no effect on immersion scores but a marginal effect on time perception.

Memory load was introduced during the gaming session to manipulate time perception to test its effect on immersion. So far, all the findings suggest the dissociation between immersion and time perception. It seems that when the manipulation of time perception was a part of the gameplay, it influences immersion instead. But when the manipulation is not a part of the gameplay, players ignore the task and invest their attention on the game; but for time perception, performing many tasks at one time reduces the accuracy.

Results from Study Ten show that although the memory load task was difficult, it does not influence their immersive experience. One of the reasons for this might be that players ignore the additional task (memory load) during their gaming session. But what happens if gamers are told that they have to focus on other tasks whilst playing digital games? Would it reduce immersion? As Lavie et al. (2004) found, when attention is focused on the goal-oriented stimuli, people are able to ignore irrelevant distractor. Cognitive control is changed based on the attentional effort required to perform a task. Would they experience less immersion if they are told to produce time perception as accurately as possible (as their primary task) as opposed to high scores?

Therefore, this study continues to manipulate time perception using memory load. The N-back test is used to manipulate time perception to test its effect on immersion. However, in this study, participants were told whether their aim is to get a high score, or to stop after 7 minutes as accurately as possible. As the results from Study Ten suggest, the 3N-back test was difficult. Therefore, we redesign this experiment using instead medium (2N-back test; second to last letter from the anchor), and very hard (4N-back test; fourth to last letter before the anchor). This is chosen to ensure the 2N task is not too easy and 4N task is hard, thus this will increase the working memory during the experiment.

4.6.1 Aim and Hypothesis

The aim of the experiment is to test whether any changes in time perception will affect immersion levels whilst playing digital games. Time perception is manipulated by using the distraction of memory load (N-back test). The hypothesis is that time perception is less accurate in the 4N-back test, and that there is no difference in immersion between the goal-oriented and time-oriented conditions.

4.6.2 Design

The experiment was a two-way factorial, between subject design. The primary independent variable was the difficulty level of the N-back test (2N or 4N). The secondary independent variable was the goal participants needed to achieve (get high scores, or stop after as close to 7 minutes as possible). The primary dependent variable was the immersion score, and the secondary dependent variable was time perception. The two factors are N-back test, 2N and 4N, and immersion, game oriented, and time oriented. Each participant was allocated randomly to one of the four conditions, but balanced to give ten participants in each condition.

4.6.3 Participants

40 participants were recruited around the National Defence University of Malaysia. The participants were both students and academics at the university. Their ages ranged from 19 years old to 45 years old (mean age = 27.91 SD= 6.20); 7 of them were female. The language used for teaching and learning in the university is English, and all of the participants were able to understand and communicate in it. All of them played digital games several times a week, for up to an hour per session. 17 of them never play the game used in the experiment (but knew about it). None of them disliked the game.

4.6.4 Materials

The game used was *Bejeweled 2* for PC was bought from Amazon UK . The endless game mode was chosen for all participants. Unlike in Study Ten, using this mode will allow us to record their scores. They were playing the game on desktop computer with 21" display size with a screen resolution of $1920x1080$ pixels. The input for the game was a normal mouse.

The experiment took place in an empty meeting room. To ensure that the surroundings were constant, the blinds in the room was shut and all the lights were switched on. The game sound was played on the external speaker at 30% volume. A smartphone was used to measure the playing time. Immersion level and time perception was measured using the Immersive Experience Questionnaire (IEQ) (Jennett et al., 2008). Demographic details were measured, covering age, gender, occupation, and participants' gaming history, including frequency of play, average playing duration, and the amount of years they had been playing.

Similar to Study Ten, memory load was added by using recorded, randomly generated alphabets. The first letter was set to appear after 10 seconds after the experiment started. Consecutive letters were set up every 3 to 7 seconds randomly. This is to avoid the timing pattern to give participants the tick of time. Similar to Study Ten, the anchor (bell ring sound) appeared at every 8th period of the sequence. Figure 4.12 illustrates the memory task used in this study.

4.6.5 Procedure

Participants were welcomed and given the informed consent form to fill. After discussing and signing it, the instructions of the experiment were explained to them. They were also instructed to switch off their mobiles, and to take off their watch for safe keeping in a box next to the table (to avoid distractions during the experiment).

They were introduced to the game and given a few minutes as a tutorial before the experiment started. At the same time, the recorded randomised alphabets were played. After the participant expressed confidence in what they had to do, and that they were ready for the experiment, the experimenter told tell them to start playing the game. The stopwatch from the smartphone and the new set of recorded alphabet audio were started simultaneously. They were told to play for 7 minutes and press the reception bell on the table next to the keyboard when they felt that they have reached this time.

For those in the 2N-back test, they had to say the two letter before the anchor and 4-N back test they have to say the four letter before the anchor. In addition, those in the game-oriented condition were told to get high scores, whereas those in the time-oriented condition were told to focus on stopping as close to 7 minutes as possible. When they pressed they bell, experimenter will stop the stopwatch, record the time and the scores. After that, they were asked to complete the IEQ. They were also asked to fill the demographic questionnaire. Participants were then debriefed as to the goals of the study.

4.6.6 Results

The data was transcribed into a single spreadsheet. The mean and (standard deviation) for total immersion scores and its component for both the N-back test and the goal to achieve. The data for immersion scores are shown in Table 4.6

Table 4.6: Mean and (Standard Deviation) for Immersion Scores and Its Components for 2N and 4N with the Goal Orientation (Game or Time) Conditions

	2N			4N		
	Time	Game	Total	Time	Game	Total
Total Immersion	102.10 (15.14)	104.50 (16.14)	103.30 (15.28)	96.40 (23.33)	94.30 (7.80)	95.35 (16.96)

It is immediately apparent that there were no significant difference on immersion scores between 2N-back test and 4N-back test condition, $F(1, 36) = 2.309, p = 0.137$, $\eta_p^2 = 0.060$, suggesting small effect, no difference in immersion between game oriented of time oriented, $F(1, 36) = 0.001, p = 0.977$, $\eta_p^2 = 0.000$, suggesting no effect or any significant difference on their interaction, $F(1, 36) = 0.185, p = 0.670$, $\eta_p^2 = 0.005$, suggesting small effect. Figure 4.17 shows the plot of means for immersion scores across conditions.

Figure 4.17: The Box Plot for Immersion Scores across Conditions

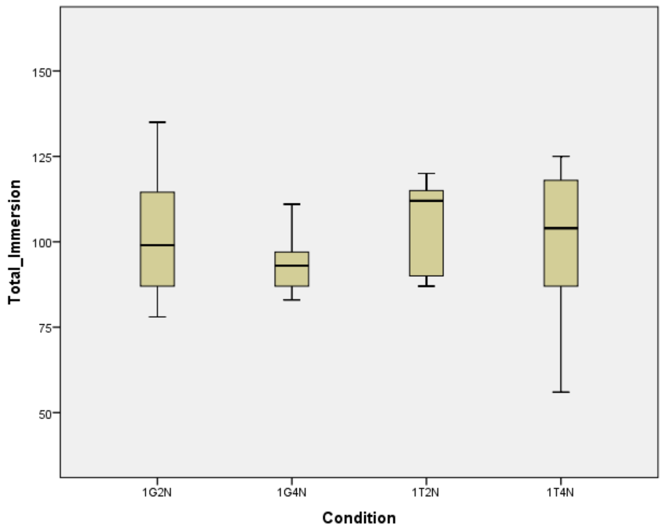


Table 4.7 shows the time perception for both N-back test and goal to achieve.

There was no significant difference in time perception between the 2N-back test and 4N-back test, $F(1, 36) = 0.01, p = 0.974$, $\eta_p^2 = 0.000$, suggesting no effect, no difference in time perception between game oriented and time oriented, $F(1, 36) = 0.014, p = 0.907$, $\eta_p^2 = 0.000$, suggesting no effect or any significant difference on the interaction effect, $F(1, 36) = 0.956, p = 0.335$,

Table 4.7: Mean and (Standard Deviation) for Time Perception for 2N and 4N with the Goal Orientation (Game or Time) Conditions

	2N			4N		
	Time	Game	Total	Time	Game	Total
Time perception	390.60 (126.94)	435.20 (188.15)	412.90 (157.87)	439.60 (174.39)	382.80 (160.07)	411.20 (165.51)

$\eta_p^2 = 0.026$, suggesting small effect. Figure 4.18 shows the plot of means for the interaction between time perception in the N-back test and task orientation.

Figure 4.18: The Box Plot for Time Perception across Conditions

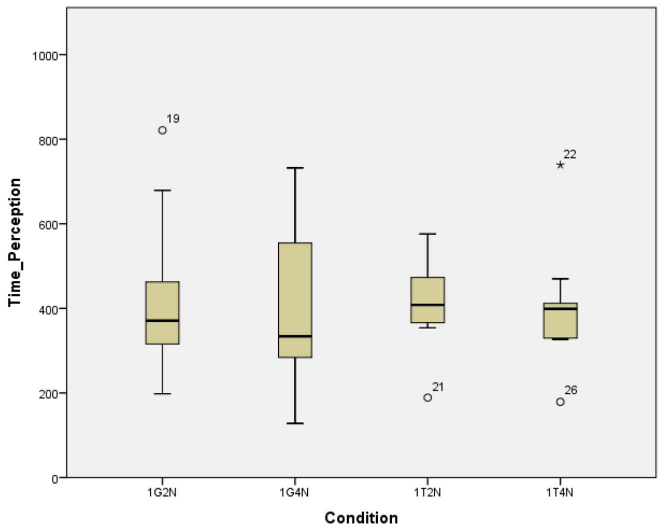


Table 4.8 shows the game scores for both the N-back test and goal to achieve.

Table 4.8: Mean and (Standard Deviation) for Game Scores for 2N and 4N with the Goal Orientation (Game or Time) Conditions

	2N			4N		
	Time	Game	Total	Time	Game	Total
Game scores	2825.40 (1677.79)	3254.60 (3172.29)	3040.00 (2479.67)	2337.40 (1586.52)	2773.50 (2039.95)	2555.45 (1792.63)

There was no significant difference for game scores between the 2N-back test and 4N-back test, $F(1, 36) = 0.48, p = 0.493$, $\eta_p^2 = 0.011$, suggesting small effect. There was no difference on game scores between game oriented and time oriented $F(1, 36) = 0.383, p = 0.540$, $\eta_p^2 = 0.013$, suggesting small effect and there was no significant difference on the interaction effect between conditions, $F(1, 36) = 0.000, p = 0.996$, $\eta_p^2 = 0.000$, suggesting no effect. Figure 4.19 shows the interaction between time perception in the N-back test and the task orientation.

Figure 4.19: The Box Plot for Game Scores across Conditions

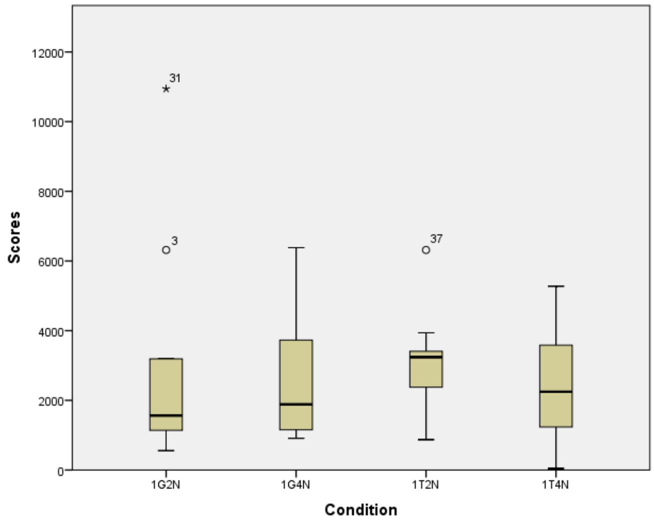


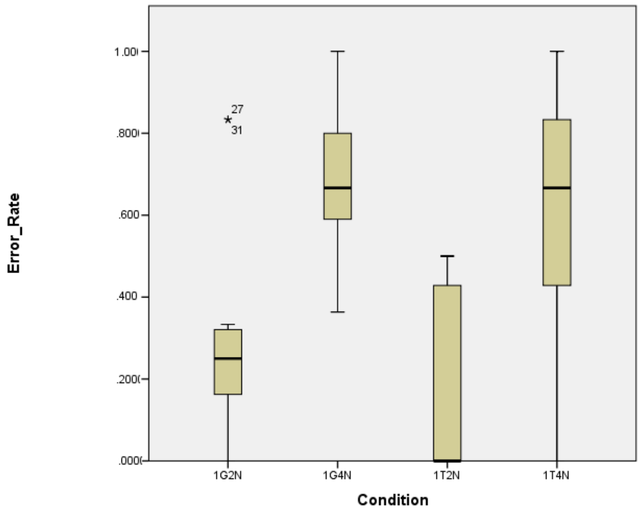
Table 4.9 shows the mean and (standard deviation for error rate made between conditions, and Figure 4.20 shows the interaction plot between the N-back test and the task orientation.

Table 4.9: Mean and (Standard Deviation) for Error Rate for 2N and 4N with the Goal Orientation (Game or Time) Conditions

	2N			4N		
	Time	Game	Total	Time	Game	Total
Error rate	0.1629 (0.2257)	0.3383 (0.2786)	0.2506 (0.2627)	0.5792 (0.3383)	0.7364 (0.1693)	0.6578 (0.2725)

The manipulation using memory load did work, i.e. participants made significantly more errors in the 4N-back test condition in comparison to 2N-back test condition, $F(1, 36) = 24.42, p<0.01$, $\eta_p^2 = 0.404$, suggesting small effect and approaching significance between task orientation, $F(1, 36) = 4.072, p = 0.051$, $\eta_p^2 = 0.102$, suggesting small effect. However, there was no significance in the interaction between the N-back test and task orientation for error rates, $F(1, 36) = 0.012, p = 0.912$, $\eta_p^2 = 0.000$, showing no effect size.

Figure 4.20: The Box Plot for Error Rate Made across Conditions



4.6.7 Discussion

The results did not support the hypothesis. There was no significant difference in time perception, immersion, and game scores across conditions. Indeed, no significant interaction to support that having the need to measure time and to perform well influences immersion and time perception. Further, the aim to manipulate time did not work. However, the difficulty for memory load was significantly higher in the 4N-back test condition compared to the 2N-back condition. Although the memory load supplied was rather difficult, participants did not underestimate time, and the level of immersion was not significantly different. Surprisingly, their game scores also were not significantly different between conditions. The effect was small indicating a complicated experimental design.

Unlike Study Ten, this study introduced a goal-related behaviour, namely time-oriented and game-oriented conditions. Based on findings from Lavie (2005), they suggest that in the goal-oriented condition, attention is focused on the goal-related stimuli. It could be that when participants were introduced to the task-oriented condition, selective attention becomes limited. They could not ignore irrelevant tasks to the gaming session because they have to attend to the task oriented to them. Therefore their immersion scores and time perception were not significant between conditions.

Having the need to get high scores is a reminder that they need to achieve high score and hypothetically will increase their attention on the game, hence increase immersion. In contrast, having the need to produce accurate time perception will be a reminder of the temporal task, hence, reducing immersion. However, the result suggest that the insignificant result could have been caused by the complexity of the manipulation. Having two independent variables could increase the confounding variables. Hence, in this study participants were required not only to attend to multiple tasks but at the same time they have to achieve the main goal (either achieve high scores or accurate time). This is rather complicated. It is hard for players to become immersed, and at the same time to produce a good time estimate.

This study also shows that both notions are sensitive. Having one notion to be manipulated could change others if the environment is not controlled properly; manipulating both is even more complicated. The aim to find more evidence of the dissociation from this study was not a success given the complexity and the sensitivity of both immersion and time perception. It is hard for players to concentrate to the game (to achieve high score) and at the same time to estimate time perception.

4.7 General Discussion

4.7.1 Manipulation of Time Perception

In this chapter, the main manipulation was switched from manipulating immersion (Chapter Three) to manipulating time perception. The aim however was the same: to investigate the effect of immersion on time perception. Results from Chapter Three indicated that there is dissociation between immersion and time perception, hence, the objective of this chapter was to gather further evidence on the dissociation between immersion and time perception.

In this chapter, time perception was being manipulated and measured using the prospective paradigm. The argument is that both immersion and time perception require attention from the players. Therefore, by manipulating time in the prospective paradigm, we were able – in the experimental designs – to test whether any changes in time perception will influence immersion, which would be the case if there was a direct relationship between them.

The first part of the manipulation of time perception was done by manipulating visual stimuli. This manipulation succeeded in manipulating time perception when the different intensities/speeds of the visual stimuli were external to the game. The results showed that participants significantly underestimated time when they played digital games with the fast moving Starfields on the background. This supported the literature on the effect of visual stimuli on time perception.

However, when the different intensity/speeds of the visual stimuli were integrated as a part of the gameplay, the effect was different. The different speed and pace of the game did not influence time perception as shown in Study Six, but it influenced players' immersion levels. One of the possible explanations for this is that when the stimuli are not a part of the game, it influences participant's time perception unconsciously. But when it is a part of the game, it does not indirectly affecting time perception but rather influencing immersion because the intensity/speed is a part of the game. These findings add to the evidence that there is dissociation between immersion and time perception.

The concern about the measurement of time perception using the retrospective paradigm was justified: the estimation is exposed to participants' random verbal estimation and the manipulation could not be captured retrospectively. This is because time estimation which is made retrospectively depends entirely on participants estimation based on their memory. This is hard to be controlled during the experiments. Participants might have different way on how to recall the temporal memory and they could just produce the estimation randomly.

Further, based on traditional manipulations of time perception (the dual-task experiment from psychology). Thus, the final three studies were concentrating on adding one additional task whilst playing digital games and producing time perception. This was done by asking participants to answer arithmetic questions whilst playing digital games and by manipulating the working memory using memory load. The results suggested that the additional task introduced during the gaming session did influenced participants to underestimate time. In contrast, the manipulation of working memory using memory load indicates there is marginal effect on time perception. However, when participants were required to attend more to either gaming or estimating time, the manipulation using memory load did not show any effect.

In short the manipulations of time perception in this chapter worked in both ways: successfully manipulating time perception and also manipulating immersion. Based on this there is a tentative evidence that there is dissociation between immersion and time perception where a different on one notion does not directly affect the other. This helps to continue this research further.

4.7.2 Prospective Time Perception Paradigm in Digital Games Research

The prospective time perception paradigm allowed us to understand how players perceive time. Unlike the retrospective paradigm, prospective time perception paradigm allows us to control participant to track time. During the gaming session, the result could indicate whether participants attended more to the game or timing task. This allowed us to manipulate either one to test the effect on the other. Also, we could reduce the 5 minutes effect and verbal estimation. The results for time perception in this chapter are rather inconsistent. Each individual experiment produced different effects on time perception. Therefore, a meta-analysis will be undertaken to test the consistency of the results.

4.7.3 Dissociation between Immersion and Time Perception

The findings from all the experiments show that there is dissociation between immersion and time perception. The findings also suggest that the dissociation occurs when participants select the task for them to attend to. If the manipulation of time perception is designed in a way that participants can ignore it, their perception of time can be affected but not their immersion. In contrast, if the manipulation is associated with the gameplay, they will attend to the game having no effect on time perception. Therefore, at this point, this research argues that immersion dissociates from players' time perception. Hence, a qualitative investigation is necessary to understand how players perceive time whilst playing digital games.

5. FURTHER ANALYSIS

The principal aim of this thesis is to test whether immersion influences player's time perception whilst playing digital games. A total of eleven experiments were conducted to achieve this aim, however the results produced are rather inconsistent. They do not show any statistically significant pattern which would support the arguments that immersion influences player's time perception in digital games (Sanders and Cairns, 2010; Haywood and Cairns, 2005). However, the findings from all these eleven experiments suggest there is dissociation between immersion and time perception.

Chapter Three, discusses four studies that were conducted by manipulating immersion to test its effect on time perception. The main objective of these experiments was to investigate whether any changes on immersion level will significantly influence player's time perception during a gaming session. Immersion was manipulated using factors from the game, player and environment. The IEQ was used to measure immersion (Jennett et al., 2008), and time perception was measured using a verbal estimation method retrospectively (Grondin, 2010). Only two of the studies (Study Three and Study Four) successfully manipulated immersion, however there were no significant effects on time perception.

The results from these four studies suggest that there is no association between immersion and player's time perception in digital games. However, the results are not conclusive to conclude that there is no disassociation between immersion and time perception. It could be that the retrospective time perception paradigm used in the experiment is not suitable to measure time perception in the context of digital games (Sanders and Cairns, 2010). Therefore, to test whether retrospective time perception paradigm is a suitable paradigm for measuring time perception in digital games, Study Five was conducted by manipulating time perception and measuring it retrospectively. The result from Study Five shows that there no significant difference on time perception between conditions. This supports that the measurement of time perception in the context of time perception using retrospective paradigm is problematic.

It is not possible, however, to be confident that this is the case in every instance and will necessarily remain the case. It is suspected that between immersion and time perception in digital games, a constituent relationship holds. In response to this, it was necessary to approach at the problem from a different perspective. Therefore, this research aims to avoid restricting the investigation by only focusing on manipulating immersion and measuring time perception retrospectively. The experimental method was amended from manipulating immersion to manipulating time perception. Thus, the other next six studies focus on manipulating time perception measuring its effect on immersion. In addition, the way in which the participants were asked to estimate their time perception was changed to prospective paradigm.

One argument to support why prospective time perception paradigm suitable to be used in these experiments could be due to the attention as the underlying foundation for both immersion and prospective time perception paradigm. As both notions require attention, manipulating time perception in prospective paradigm would make it possible to monitor whether participants are focusing their attention on the temporal task or on the game (Block and Zakay, 1997). If they pay more attention to tracking time, their time estimation is expected to be accurate whereas immersion level decreases.

Chapter Four, discusses six studies conducted using a manipulation of time perception to investigate the effect on immersion. The main objective of these experiments was to investigate whether any changes on time perception will influence immersion. Unlike studies presented in Chapter Three, the experimental manipulations for these studies were done by altering the games and the player but not the environment. The same IEQ (Jennett et al., 2008) was used to measure immersion but time perception was measured using production method prospectively. Two studies (Study Six and Study Seven) successfully manipulated time perception but there were no significant effects on immersion. Only one study (Study Eight) however, shows significant effects on immersion and not time perception although time was being manipulated. For the final three studies (Study Nine, Study Ten and Study Eleven), no significant difference was found for both time perception and immersion.

Surprisingly, all of the results suggest disassociation between immersion and time perception in digital games. It seems that participants are able to ignore irrelevant task during gaming session which causing the dissociation. However, the overall picture from this is inconclusive: effects size from all of the studies on manipulating time perception are inconsistent. Factors such as ecological validity could cause the inconsistency on effects size in the laboratory studies compared to a substantial effects size outside the lab. Hence, it can be argued that further analysis should be conducted to strengthen the current results.

Furthermore, it is possible to have confidence in the results for immersion, as the IEQ is a well-established and widely used questionnaire for immersion research (Jennett et al., 2008; Seah and Cairns, 2008; Sanders and Cairns, 2010; Cox et al., 2012; Thompson et al., 2012; Nordin et al., 2013, 2014). In contrast, less confidence can be had in the results for player's time perception. This is due to a lack of literature focusing on the reliability of the measurement technique used to measure player's time perception specifically in the context of digital games, and whether the manipulations of time perception in these studies work. Therefore, the results for time perception were re-analysed using meta-analysis to test whether the results for time perception in all of the studies are show a consistent effect. The results from meta-analysis show that the results are inconsistent—due to substantial heterogeneity in each experiments and lead to considering a further qualitative investigation.

5.1 Meta-Analysis

5.1.1 What is Meta-Analysis?

Meta-analysis is one of the statistical techniques for data analysis which aims to understand the results of any study in the context of all other studies (Borenstein et al., 2011). One of its advantages is that it enhances the consistency of the statistical results from several individual studies which are not consistent individually Borenstein et al. (2011). It uses established or existing reports as the underlying foundation and integrating the materials to produce evidence-based results (Boswell and Cannon, 2012). It is also known as the analysis of analysis (Cumming, 2013). Borenstein et al. (2011) argue that meta-analysis is one of the techniques that makes it possible to address issues that other statistical tests could not.

This is because the results from meta-analysis aids understanding of whether the effect sizes from all the individual studies are reasonably consistent from study to study. Moreover, it computes a single estimate effect to suggest whether the overall effect is favouring the control condition or experimental condition. For example, in this case, the single estimate effect helps to suggest whether participants favour underestimation or overestimation of time perception whilst playing digital games. Also, if the effect size varies from study to study, meta-analysis also helps to quantify the extent of heterogeneity of the studies (Borenstein et al., 2011).

5.1.2 Why Perform Meta-Analysis?

Deeks et al. (2008) claim that meta analysis helps to increase the statistical power. They argue that many individual studies are too small to detect small effects, but when several are combined there is a higher chance of detecting an effect. Secondly, they claim that the estimation of an intervention effect can be improved when it is based on more sources of information, thus improves precision. Moreover, meta-analysis helps to answer questions that are not answered by individual studies. Deeks et al. (2008) claim that every study often concerns a specific type of participants and an explicitly defined intervention. But when a number of studies in which these characteristics differ are grouped together, it allows investigation of the consistency of effect and, if relevant, allow reasons for differences in effect estimates to be investigated. Finally they claim that meta-analysis helps to settle controversies arising from apparently conflicting studies or to generate new hypotheses for further investigation, which is very useful for the next qualitative investigation.

5.1.3 How to Perform Meta-Analysis?

As meta-analysis is relatively uncommon in HCI, an overview of the steps are presented here:

Firstly, the main important element to consider before conducting meta-analysis is to compose a valid research question to be the foundation of combining several studies. The question determines whether each individual study is suitable to be combined together for meta-analysis (Cumming, 2013). It also will ensure consideration of the potential interventions, participants, setting of each study, and its measurement unit. Having a clear research question will provide a clearer indication of the possible single estimate effect that will be produced.

Secondly, ensuring that the analysis is conducted with only several individual studies that address the same issue (Borenstein et al., 2011). Otherwise, meta-analysis is not the best technique for testing the accuracy and consistency of the effect of distinct studies. The decision on whether several different studies are addressing the same issue can be validated based on four main factors, namely intervention, participants, settings and outcomes.

- Intervention : Is the study intervention testing the same topic? Investigating time perception is not similar to testing felt time
- Participants : Are the participants from each study representing the same population? This is important because studying children is not the same as studying adults

- Settings : Are the settings of the studies similar? Study conducted in the lab is different from study in the wild
- Outcomes : Are the outcomes the same? The outcome of time perception that is measured in hours is not similar to that measured in seconds.

All of these factors from all of the studies are required to be sufficiently the same, which justifies the theory that there is something in common to allow for investigating the overall estimate effect. This is however, very crucial in such a way that thorough judgement is need to ensure that the studies do not differ in ways which are likely to affect the outcome (Cumming, 2013). For example; one study on the effectiveness of a new drug was conducted with adults, and the same study was repeated with children. These two studies may look similar and have the similar aim but they are actually different. The participants for both studies are not from the same age group. Therefore, it is impossible to determine a single overall effect because children react to drugs differently from adults. In addition, the variables of the outcomes also should be in the same format, so they can be combined. For example, an overall estimate effect cannot be made if one study measures time in years, and another study with milliseconds.

Thirdly, identifying the type of data. Deeks et al. (2008) categorised types of data into five categories, namely Dichotomous data (or binary data). For this type of data, each participant's outcome is one of only two possible answers. Another type of data is Continuous data. For this type of data, each participant's outcome is a measurement of a numerical quantity. Moreover, Ordinal data (including measurement scales) is the outcome is one of several ordered categories, or generated by scoring and summing categorical responses. Counts and Rates calculated from counting the number of events that each individual experiences. Finally Time-To-Event (usually survival) data that analyses the time until an event occurs. The type of data identifies the ways in which the effect of an intervention can be measured.

As for the analysis of time perception in this thesis, the results for time perception from all of the experiments are recorded in the unit of seconds which falls under the category of Continuous data. Therefore, the following steps are specifically focused on conducting meta-analysis to calculate the effect of an intervention for Continuous data.

Fourthly, computing the effect measures for continuous outcomes. Two summary statistics which are commonly used for conducting meta-analysis of Continuous data are the mean difference or the standardised mean difference (Deeks et al., 2008). Deeks et al. (2008) explain that the mean difference is a standard statistic that measures the absolute difference between the mean value in two conditions. It estimates the amount by which the experimental intervention changes the outcome on average compared with the control. It can be used as a summary statistic in meta-analysis when outcome measurements in all studies are made on the same scale. In contrast, the standardised mean difference can be applied when all the individual studies are measuring the same outcome but it is measured in a variety of ways (for example, all studies in psychology related to emotion measure mood but they use different psychometric scales for one study to another). In this case, it is necessary to standardize the outcomes of the studies to a similar scale before they can be combined. Furthermore, the standardised mean difference expresses the size of the intervention effect in each study relative to the variability observed in that study (Deeks et al., 2008).

Fifthly, there are two main models used to run the meta-analysis for continuous outcomes. This can be done using the free software meta-analysis tool called MetaLight available at `http://eppi.ioe.ac.uk/free-tools/meta-analysis/`. These models are: fixed effect models and random effect models. Fixed effect model refers to the analysis that has been done with an assumption that the true effect size is the same in all studies, thus, the single estimate from this model is the mean of these effect sizes (Boswell and Cannon, 2012). In contrast, random effect model refers to the analysis that been done with an assumption that the true effect size is distinct from one study to the next. Thus, the single estimate effect from this model reports the mean of random effect sizes that could have been observed from the studies (Boswell and Cannon, 2012).

Furthermore, the decision on which model to follow can be made based on what the research wants to achieve and the nature of the results from the individual studies. A fixed effect model can be used if two conditions, namely all the studies, are functionally identical and the goal is to compute the single effect size for the identified population and not to generalise to other populations (Boswell and Cannon, 2012). In contrast, a random effect model can be used when the researcher is gathering data from studies that were done independently, in which it would be unlikely that all of them were functionally similar. Typically, the participants or the interventions would have differed in ways that would have impacted the results. Hence, we are not advised to assume a same effect size from these studies (Boswell and Cannon, 2012).

Lastly, although all selected studies may be addressing a similar issue, any kind of variability among studies may produce statistical heterogeneity (JPT and Green, 2011). Statistical heterogeneity refers to variability in the intervention effects being evaluated in the different studies (JPT and Green, 2011). It reveals the observed intervention effects that vary due to random errors or by chance (Boswell and Cannon, 2012). Another two types of heterogeneity are clinical heterogeneity and methodological heterogeneity.

Clinical heterogeneity refers to variability in the participants, interventions and outcomes. Whereas methodological heterogeneity refers to variability in study design and risk of bias (JPT and Green, 2011). Significant statistical heterogeneity means that differences between studies exist which may make it invalid to pool the results and compute a single estimate effect, but this does not necessarily suggest that the true intervention effect varies. Whereas, insignificant statistical heterogeneity means there is no statistical evidence for differences between studies (Borenstein et al., 2011). However, insignificant statistical heterogeneity not always means homogenous (Deeks et al., 2008), which means further analysis is required to test the homogeneity. Heterogeneity could be tested using the $\mathrm{I}^2 availablefromMetaLight.$

According to Deeks et al. (2008), the thresholds for the interpretation of $\mathrm{I}^2 areasfollow$:

- 0% to 40%: might not be important;
- 30% to 60%: may represent moderate heterogeneity*;
- 50% to 90%: may represent substantial heterogeneity*;
- 75% to 100%: considerable heterogeneity*.

Results from meta analysis are usually illustrated using the forest-plot diagram. Forest-plot diagrams provide information and context for the analysis. Rather than displaying summary data separately for the experimental condition, the forest plot will display the estimates and standard errors as they were entered beside the control condition (Deeks et al., 2008). The effect size from each study is represented with a square box with the single estimate effect (usually centre line of diamond). Connected to the confidence intervals (lateral tips of diamond), and a solid vertical line of no effect. The size of the box represents the weight of each study for the analysis. Each side (left and right) represents the effect either favouring the experiments or favouring the control. Classic examples are studies on the effectiveness of drugs, the left side of the forest plot represents a positive effect of the experiment whereas the right side of the forest plot represents a negative effect. This is determine by the researcher when labelling the side of the diagram.

5.2 Meta-Analysis on the Results from Manipulation Time Perception whilst Playing Digital Games

Following the steps described in the 5.1.3 this research continues to test whether the effect on the manipulation on time perception in the studies produced consistent effect using meta-analysis.

Firstly, the research question for the meta-analysis of time perception whilst playing digital games is “Does the manipulation of time perception influence player’s time perception in digital games?”. The aim is to test whether the manipulation of time perception during a gaming session producing a consistent effect.

Secondly, the question for this meta-analysis is really focused to test whether the manipulation of time perception influences participants’ time perception whilst playing digital games. Despite of all of the experiments, only those studies presented in Chapter Four are manipulating time perception to test its effect on immersion. Thus, only these experiments are chosen for the meta-analysis. However, amongst all of these six experiments, only five experiments were included for the analysis, these experiments include: Study Six, Study Seven, Study Eight, Study Nine, and Study Eleven. Study Ten is excluded because it has three conditions which does not fit the criteria for meta-analysis. All of them were chosen based on their characteristics; they are investigating the same intervention, the participants from all the experiment are from the same group of population, the experimental settings were similar (all experiments measured time using production method prospectively) and the outcomes are also similar. All these five experiments were conducted with the same aim: to manipulate time perception to investigate whether any changes of time perception influence immersion.

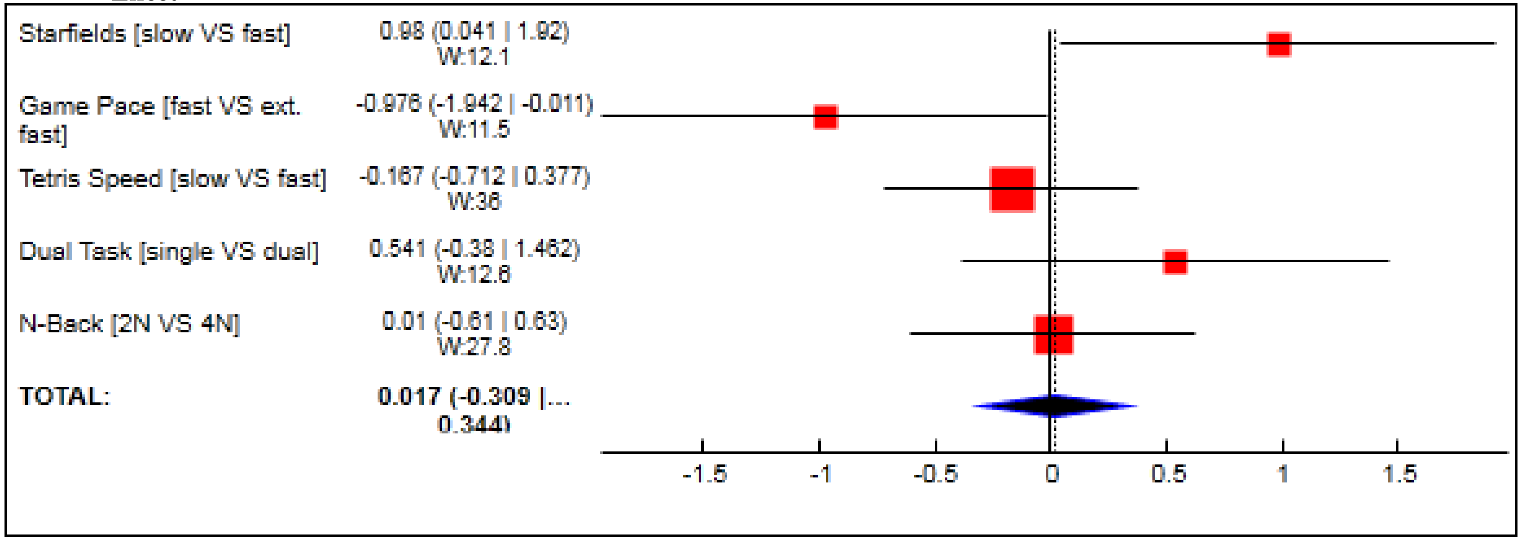
Thirdly, all of them used similar measurement methods, using the same time unit (in seconds) and were measuring the same effect. Therefore, they are all suitable to be combined to test whether there is a single estimate effect. Further, all the experiments were designed to manipulate time perception.

Fourthly and Fifthly, all the data from these five experiments were Continuous data. Data that can take any value (within a range) which, in this case, is time in seconds (Boswell and Cannon, 2012). However, the duration of playing digital games was not uniform for all of these experiments and the manipulation of time perception is also distinct between studies. Therefore, it was decided to apply the standardised mean difference for summary statistics, using the fixed effect model from MetaLight to compute the single effect size for all the experiments. The expected outcome is to determine whether players favour underestimation of time (left) or favour overestimation of time (right) during the experiment. With the statistical assumption of this analysis, that the underlying effect from all the experiements are the same, a single pooled estimate can be produced using the fixed effect model. As described, this model produces weight for every single study. This is calculated based on the formula $weight = 1/variance - of - trial - estimate$ or $weight = 1/standard - error - squared$ (Hedges, 1982). If the study has a high variance, this means it contains low information and will be weighted low and vice versa.

5.2.1 Analysis

The summary of the analysis of the meta-analysis of testing the effect of the manipulation of time perception is illustrated in 5.1.

Figure 5.1: Forest Plot for Meta-Analysis of Five Experiments in The Prospective Time Perception Paradigm Showing The Single Estimate Effect



The summary statistic was done using *continuous: Hedge g test* from MetaLight. The value of g enables us to transform all the effect sizes from all studies into one common metric. This is then used as the primary result in meta-analysis that will be intuitive for many researchers (Hedges, 1982). From the forest plot, we can see that the effect sizes are reasonably consistent for all five studies, Most fall in the range of 0.50 to 0.90, which suggests that it would be appropriate to compute a summary effect size.

Using the fixed summary effect size, the result was 0.0175 with a 95% confidence interval of -0.309 to 0.344 which is almost 0 (which indicates participants neither favoured underestimation nor overestimation when time perception was manipulated). The p-value for the summary effect was 0.0442 which is less than 0.05, this indicates that the meta-analysis was statistically significant.

Further, a heterogeneity test was conducted to test whether this result happened randomly or by chance, or if it was due to the heterogeneity of the studies. It shows $I^2 = 59.1\%$, which would be interpreted as substantial heterogeneity. This suggests that the manipulation of time perception had a different effect in each of the different studies. It is important to note that, since heterogeneity is substantial, to confirm the single estimate effect the data was tested with a random summary effect size. The results of which suggest a similar pattern is occurring.

5.2.2 Discussion

The results show that the manipulation of time perception in the experiments does influence player's time perception. However, the single estimate effect suggests the manipulation affects players' time perception differently across all of the experiments.

The nature of human time perception is very sensitive (Brown and Boltz, 2002). Little work has been done to indicate how best to manipulate players time perception without producing inconsistent effects. When the phenomenon of time perception is brought into the lab, and by altering the independent variable to manipulate time perception, participants may experienced time perception differently. This is because time perception is influenced by many factors, namely; mood (Hoffer and Osmond, 1962), physiological effect (Meissner and Wittmann, 2011) and stress (Zakay, 1993), etc. Clearly the variability is high, even though the experiment is conducted in a controlled lab environment. The experimental design could not control all of the said factors on the participants as all humans are different to each other.

There is a lack of available methodology for conducting research on time perception, especially in the digital games environment. Currently, there is no recommended duration for studying temporal tasks when conducting time perception research in digital games environment. The different durations used in all five studies may be the reason why the manipulation of time perception did not affect participants uniformly. Furthermore, different games were used for all of the five experiment, this could also potentially contribute to differences in time perception. Therefore, it is not possible to be sure as to whether time was affected by the type of the games or by gamers during the experiments.

Referring to the literature on time perception in digital games, time perception is shown to be altered when participants play digital games. As most of the data was collected retrospectively in these previous research studies, it is unclear whether player's time perception was altered. This is because the retrospective paradigm requires participants to estimate their time perception based on the memory stored. It is ambiguous how player's perception of time is being altered when they were estimating time retrospectively.

The method used to measure time perception for the majority of the studies on player's time perception whilst playing digital games involved collecting players thoughts about their time perception after the experiments rather during the experiments. Considering the results from the meta-analysis, the results suggest that time perception is difficult to be manipulated and measured objectively when players are playing a digital game. Therefore, statements made by players about their time perception whilst playing digital games need to be reported carefully. Researchers should be able to identify whether the question they are asking about time is referring to time perception or felt time for the previous gaming session, because the two are distinctly different concepts.

For future work, it is suggested that a series of experiments that manipulate time perception is run using the same type of game and a similar playing duration. Then, the summary effect size of these studies are computed using meta-analysis to test whether participants perceive time differently. Also, as can be noted, remembered duration was used in the majority of the studies to empirically test time perception in digital games. A qualitative study focusing on understanding how players perceive time can then be done to wrap up this thesis. Focusing on participants memory of their playing time, a grounded theory could be used to construct a theory of how players perceive time whilst playing digital games.

5.3 Qualitative Analysis

The attempts to investigate whether immersion influences time perception whilst playing digital games using quantitative analysis produced inconsistent results. The first part of the experimental investigation shows that the manipulation of immersion does not have any statistical significant effect on player's time perception during a gaming session. Whereas, the results from the second part the experimental investigation suggests that the manipulation of player's time perception does not significantly influence immersion in games. Moreover, the results from meta-analysis also suggest that there is no significant single estimate effect to determine whether players favour underestimating or overestimating time when their time perception was manipulated during a gaming session. Further, the meta-analysis does suggest that the result produced was due to the moderate heterogeneity across the studies and not by chance.

Therefore, with the collected evidence from the experiments, it can be argued that there is disassociation between immersion and time perception whilst playing digital games. Perhaps, due to the complex nature of gaming, the cognitive mechanisms involved during the gaming session may be different from the mechanism for estimating time. The majority of research on time perception is usually concerned with relatively short time durations, and often the experiments involved simple tasks, such as observing flashlights or listening to simple auditory signals. Playing digital games, on the other hand is clearly a multi-modal activity that produces multi-dimensional experiences involving many aspects of the player's sensory and social experience (Jennett, 2010). Hence, using a laboratory setting to capture the effect of immersion on time perception is particularly difficult due the complexity and nature of digital games.

For this reason, the study focuses on a qualitative method to understand how players perceive time whilst playing digital games. The results from the qualitative analysis help to understand whether participants able to ignore any irrelevant tasks during gaming session to ensure they could enjoy the immersive experience as shown in Chapter Four.

Qualitative analysis is the most suitable method at this stage because it helps to explore the fundamental areas of any topics for which little is known (Corbin and Strauss, 2008). It aids to interpret and better understanding of the complex reality of a given situation. Furthermore, qualitative methods can uncover complicated information about phenomena that might be difficult to gather quantitatively. These include; emotions, feelings, ideas, opinions, thought processes, etc. The flexibility and openness of the method facilitates greater spontaneity and adaptation in the interaction between the researcher and participants (Corbin and Strauss, 2008).

This qualitative study involved interviewing players to discuss their gaming habits and experiences from playing digital games. These interviews were transcribed and analysed using open coding, axial coding, and selective coding (Corbin and Strauss, 2008). Finally, a grounded theory was developed.

The study is presented as follows. First, the methodology applied is described and then the resulting grounded theory is discussed. Following this is a discussion on how these findings relate to answer the research question of the effect of immersion and time perception as considered in this thesis.

5.3.1 Grounded Theory

Grounded theory is a method used to ground the theory from sets of data (Corbin and Strauss, 2008). This means that there is an empirical investigation in conjunction with the development of the theory. This method allows a theory to be derived from data systematically and which is analysed throughout the study (Corbin and Strauss, 2008). Since the theory is derived from data, it is claimed that it offers insight and enhances the understanding of the research topic. Further, it enables participants to explain a specific topic thoroughly and this method also provides meaningful guidance for participants in explaining their thoughts systematically.

It is important to note that, during the process of grounded theory, a researcher should not begin their research with a preconceived theory in advance (unless if their work is to extend existing theory). This is because, having a preconceived theory may lead the interviews to validate the theory rather than gaining more and richer information. Therefore, the research begins with defining an area of study and allow the theory to emerge from the data.

The analysis of the data can be done using three coding processes called open coding, axial coding and selective coding. Open coding is the analytical process used to identify the categories, properties and dimensions of the data. For open coding, the data are divided separately into small statement and the concepts are identified. The next phase is axial coding. Axial coding is the phase used to relate concepts or categories to each other. Finally, selective coding is a process of integrating and refining all of the categories and concepts in order to produce a central theory.

As mentioned, Corbin and Strauss (2008) argue that in order to develop a grounded theory, the data must be analysed and coded as it is collected. This allows of the development of new questions for the next participants to get more detailed information. The analysis of the data depends on the interplay between the data and the researcher. The researcher identifies the categories including its subcategories, the data properties in the transcript and deciding what are the next questions to ask, and also how the answer from those questions fit with the current existing categories. Also, the process of building up the theory was done entirely based on participants' responses. In addition to the description of the category or subcategory, all the corresponding quotes from the transcription based on participant responses, will be shown. This is not an exhaustive list of the categories and subcategories coded, quotes shown are selected examples.

If it is necessary to expand and re-defined some categories, this can be done by asking questions in subsequent interviews accordingly. Over time, some categories may need to be dropped if they are no longer relevant. This however, will influence the next interview process as researcher needs to focus on building new questions and to be focused on some topics more than others.

This process will continue until the researcher reaches saturation of the data. This happens when no new categories or properties appear to emerge from the data. At this time, the researcher stops conducting interviews. In the HCI domain, reviewing a complex phenomena and developing applicable frameworks sometimes requires an in-depth nature of qualitative analysis (Adams et al., 2008). Similar to this current study, the in-depth study will help to understand and to answer the research question. Indeed, Smith (1996) argues that qualitative research can be enhanced or assessed for validity using the participant's response. The internal coherence and the presentation of evidence in a qualitative study are two important elements that support the interval validity and the reliability of the study. The internal coherence is achieved by supporting the arguments with the data and ensuring that the process of obtaining the data consistent. Additionally, the presentation of evidence is important in grounded theory as all the arguments built are based on sufficient quotations/evidence from the participant's answers which enables readers to evaluate the interpretation.

Therefore, the qualitative study presents the main themes of the grounded theory along with corresponding quotations from participant's transcript. Thus, the validity and the reliability of the interpretations for developing the theory can be assessed by the reader.

5.3.2 Data Collection and Analysis

Design

The aim of the study is to understand the "nature of player's time perception" whilst playing digital games. Given the exploratory nature of this question, and in order to gain a rich source of information to answer it, a qualitative study was undertaken. Participants were recruited from a previous pool of participants (all of them having participated in an experimental study before), and some of them had known the interviewer prior to the experiments. The interviews were conducted in a friendly manner—in the style of an informal chat—to ensure that the participants were comfortable and at ease. They took place in the living room of the Home Lab (Department of Computer Science, University of York) and in individual meeting rooms of the JB Morrell Library (University of York). The interviews were conducted over a cup of tea or coffee paid for by the researcher as a token of appreciation for participation.

5.3.3 Participants

A total number of 8 participants were interviewed in this study, 7 were male and 1 was female. Their ages ranged from 21 to 30 years (mean age: 24.63 SD:3.96). All of them were either students or members of staff at the University of York. The student participants were a mix of both undergraduate and postgraduate. All of them have had experience of playing digital games before and play digital games several times a week for more than an hour per session. In this study, it appears that the theoretical saturation was reached at 9 participants.

Procedure

When participants arrived at the interview room, they were provided with their choice of refreshments and allowed to relax for several minutes prior to the interview

Following this, prior to the interview, the participants were asked to give their consent to take part in the study and any issues regarding the procedure were discussed. The participants were asked to give their signature to confirm that they understood the procedure and were happy to participate in the study. The interviews were conducted face-to-face for a period of approximately 45 minutes to an hour. The interviews were recorded using a portable recorder with a microphone attached. The recording was done with participant's consent. The questions asked were semi-structured to cover the following:

- Some information about them and their commitment to their study and work
- Some questions about their gaming preference?
- Their reason for playing?

- How they feel about time whilst playing digital games?

The list of all the questions can be seen in the Interview Schedule (see Appendix D). The questions asked covered a wide variety of topics which were not only focused on time. These questions were first developed to be used as a starting point to initiate the conversation about participant's experiences playing digital games. This is useful in order to get them to discuss about their experience. The questions were open-ended which helps to produce a more relaxed and casual interview session. At the same time, questions were carefully crafted to provide a greater understanding of how players perceive time whilst playing digital games.

The overall aim of the interview was to gain an understanding of time perception, however there were a number of more general questions included about players experiences of digital games. Some examples include; discussion of participants favourite games, games they would like to play and types of games they don't enjoy playing.

The grounded theory later however, will be focused on only the responses that relate to time perception. By asking participants other topics will ensure that they continue talking and prompt them to think about a wide variety of their experience with digital games. This is helpful in understanding the issue holistically.

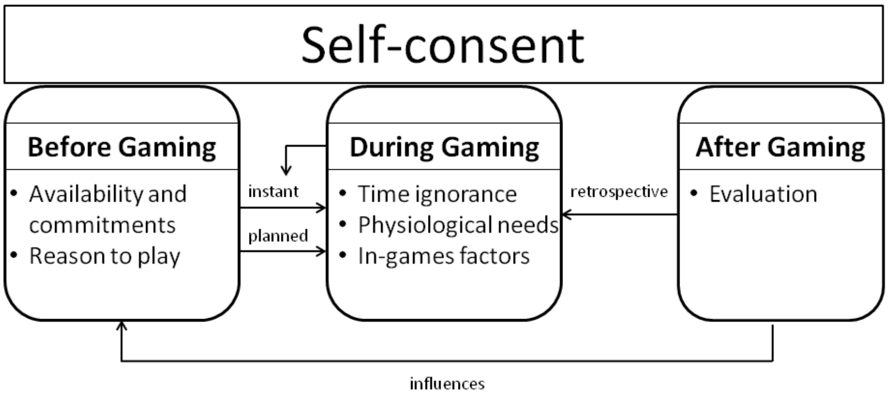
Data Collection and Analysis

The recorded interview was transcribed immediately after each completed interview. This is essential in the analysis process and allows for the addition of further questions for the next interview. The recorded audio was played using the Windows Media Player and the transcription was done manually using Microsoft Word. No audio to word converter was used during this process. Transcribing the recorded audio manually allows the interviewer to listen and learn about questions asked from previous interview. This is very helpful to craft more questions for future interviews.

From the analysis, the main theme of the grounded theory is identified and is presented with the phrase self-consent", which is used explain how players are actually aware of time before, during and after their gaming sessions. They give a consent for themselves to ignore time—thus they can play digital games. As can be seen in Figure 5.2, the grounded theory helped to clarify how self-consent could be the key to understanding how players perceive time whilst playing digital games. The following part of the grounded theory will be described:

- Self-consent before the gaming session

Figure 5.2: The Grounded Theory



- Self-consent during the gaming session
- Self-consent after the gaming session

It is important to note here that, there is no intention of producing a substantial and concrete theory on time perception or to push the boundaries of existing theories especially in psychology or other research area. This study aims to understand how digital games players perceive time whilst playing digital games. The results from this research may be helpful in a discussion of inconsistencies in the findings of previous quantitative investigations

Self-Consent Before the Gaming Session

Giving oneself consent to play digital games was found to be the main factor that influences how players perceive time whilst playing digital games. Without this consent, players would not play digital games at all. The giving of the self-consent before starting to play is significant because it means players permitted themselves to play digital games of their own will and no one forces them to play, i.e. they really want to play the game whether it is for a short or a long time. For example, "well I got about 200 hours login on the FPS games I bought two years ago"(Participant 1). Furthermore, self-consent can occur instantly or way in advance. For example, a player can suddenly decide to play digital games without prior plan, or they can plan the playing session way in advance. For example, "I generally play digital games in the evening. I usually get home in the evening, then I guess there is like four hours gap for gaming before I go to bed"(Participant 3). See Table 5.1 for the categories that will be described.

Table 5.1: Self-Consent Before Playing Digital Games

Categories	Subcategories (if any)
Availability and commitments	Instant Planned
Reason to play	—
Gaming preferences	—

Availability and Commitments: First, the two important elements that influence how a player gives themselves a consent to ignore time and play digital games, are their availability and commitments, see Table 5.2. Player's availability will determine how the self-consent is given to play digital games. The availability can be instantaneous or planned. Instant availability is for example, in between two tasks or waiting when for something, such as "I play casual games whenever at the bus stop whilst waiting for the bus or in bed while waiting for my partner to come to bed" (Participant 2). Whereas, planned availability is made in advance in which players allocate certain times in future to play digital games, for example, "during the term time, I will focus on my revision and I will try to reach to certain chapter. Then when I know I have studied enough I will reward myself to play digital games" (Participant 4).

Table 5.2: Examples of Instant Availability

Participant	Quote
5	"Whenever I can play, basically. Say when I finished lab, I go back home and I just want to relax and unwind. I either play badminton or play digital games."
6	"I don't plan to play because playing games is a part of my daily routine."
8	"Depends on my mood. Like one of my housemate come and ask me to play. So I play one game then I lose then I play again maybe 2-3 times. We do not plan to play. Nothing commits."

The availability depends on player's commitments. The availability decreases as commitment increases. See Table 5.3. This can be seen from this example "I am too busy now. I used to picked up a game and be completely absorb with it [...] but I don't feel like it anymore" (participant 3) and "I do not do much now. Because now I have got relatively less time, I tend to play digital games during my free time" (participant 7). No self-consent or permission is given if players have little availability and pressing commitments. This will directly stop them from playing. However, in certain cases, although players realise that they have less availability and at the same time they have commitments, they choose to ignore them and give themselves consent to play games. This can be seen from the example "I know that I am going to miss a lecture anyway, then I just continued playing" (participant 4).

Table 5.3: Examples of Planned Availability

Participant	Quote
1	"I just play on the weekend nowadays where the server is always full and it is just more fun"
4	"After I am done with two solid hours of studying then I play digital games"
6	"I try to limit myself to play digital games one hour per day"
7	"I like to get to work at a sensible time. So I can do full work during that time. So that when I get home in the evening I can cook dinner and do some house works, and see my wife in the evening. Then when I get some free time before bed, this is the time to play digital games. The prime gaming time is from the time when my wife goes to bed until the time I go to bed."

Reason to Play: In addition to availability and commitments, reasons to play also influence players to consent to ignore time. Without a justifiable reason to play, players would not giving any consent to ignore time to play digital games. See Table 5.4. Although players have a lot of time and less commitments, without an acceptable reason to play they will not play the game. Thus they do not give themselves consent to start playing. Again, the reason to play comes after player knows their availability and their commitments. A combination of these three elements contributes to players self-consent to play.

Players changed their gaming preferences depending on how much time they have consented to play. This is to ensure that the preferences fit the availability and the commitments. For example "I am also playing more single player game now than when I was in my undergraduate." (participant 2) and "My favourite type of game probably games that I like to talk about the most is the world RPG. Those are my favourite games. However, those are not the game that I play at the moment because there is no enough time to spend my time but that is definitely my favourite game." (participant 3).

This shows that, players changed their game preference to fit into their availability and their commitment. However, the reason to play is still the

Table 5.4: Examples of Reason to Play

Participant	Quote
2	"Entertainment, really. I mean it does makes me feel happy. You know it is just getting into unusual situations and do things that you can't normally do."
3	"I can't think of why I want to play a lot of tetris, I mostly play tetris because I feel like playing tetris. There is no motivation. It always, like sort of a craving, like for food or something."
5	"Because of fun"
8	"Most of the time either my competitive spirit or my friends' competitive spirit. Especially when none of us ready to lose."

same.

Self-Consent During the Gaming Session

Having the consent to play will then allow players to play digital games whether it is an instant session or a planned session. They know that they have to spend some time gaming. However at this point, if it is a planned session players might have an idea of how long they need to play, whereas for an instant session players might not have any clue how long they will spend playing.

After players give themselves a consent to play, they already know that the decision to continue with the gaming session was made based on their availability and it would not affect their commitments, therefore, they will play. During the gaming session, players awareness of time but having the consent to ignore time allows them not to be bothered by it or to consciously track it. This will then allow them to enjoy the gaming session and achieve whatever they want to get (reason to play) from it. See Table 5.5 for the category and subcategories that will be described.

Table 5.5: Self-Consent During the Gaming Session

Categories	Subcategories (if any)
Time ignorance	—
Physiological effects that remind the player about time passing	—
In-game factors that provide information on time	—

Time Ignorance: During the gaming session, players do not have any strategy to stop them from thinking of time. This is because before they start any gaming session, they already know that there is no need for them to track time, since the decision to play is made based on their availability and commitments. In fact, it was found that during the gaming session players give themselves a consent to ignore time by keeping away other types of distractions. For example "I silent my phone when I am playing so I don't pick it up. I hide any of my ipad away because you are focusing on the game. I keep them charged and not to focus on it"(participant 6). This helps them to concentrate on the game.

It may be possible to assume that external activities, such as checking a mobile phone, alerts the player to time passing. From the study interviews, there is some evidence that players deliberately choose to remove or ignore these external distractions to allow themselves to enjoy playing games. For example "During my gaming session, it is usually at night. You are not going to receive text, or checking your facebook. Most unlikely I am going to check my phone". See Table 5.6. Giving consent to ignore time during the gaming session helps players to concentrate on the games and achieve the reason to play. Similar to the resulting grounded theory of immersion, players keep away all their electronic devices, dim the room and increase the volume to ensure that there are not aware of the surroundings activities (Brown and Cairns, 2004).

Table 5.6: Examples of Ignoring Time

Participant	Quote
1	"No, I do not look at the clock to check what time it is. Unless I have something in the oven."
2	"No, I do not do anything to stop me to think about time."
5	"I guess when I play I try to fully get into the game. I naturally let go all the thinking of time to play the game."
7	"I do not have any clock in my room, and when I play digital games I play on full screen."

Physiological Effects That Remind the Player About Time Passing: While a gamer might be able to ignore time and other distractions (e.g. their phone), a physiological need such as needing to go to the toilet or to eat something may become so urgent that it cannot be ignored and thus force the player to stop. Physiological needs such as hunger, thirsty, tired, etc. Based on statements made by participants on this subject, it can be assumed that when a physiological need distracts the gamer into stopping, the gamer will usually check the time at this point. See Table 5.7. Our body works very well to remind us that we need to fulfill our physiological needs. When the body requires something, players would stop playing and provide whatever that the body needs, for example going to the toilet, getting a drink or even stopping playing completely. This can be seen from "when I started yawning then I will check the time"(participant 5), "when we play game and really into the game, we do not pay any attention to time but afterwards at some point there whatever just break the concentration like need to go to the toilet."(participant 2) and "we do not have any clock in the living room. Only in the kitchen. So I will see the time when I get into and out from the kitchen to make a cup of tea because I am thirsty."(participant 3). At this point, they will check the time accordingly and may take note of the actual time they have spent playing games.

After the physiological needs have been fulfilled, the body is refreshed and players are again ready to continue the gaming session. At this point, the self-consent is very crucial. If players give an instantaneous consent to continue playing the game after they fulfill their body needs, they will continue playing the game. Not until they have stopped giving themselves consent to ignore time, they will keep continue playing as long as they want, based on their availability and commitments. Therefore, self-consent to ignore time during the gaming session is important when players are deciding whether to continue their gaming session. Thus, it may results in them playing digital games for a long duration.

Table 5.7: Examples of Physiological Needs

Participant	Quote
1	"your eyes hurt, it's not the time you thought it was, you are tired "
3	"I stop playing games because I think it's general thing in the evening for people have a cup of tea. Even sometimes if I am not thirsty I will have a cup of tea. "
4	"No I stop playing when I am very tired. Better go to bed and sleep. We are very well aware of time and keep track it. At that time, we will decide to stop and get rest."
6	"I played Starcraft before, we have to win the mission. So when we lose, these dudes will say something like one more win, one more win and it keeps going. But when I am so tired then I stop."
7	"So when I am knackered I probably need to go to bed rather than play digital games."

When this instantaneous consent to ignore time is granted, players would completely ignore time. The given consent provides them with the permission not to worry or no need to track time. For example"it's just you, when you look at the clock you think it's going to be one time but it's way after that time. That's the experience of time I got. You are not consciously aware of time passing. So you only know that the time passed when you look at the clock. So you start playing something like oblivion, then you look at the clock it's 10 before you know it."(participant 1).

The consent to ignore time allows players not to think of time at all during the gaming session, for example "I mean like, you may think, you think you have been played for an hour but it was actually more"(Participant 2). Another examples are "I find that with games that are immersive, when you are trying to get into the next part, you do not think about time. You do not track time with games."(participant 7) and "You look at the clock and realised you lose time. What happen after that? You just continue playing" (participant 1). Further, the consent is given without any conditions and almost instantaneously. Based on the examples above, it can be said that participants make a decision to ignore time and continue playing without taking much time to consider the consequences. They have decided to permit themselves to continue playing as if they have unlimited time to enjoy the gaming session.

In-Games Factors That Provide Information on Time: Players are not only aware of time because of their physiological needs but the in-game components could also stop them from playing and prompt them to check time. See Table 5.8. The in-game components include such things as players needing to do repetitive actions and getting bored of them. When this happens, players may stop playing and re-consider whether they can consent to play more. For example, referring to a digital sports game the participant states "The only reason I notice time is I know how long the half time is and I know how long it takes for one game. But I do not keep track. I do not consciously count the playing time. It is so easy to be carried away unless if we only play one or two games."(participant 8).

From the participants answers, there is evidence to suggest that players check on time and consider stopping playing not because they are tired or hungry, among others things, but because they have reached a point of boredom. They could not play for longer because they are no longer interested in the game anymore. For example "I can remember one time I got the urge to play FIFA, I played for 20 minutes alone and I got bored and stopped. The match was so boring."(Participant 8) and "I tend to get fidgety around 3 hours even for the games that I really enjoy. I tend to get bored at that point of time"(Participant 7). When this happens, they usually stop, check on time and make a decision whether to continue or not. During this pause time, if they decide that they want to continue

Table 5.8: Examples of In-Games Factors

Participant	Quote
3	"Boredom, sometimes the game can get repetitive. Sometime it gets very difficult and sometimes it repeats. Oh I got to this again, oh I got to do that before that. That is when I stop playing. When I feel like I got to do something other than I want to do."
4	"when I just bored of the games when I decided it is time to stop. Or when I am doing well in gaming, I know I have to stop before I feel horrible."
6	"I stop playing if the game is really bad and I do not like it. I never feel VG wasted my time. Also my directional skills are better why would I regret?. My creativity is improved too. When I draw, digital games inspire me!"
7	"Yes, yes definitely. It depends on the game. If I play the game that I can easily hook. I will keep thinking about it although I am not playing it. But if I play game that is not particularly grab me, then I will happily forget it and not even notice about it. The good dg will influence the time I am craving."
8	"It could be playing too many hours until 4 am or because of stress. When we play and we feel stress we just stop. I guess there is no really in between, like realising I have been playing for two hours, then realising it is better to do something else better. Do it all the way or nothing at all."

playing, they give themselves an instantaneous consent to ignore the time and continue playing. On the other hand, if they decide to stop they could give the planned consent to continue later, for example "Sometimes I rage quit. I just stop the game all together and continue later"(Participant 6).

Evaluation After the Gaming Session

After completing the playing session, players will evaluate the overall session to justify whether the self consent given before and during the session were necessary. The evaluation was done after players finished each session. See Table 5.9. One of the examples of the evaluation of the consent given to ignore time and continuing playing could be seen from this here "When I save the game it tells me how long I have spent. Every time I save it then the time piles up. So I know how long I spend."(Participant 5). This evaluation was made after he saved the game before logout. He evaluates how much time he has spent in that session and clearly notices how many hours have passed. Usually, the evaluation of the playing time is done retrospectively, where the participants look back on their playing session.

Table 5.9: Examples of The Evaluation After the Gaming Session

Participant	Quote
5	"Sacrifice a bit of sleep and when I know if I got nothing to do the next day, so I play like hell. Especially during term break."
6	"I learn more about the game. I will research about it first. Then I will plan what I want to do. Final fantasy, I used to look at the monster that you can summon. And I talk about Dota. That is a lot of planning. Usually, during gaming, I will go for one more mission, one more mission, one more mission. Although you are tired and you know that it's late, you want to continue to see the progress and you can lose the game."
7	"But if you are having fun, I believe it is a good time. You are not wasting time when you are having fun."
8	"I have no guilt at all. The only time when we think of the past is when we meet up again and make fun of each other. We talk about how we did and make fun of others who did not do well. People in this house are quite discipline. No one will play without someone else."

The results from the evaluation allows players to acknowledge and realise how much time they have spent playing the game. They may have noted that they should have done something else rather than playing digital games.

But this only appears to happen after the whole gaming session not during the gaming session. They will reconsider their availability and commitments together with the evaluation of the previous session. Hence, this allows them to determine whether to give themselves consent to continue their gaming session.

The result of the evaluation seems to influence how players give themselves consent for the next gaming session. They could either play shorter or maybe longer based on the combination of the results of their evaluation and their current commitments and availability. If players feel that they have spent too much time playing digital games and the result of this is affecting their commitment, they will reduce the availability for the next gaming session. For example "If I know I play for so long before, I will turn off the computer and do something else. I would say I have a very strong self determination. For me when I play digital games I will try to stop no matter what. I will stop if I play a lot" (participant 4). This suggests that they feel bad about it and may then plan future gaming sessions to suit their availability and commitments. Also, the evaluation of self-consent changes how players consider time whilst gaming. For example "if I need be aware of time I put a little clock next to me so I am aware about time."(Participant 1).

5.3.4 Discussion

A grounded theory is presented regarding how players perceive time whilst playing digital games. The results from the grounded theory show that players are actually aware of time whilst playing digital games but they give themselves a consent to ignore it. This self-consent is given before and during the gaming session and it is also evaluated after players finished playing digital games. Hence, the theory suggests an overall view of player's "self-consent" with respect to time whilst playing digital games.

The results from the grounded theory suggest that before players start to play digital games, they consider two main components namely their commitments and availability and their reason to play. Based on these components, players determine how much time they have available to spend on playing digital games. When the availability is less and commitments are pressing, a consent to play digital games for a short time if given. In addition, players give themselves a consent to play for a long duration when their availability is more and commitments are less. However, the consent also depends on player's reasons to play. This reason could come from the player or the game. For example, deciding whether to complete a mission in the games or to kill time whilst in the bathroom. This shows that, players are aware of their time and taking all of these matters into consideration before they give a consent to ignore time and start to play.

During the gaming session, the awareness of time arises when the player's body requires something, for example, the bathroom, food, water, sleep, etc. When the body needs something, it causes the players to stop playing for a while, check the time and immediately fulfill whatever their physiological needs are. Moreover, the in-game factors, such as repetitive actions, finishing a level, challenging obstacles, boredom etc, also result in the awareness of time during the gaming session. For example, when players completed a level, they quickly checked on time before continuing. At this time, players may give themselves an instantaneous consent to ignore time and to continue playing digital games or to stop playing.

After players have finished playing digital games, they evaluate how long they have spent playing digital games. Retrospectively the cummulative amount of time may be large, but players evaluate it by taking consideration of their availability and commitments. Although they may acknowledge that they have been playing for a long time, if amount of playing hours does not affect their availability and commitments, they will give further consent to ignore time. If the amount of time played begins to affect whether the player can attend to their commitments, they could be said to no longer consent to ignore time and as such, be more easily distracted from the game.

The theory presented helps to answer the qualitative research question of how players perceive time whilst playing digital. Digital games players are aware of time but give themselves a consent to ignore it and not to think about it. This consent or permission is given unconsciously, especially during the gaming session. Having the consent to ignore time allows players to continue playing digital games and achieve whatever that they want to achieve from playing digital games (their reason to play). Players however do not always give consent to ignore time to play digital games but do appear to evaluate their given consent after they have completed a gaming session. The result of the evaluation influences their future self-consent.

Considering the finding that players are aware of time but allow themselves to ignore it, does not support findings from the literature. Literature suggests that players lose track of time (Haywood and Cairns, 2005), underestimate time or their ability to perceive time is altered when players play digital games (Luthman et al., 2009; Wood et al., 2007; Rau et al., 2006). To account for this, all of the studies on time were conducted by asking participants to describe their experience of playing digital games in regards to time after the gaming session (retrospectively). This clearly is in the "evaluation phase" as described in the theory. Regardless of the setting of each of the studies (lab or internet cafe), the investigations were always done after the gaming sessions (Sanders and Cairns, 2010; Luthman et al., 2009; Wood et al., 2007; Rau et al., 2006). When participants were asked to describe what happened to time, they evaluated their previous playing time and accumulated the time played. It could possibly be that to justify a large amount of hours played, they claimed that they lost track of time, or that their time perception was altered by playing digital games.

As for immersion, this thesis argues that players do become immersed in digital games when they play digital games, but immersion does not alter the tracking of time. The results from Brown and Cairns (2004)'s grounded theory suggest that immersion is a prosaic or a moment-to-moment experience. Which means the experience is not maintained uniformly. As the game develops, the barriers to immersion change, causing the breakdown of immersion and at the same time building it again. They also state that these barriers are created by the gamers and also the games.

It can be argued that the theory in this thesis extends Brown and Cairns (2004)'s theory of immersion, specifically to justify player's time perception rather than looking at what causes the breakdown of immersion. The analysis of the grounded theory suggests that during the gaming session, two elements from both the gamers and the games affect players awareness of time. This is similar to the barriers of immersion. Perhaps, when players encounter barriers to immersion, they may turn to check time unconsciously but then instantaneously continuing playing and ignore the time. Therefore, it seems that immersion could be the factor which causes them to lose track of time. However, this research finds that players choose not to think about time and continuing playing. They are losing track of time because they keep ignoring time to enjoy the immersive experience.

Time ignorance whilst playing digital games also can be explained using the continuation desire theory by Schoenau-Fog (2011). His theory explains that users in entertainment interaction, for example in digital games, require the desire to continue to be engaged in digital games. Without this desire, no one will continue the engaging experience. He concludes that there are four main elements that influence player's desire to continue namely; objectives, activities, accomplishment and affects. All of these elements come from the gamers and the games. His theory however, did not include one important element in the continuation desire theory, which is time. Although gamers have all the desire to play, they would not play if they did not have time. On top of the continuation desire, player's self consent regarding time is very important to allow them to continue the engagement in digital games.

The "self-consent" theory also supports the inconsistency of the results on time perception in the previous experiments. Experiments conducted previously were really focused on players time perception whilst playing digital games. Time perception refers to time estimation without using any timing devices. The estimation can be done either prospectively (during play) or retrospectively (after play) (Block and Zakay, 2001). The results from the grounded theory show that players do not estimate time whilst playing digital games, rather they choose to ignore it. Furthermore, the experiments in the prospective paradigm require participants to keep track of time, which goes against how players apparently perceive time. In addition, arguably it is impossible to replicate the act of"self-consent" environment in the lab setting. Players' individual availability and commitments are different from each other. When participants come to the lab for any experiments, they give themselves a self-consent to participate, but instead of giving themselves consent to play, their self-consent is instructed based on the experimental designs. Therefore, the limitations of the experimental design did not make it possible to detect true differences in time perception.

The grounded theory presented here is a new finding and not yet substantial and comprehensive enough to fully explain how players perceive time whilst playing digital games. The method itself has its own limitations. Indeed, the process requires a lot of time and attention to collect and analyse a huge amount of data. Data collected using this method is rich and without an appropriate evaluation method for coding and critical inspection of the questions asked, the reliability of the results could be reduced (Charmaz, 2006). Therefore, several months were spent properly crafting the questions and running the analysis to avoid being biased in interpreting the interviews. In addition, this theory has not yet been empirically tested to allow for scrutinisation of the findings. With a limited amount of time, it was not possible to extend the work to test the theory. However, it can be argued that this thesis presents a comprehensive interpretation, this was made conceptually broad and aims to present new avenues of study to further deepen the understanding of player's time perception in digital games and other similar contexts.

5.4 Conclusion

The results from meta-analysis show that there was inconsistency on players' time perception when time perception was being manipulated. It shows the manipulation influences time perception differently. The results also support the argument that there is dissociation between immersion and time perception because the manipulation on time perception did not affect immersion. In the context of immersion, it can be assumed that players able to ignore the irrelevant task to maintain their immersion experience. This dissociation seems to fit into how players perceive time whilst playing digital games. From the result of grounded theory, players give themselves a consent to ignore time to play digital games.

6. CONCLUSION

This thesis aimed to answer a very focused question: whether immersion influences players' time perception whilst playing digital games. To answer this, eleven quantitative studies, one meta-analysis, and one qualitative study (grounded theory) have been conducted. All the quantitative investigations were designed either by manipulating immersion to test whether it has any significant effect on time perception (Study One-Study Four), or by manipulating time perception to discover any significant effect on immersion (Study Five-Study Eleven) during the gaming session. To measure immersion level for all studies, the Immersive Experience Questionnaire (IEQ) operationalised by Jennett et al. (2008) was used, whereas time perception was measured using both the retrospective (Study One-Study Five) and prospective paradigms (Study Six-Study Eleven).

Given that the results were inconsistent across studies, it was not possible to discern any significant pattern of the relationship between immersion and time perception. Therefore, further analyses were conducted to bolster the understanding of the effect of immersion on players' time perception whilst playing digital games. The analysis included a statistical test called a meta-analysis, which aimed to analyse the single estimate effect on players' time perception when time perception was manipulated in the experiments. The analysis also included a qualitative study (grounded theory) in which gamers were interviewed to understand how they perceive time whilst playing digital games.

6.1 Summary of Studies and Their Limitation

6.1.1 Manipulating Immersion (Study One—Study Four)

The first part of the investigation was focused on the manipulation of immersion to test it influences players' time perception. The idea was mainly focused on showing that immersion has a direct effect on time perception, as suggested in the literature (Brown and Cairns, 2004; Haywood and Cairns, 2005; Sanders and Cairns, 2010). Four experiments were conducted to investigate this, mainly by manipulating the external factors to the games, such as the player's motivation to play (Study One), their cognitive processes (Study Two), and surrounding lighting (Study Four). Study Three was an exception as the manipulation involved changing the game platform. This thesis followed Jennett (2010)'s argument that immersion is influenced by the games, gamers, and the gaming environment. Thus this thesis argues, that there is dissociation between immersion and time perception whilst playing digital games.

Except for Study Three, our studies focused on manipulation of the gaming environment, using conventional games that are available in the current market. As it is difficult to acquire source code for ready made games, in-game factors could not be manipulated. It could be argued that creating a game for the purpose of a study such as this may result in bias. It might, for example, direct the gamer to play in such a way as to reflect the effect that the research desires. However, there was an exception given for Study Three to use a custom-made game because the design of the experiment required one similar game to be played on different platforms (desktop vs iPad). Therefore, it was convincing to develop one game for both platforms in the experiment because during the experiment it was difficult to find a conventional games that comes in both desktop and mixed reality in San Luis Potosi, Mexico. Although the results show a significant difference on immersion level but the game developed was a simple game which has a limited gameplay that may result the results in bias.

The game platform (mixed reality vs pc) and the surrounding lighting studies showed a significant effect on immersion. These two studies strongly suggested that, whether players realise or not, they are always indirectly paying attention to their surroundings whilst playing digital games. When the surroundings are highly visible to them, their attention seems to be diverted to the surroundings. This corresponds to the work of (Jennett, 2010), which showed that when players are more immersed in the games, they are less aware of the auditory and the visual distractions when playing games. However, in that study, the games were substantially altered to influence immersion. While it may be that the changes in lighting levels simply have a generic effect on attention, it does not result in increased processing of surrounding stimuli. This was shown in the result in Study Four. This is apparent when players are playing in a bright room: they are less immersed in the game. Further, result from Study Four has shown that when less attention is paid to the surroundings, immersion level increased.

Although immersion was successfully manipulated, the hypothesis on time perception was completely rejected. None of these studies show a significant effect on time perception. Time perception was measured retrospectively for all of the studies. The experiments were designed to ensure that the players were unaware of the need to estimate/measure time until after they had completed their session. The question to measure time was presented as the first question on the IEQ to be completed by the participants. The question was asked in different ways, such as an open answer question, and check boxes (i.e. choosing one box that represented their time estimation). The results show no significant effect or significant correlation for time perception in all experiments.

The results for time perception from all four experiments suggest that measuring time perception retrospectively in the gaming environment could be problematic. Therefore, Study Five was conducted at this time to test the effectiveness of the retrospective time perception paradigm in the context of measuring time perception in digital games. Study Five involved manipulating time perception using different intensities of a visual stimulus – moving stars – on the background screen. The results from Study Five were similar to other four studies, i.e. that time perception could not be measured retrospectively despite time was being manipulated.

This may be due to many factors. Firstly, the duration of playing session. Wearden and Lejeune (2008) argue that most of the experiments on time perception in psychology were conducted using short durations of up to 120 seconds maximum. This is because most research on time perception in psychology is focused on modelling human time perception. The the experiments usually involved simple tasks such as judgements of the lengths of flashes of light, bursts of tone, and completion of a very basic and simple perceptual motor tasks (Yarmey, 2000). In contrast, playing digital games is not a simple task; as such, it is unsuitable to run an experiment for less than 2 minutes. This is because the complexity of gaming activities requires more time for participants to become absorbed.

On the other hand, the retrospective time perception paradigm uses memory to recall the duration and to make a time judgement. This entirely depends on the amount of contextual changes encoded during the duration that is estimated (Block and Reed, 1978). These changes are available from many different angles. For example, by the structure of events filling a time interval, grouping, or counting some repetitive activities (Yarmey, 2000).

There is one main concern about the measurement of time perception where in the context of digital games it could be unsuitable to measure time perception retrospectively. This research used puzzle/casual games for all of the experiment and it can be assumed that playing this type of genre does not involve many contextual changes compare to a more richer, role-playing and vast storyline games. Playing puzzle/casual games mainly focusing on one activity where temporal information about repeated experiences is reconstructed from less time stamps from memory. Furthermore, participants were finding it most manageable to estimate longer events by rounding to the nearest 5 minutes, i.e. the “5 minutes effect”.

6.1.2 Manipulating Time Perception (Study Six—Study Eleven)

It is hard to keep participants playing for a long time without first informing them of them how long they have to spend in the experiment. This is because when participants are recruited, they usually ask how long the session will be; to keep this information away from them is difficult. In this sense, the prospective paradigm seemed to be a more practical way of estimating time, with information about the timing aspects now possible to reveal at the beginning. Hence, in the second part of our investigation, the studies used the prospective time perception paradigm.

In the first phase of the investigation, Study Three and Study Four show that immersion was successfully manipulated, but did not show any statistically significant effect on time perception. So then the question became, if immersion influences players' time perception whilst playing digital games, why isn't it apparent in these two studies? If it is to be assumed that there is no association between immersion and time perception, then any changes in perception of time, in theory, would not affect immersion level. However, this is not the case, as players' time perception is argued to be affected by immersion only when players estimate time perception prospectively (Sanders and Cairns, 2010). It may be that immersion influences players' time perception when time is measured prospectively. Therefore, there was no clear significant effect on time perception found in the first five studies because time perception was measured retrospectively. As discussed before, retrospective time perception paradigm has many limitation to measure time perception in the context of digital games.

Assuming that immersion is associated with time perception in the prospective paradigm, any significant difference of prospective time perception estimation will directly influence immersion whilst playing digital games. Thus, in the second part of this investigation, the aim was to manipulate time perception to investigate its effect on immersion. If the manipulation of time perception manipulates both time perception and immersion, then perhaps the hypothesis on the dissociation of immersion and time perception is wrong because there is association between them.

For that reason, to gather more evidence on the dissociation between immersion and time perception, another six studies were conducted to test the effect of time perception on immersion. Firstly, the results from Study Five did suggest the manipulation of time perception was not able to be measured retrospectively. Therefore, to confirm that the manipulation on time perception work but retrospective paradigm is unsuitable for the experiment, Study Six was designed to repeat Study Five but with time is measured prospectively. The result produced was as expected: time perception was significantly overestimated in the slow Starfields.

This finding supports that the assumption of the problem with retrospective paradigm was true. Thus, the research continued to manipulate time perception and use prospective time perception paradigm to measure time. With the manipulation of different speeds of the game (Study Seven), different game paces (Study Eight), using dual task activities (Study Nine), and two studies on manipulating the cognitive processes using the N-Back test (Study Ten and Study Eleven). These manipulation factors were identified as influencing time perception.

Study Seven suggests that the manipulations on time perception worked successfully. Time perception was successfully being manipulated, however there is no significant effect on immersion scores. Except for Study Eight, which found that immersion scores were significantly different between conditions and not on time perception – despite that time was being manipulated. In contrast, results from Study Nine, Study Ten and Study Eleven suggested no significant difference in either time perception or immersion, however Study Nine shows players were significantly underestimating time when they play digital games whilst performing a secondary task.

The findings from all of the experiments in the second part of the investigation (Study Six-Study Eleven) suggest that there is disassociation between immersion and time perception. Although time perception was measured prospectively, the significant difference in time perception did not affect immersion. In fact, in Study Eight, immersion level was significantly different between conditions but with no significant effect on time perception. The results produced are rather inconsistent than showing a significant pattern of the relationship between immersion and time perception. Interestingly, after conducting eleven studies, it was found that it was challenging to empirically test whether immersion influences time perception because of the high variability in participant that is hard to be controlled in the lab.

The prospective time perception paradigm uses attention to measure time perception (Block and Zakay, 1997). At the same time, immersion requires attention from the players to be invested and focused in the game (Jennett, 2010). Therefore, when attention is diverted into estimating time and playing the game during the gaming session, either immersion or time perception can be affected. This entirely depends on how the player prioritises the demand. If the player feels that the temporal task is more important, they will invest most of the attention on the measuring of time, hence producing accurate estimation and less immersion. In contrast, if the gaming activity is the most important task, the player able to ignore irrelevant tasks to the game and invest their attention on the game which include to ignore the needs on temporal task. The dissociation between immersion and time perception happen when participants are not actively thinking about time during the gaming session. This produced high immersion and less accurate time estimation. Digital games are designed to be engaging. When all of the player's attention, goals and thoughts are focused on the game as opposed to other things, the player would be hooked to the game (Sanders and Cairns, 2010) thus reducing the player's ability to estimate time prospectively.

At this point it can be argued that there is dissociation between immersion and time perception. Immersion is one of the selective attention (Jennett, 2010) on its components, which could cause players to ignore any concurrent irrelevant task during the gaming session. Therefore, the results from this research show that it is not immersion that causing players to lose track of time but themselves (they choose not to think about time).

6.1.3 Further Analysis

The empirical investigations in this study suggest that immersion does not influence players' time perception. If immersion is not affecting players' time perception, then why do players claim that they are losing track of time when they immersed in digital games? Is it only a statement given by digital games players to justify the time they have spent gaming? To understand this, further analysis was conducted firstly to analyse the single estimate effect of the effect on time perception whilst gaming. This estimate helps to determine whether players are more likely to underestimate or overestimate time perception during the gaming session. This is done by using a statistical analysis called a "meta-analysis". Meta-analysis is an analysis that attempts to determine whether a variety of different studies are displaying a single effect. The results from the meta-analysis on five experiments (Study Six, Study Seven, Study Eight, Study Nine, and Study Eleven) suggest that the experimental manipulation of time perception influences players differently. This depends on the design of the experiment –the design could influence players to underestimate time or overestimate time. In short, the meta-analysis showed that there is inconsistency of the variable (time perception) across the studies. A moderate heterogeneity effect appears across all of the studies, which means that the single estimate effect of the variability is moderately due to the heterogeneity of the studies, rather than a sampling error.

Considering results from the empirical investigations and the meta-analysis, it could be concluded that immersion is disassociated from time perception whilst playing digital games. To understand further why players claim that they are losing track of time whilst gaming, a qualitative study (grounded theory) was run, which aimed to understand how players perceive time during a gaming session. The grounded theory suggests that a player gives themselves permission (i.e. *"self-consent"*) to ignore time and continue to play digital games. This consent is given in advance, prior to the gaming activity, or instantly. During the gaming session, there are two factors that cause players to be aware of time: namely physiological needs and in-game factors. These two elements increase players' awareness of time. However, players could instantly give themselves permission to ignore about time and continue playing. This can happen repetitively, and during that time, players do not care about the amount of time they have given themselves to play. However, when they look back after the gaming session ends, the collection of time for the entire gaming session may appear to be larger than expected. Thus, they claim that they had lost track of time.

6.2 Conclusion

In short, time seems to fly during any gaming session – especially when players are hooked in the game. In fact, many players claim that they are losing track of time when they are immersed in digital games. However, to empirically investigate this is rather complicated given the nature of both notions – immersion and time perception. Both are sensitive and fragile, therefore it is difficult to only manipulate one notion in a way that the manipulation would not influence the other. Results from the empirical studies conducted in this thesis suggest that there is disassociation between immersion and time perception. However, one could argue that the disassociation could be from the moderate heterogeneity across studies. The result from grounded theory nonetheless suggests that players are indeed not losing track of time, but that they give themselves permission to ignore time and continue to play. Hence, when players give themselves a lot of permission to keep playing. It could be that after the session ends, they realised they have spent huge amount of time on the games, thus, they use the phrase "losing track of time" to represent their temporal experience whilst gaming.

6.3 Contributions and Implications

The particular findings in 6.1.1 help to add more knowledge about immersion and time perception. Turning to the theoretical accounts of immersion, this work perhaps supports the importance of sensory immersion in the SCI-model (Ermi and Mayra, 2005). There, sensory immersion is concerned with the audio-visual dominance of the game over the real world. It is worth noting though, that this dominance need not be as a consequence of the gaming technology but simply due to the ability to withdraw awareness of the surroundings, which of course a large screen, 3D visuals, and sophisticated sound systems aim to do. Moreover, Ermi and Mayra (2005) argue that sensory immersion is presence. This contradicts to Cairns et al. (2014a)'s argument where immersiveness does not increase the sense of spatial presence whilst playing digital games. They argue that immersion is a high involvement experience would support presence when other factors were absent or insufficient. Thus, the findings from this thesis could add more knowledge on the different of immersion and presence in digital games.

Interestingly though, the notion of incorporation Calleja (2011) cannot really account for the change in immersion described here, as the experimental manipulation is entirely outside of the game.

Furthermore, findings on time perception in 6.1.1 contribute to the methodology in conducting research on time perception in digital games. At the time of conducting this research, there was no literature suggesting which method was most appropriate. The results suggested participants that were struggling to recall their playing time, and as a result, they tended to round their retrospective time estimation to minutes ending with 0 or 5. Hence, research on time perception in the future should be designed carefully and to take into account this 5 minutes effect, which influences the overall results on time perception.

The question regarding time should be clearer and more defined to avoid participants providing their estimation only to end the experiment, as opposed to giving a true and considered estimate. While check boxes with time interval in seconds (one box represents 30 seconds) appear to be appropriate, it was found that participants although they were given the check boxes to tick, they were not used to estimate time in seconds. Most of them use minutes to represent time in daily activities. Therefore, check boxes in minutes (i.e half minute, one minute, one and half minutes, two minutes etc) could be used to help participants to estimate time in a retrospective paradigm. Also, to avoid participants to choose the middle of the range, in future study could ask participants to tick the minimum duration and the maximum duration on top of the exact duration. This would reduce them to just use their verbal estimation but they have to recall and think about the previous session.

However, a prospective paradigm seems to give a clearer estimation of time perception in a digital games environment. The results support existing literature in that time perception is found to be significantly different only in prospective time perception paradigm (Sanders and Cairns, 2010). Not only that, the research also found a similar effect according to the literature in that time perception is measured differently when one experiment is repeated with a different paradigm (Block and Zakay, 1997). The results also contribute to the methodology for conducting time perception research in digital games. An appropriate duration of play, between 7 minutes to 20 minutes, is suitable for playing casual games. This is because when the duration is too long, participants lose track of the need to measure time. Also, it is beneficial to conduct studies in a prospective paradigm because it removes the concern of having to answer questions about how long the experiment will take, without giving the aim away.

The meta-analysis we conducted 6.1.3 could potentially be of use for other researchers in HCI. Considering that some researchers in HCI work on many experiments to answer one specific question, the data from several experiments could be re-analysed to produce a single estimate effect out from several inconsistent individual studies to suggest whether the test subject favours advantages or disadvantages. This thesis aims to present a simple way of conducting a meta-analysis based on the empirical investigations.

6.3.1 Limitations of Approach and Future Work

One of the limitations to conduct this research was lack of literature on empirical investigations on time perception in the context digital game environment and in HCI. This research had to applied all the available methods from psychology research area to find the suitable methodology. Most research on time perception has been conducted in psychology, usually with the aim to understand models of human time perception. The tasks used in the experiments are rather simple and the duration is short. The difference in paradigm may also contribute to limiting the scope of exploration in this research.

Research on time in digital games mainly was conducted by asking players to describe their experience with regards to time after the gaming session. This allows participants to give a subjective experience of time. Further, conducting time perception research in the lab increases participants' accuracy of estimating time (Tobin et al., 2010). As this research was conducted in the lab environment rather than a natural gaming environment, Kaye(2011) suggests that this lowers the ecological validity and thus, limits the discovery potential of the research. On the other hand, only events that are relatively long (lasting more than 20 minutes) in the lab usually resulted in an underestimation of time (Yarmey, 1990). In this case, participants were only required to play games for less than 20 minutes. Therefore, it may not have been long enough to produce the effect. Further, the experimental design may also have an effect on the results, as Tobin and Grondin (2009) found that time estimation is more accurate in the lab setting compared to the natural environment.

Regarding the duration used in the experiments, in most psychophysics experiments, a duration between 8 and 24 minutes is considered a very long duration for retrospective estimation. However, in digital games, it would be considered a relatively very short period of play. (Tobin and Grondin, 2009). Moreover, they claim that to running an experiment with a long play session is difficult since participants' time is limited due to their daily activities. Similar to this case, in a retrospective paradigm, participants are not aware of the task of measuring time. Thus, if the participants are asked to play the digital games for a long session without them knowing anything about time, it may trigger them to start asking when the experiments will finish. When this happens, the retrospective paradigm will change to be a prospective paradigm. This happens because the impression of duration is often affected by the current experiences, including anxiety (Friedman, 1990).

For future work, we would suggest to investigate time perception when players play for long hours. For example, at an LAN party where players spend the day playing videogames. The investigation could be focused on how players perceive time during that gaming session and could test whether the perception changes over time. Rather than talk about the experience of time, future work could aim to analyse how players perceive time on the spot during the gaming session.

Secondly, future research could focus on the game genre and its influence on time perception. It was found that different Tetris levels affected how time was perceived, which may suggest that different game genres may influence time perception. Also, more qualitative analyses are required to understand factors related to the way that players consider time before and during the gaming session, since the current literature looks at the factors after the player has finished gaming.

Thirdly, further work on validating the theory would strengthen the understanding of time perception whilst playing digital games. This could be done by employing a diary study in which participants are required to record the reason why they play, how long they play, why they stop, and why they continue. This would help to give a clearer view of how players perceive time whilst playing digital games.

APPENDIX

A. APPENDIX A

Informed Consent Form

The purpose of this form is to tell you about the study and highlight features of your participation in the study.

1 Who is running this?

The study is being run by Imran Nordin who is a PhD student in the Department of Computer Science at the University of York. He is supervised by Dr Paul Cairns who is a Reader in the same department.

2 What is the purpose of the study?

The study aims to investigate the user experience of playing digital games.

3 What will I have to do?

You will be asked to play a pc game called *Bejeweled 2*. During the playing session, you need to perform another task as explained in the instruction sheet. You will then be asked to complete a questionnaire on paper. The questionnaire is relatively straightforward asking about details about yourself, the games you normally play and your experience of playing the game.

4 Who will see this data?

Obviously the data will be compiled and analysed by Imran Nordin and Dr. Paul Cairns. However, once it has been compiled and analysed, it will be completely anonymised and you will not be able to be identified with your data. The experiment may be published in an academic journal but the data will only be presented in summary form and you will not be directly identifiable in any way. I am happy to share your data with you, therefore feel free to request.

5 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.

6 Can I ask a question?

Do ask me any questions you may have about the procedure that you are about to follow. However, during the study, please refrain from talking to me and save any questions you may have until the end of the experiment. 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 your questions.
Please turn to next page

7 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 we will be obliged to treat your data as described.

Name:

Signature:

Date:

B. APPENDIX B

Immersion Experience Questionnaire

You are invited to participate in a research study that investigates the experience playing videogames.

Researcher's contact details

Name : Aliimran Nordin

Address : Department of Computer Science, University of York, Deramore Lane, York, YO10 5GH, United Kingdom

Email : imran@cs.york.ac.uk

Supervisor's contact details

Name : Dr. Paul Cairns

Address : Department of Computer Science, University of York, Deramore Lane, York, YO10 5GH, United Kingdom

Email : paul.cairns@york.ac.uk

Please read each statement and circle a number to indicate your level of agreement with the statement.

How long have you spent playing the game just now?
Please tick (√) in one of the box below

1 minute	11 minutes	21 minutes	31 minutes
2 minutes	12 minutes	22 minutes	32 minutes
3 minutes	13 minutes	23 minutes	33 minutes
4 minutes	14 minutes	24 minutes	34 minutes
5 minutes	15 minutes	25 minutes	35 minutes
6 minutes	16 minutes	26 minutes	36 minutes
7 minutes	17 minutes	27 minutes	37 minutes
8 minutes	18 minutes	28 minutes	38 minutes
9 minutes	19 minutes	29 minutes	39 minutes
10 minutes	20 minutes	30 minutes	40 minutes

41 minutes	51 minutes
42 minutes	52 minutes
43 minutes	53 minutes
44 minutes	54 minutes
45 minutes	55 minutes
46 minutes	56 minutes
47 minutes	57 minutes
48 minutes	58 minutes
49 minutes	59 minutes
50 minutes	60 minutes

1. To what extent did the game hold your attention?
   Not at all 1 2 3 4 5 A lot

2. To what extent that did you feel you were focused on the game?
   Not at all 1 2 3 4 5 A lot

3. How much effort did you put into playing the game?
   Not at all 1 2 3 4 5 A lot

4. Did you feel that you were trying your best?
   Not at all 1 2 3 4 5 A lot

5. To what extent did you lose track of time?
   Not at all 1 2 3 4 5 A lot

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

Not at all 1 2 3 4 5 A lot

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

Not at all 1 2 3 4 5 A lot

8. To what extent did you aware of yourself in your surrounding?

Not at all 1 2 3 4 5 A lot

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

Not at all 1 2 3 4 5 A lot

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

Not at all 1 2 3 4 5 Very much so

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

Not at all 1 2 3 4 5 Very much so

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

Not at all 1 2 3 4 5 Very much so

Please see next page

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

Not at all 1 2 3 4 5 Very much so

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

Not at all 1 2 3 4 5 Very much so

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

Not at all 1 2 3 4 5 Very much so

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

Not at all 1 2 3 4 5 Very much so

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

Not at all 1 2 3 4 5 Very difficult

18. Were there any times during the game in which you just wanted to give up?
Not at all 1 2 3 4 5 A lot

19. To what extent did you feel motivated while playing?
Not at all 1 2 3 4 5 A lot

20. To what extent did you find the game easy?
Not at all 1 2 3 4 5 Very much so

21. To what extent did you feel like you were making progress towards the end of the game?
Not at all 1 2 3 4 5 A lot

22. How well did you think you performed in the game?
Very poor 1 2 3 4 5 Very well

23. To what extent did you feel emotionally attached to the game?
Not at all 1 2 3 4 5 Very much so

24. To what extent were you interested in seeing how the game's events would progress?
Not at all 1 2 3 4 5 A lot

25. How much did you want to "win" the game?
Not at all 1 2 3 4 5 Very much so

26. Were you in suspense about whether or not you would win or lose the game?
Not at all 1 2 3 4 5 Very much so

27. At any point did you find yourself become so involved that you wanted to speak to the game directly?
Not at all 1 2 3 4 5 Very so much

28. To what extent did you enjoy the graphics and the imagery?
Not at all 1 2 3 4 5 A lot

29. How much would you say you enjoyed playing the game?
Not at all 1 2 3 4 5 A lot

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

Not at all	1	2	3	4	5	Very much so

31. Would you like to play the game again?

Definitely not	1	2	3	4	5	Definitely yes

End of questionnaire

Thank you

C. APPENDIX C

Cuestionario inmersión

¿A qué grado capturó tu atención el juego?por favor seleccione sólo una de las siguientes opciones
¿A qué grado te sentiste enfocado en el juego?por favor seleccione sólo una de las siguientes opciones
¿Cuánto esfuerzo pusiste en jugar el juego?por favor seleccione sólo una de las siguientes opciones
¿Sentiste que estabas dando lo mejor de ti?por favor seleccione sólo una de las siguientes opciones
¿En qué medida perdiste la noción del tiempo?por favor seleccione sólo una de las siguientes opciones
Mientras jugabas ¿En qué medida te sentías consciente de estar en el mundo real?por favor seleccione sólo una de las siguientes opciones
¿En qué medida te olvidaste de tus preocupaciones cotidianas?por favor seleccione sólo una de las siguientes opciones
¿En qué medida estabas consciente de tus alrededores?por favor seleccione sólo una de las siguientes opciones
¿En qué medida estabas consciente de eventos que sucedieron alrededor de ti?por favor seleccione sólo una de las siguientes opciones
¿En algún momento sentiste la necesidad de dejar de jugar y ver que estaba pasando a tu alrededor?por favor seleccione sólo una de las siguientes opciones
¿En qué medida sentiste que estabas interactuando con el entorno del juego?por favor seleccione sólo una de las siguientes opciones
¿En qué medida te sentías como si estuvieras separado de tu entorno real?por favor seleccione sólo una de las siguientes opciones
¿En qué medida sentiste que el juego era algo que estabas experimentando, no solo haciendo?por favor seleccione sólo una de las siguientes opciones
¿En qué medida era más fuerte el sentimiento de estar en el entorno del juego que el de estar en el mundo real?por favor seleccione sólo una de las siguientes opciones
¿En algún momento te sentiste tan envuelto que ni siquiera sentías que estabas usando controles?por favor seleccione sólo una de las siguientes opciones
¿En qué medida sentiste que te movías a través del juego a tu propia voluntad?por favor seleccione sólo una de las siguientes opciones
¿En qué medida encontraste el juego desafiante?por favor seleccione sólo una de las siguientes opciones
¿Hubo ocasiones durante el juego cuando te dieron ganas de simplemente rendirte?por favor seleccione sólo una de las siguientes opciones
¿En qué medida te sentiste motivado mientras jugabas?por favor seleccione sólo una de las siguientes opciones
¿En qué medida encontraste el juego fácil?por favor seleccione sólo una de las siguientes opciones

¿En qué medida sentiste que progresabas hacia el fin del juego?por favor seleccione sólo una de las siguientes opciones
¿Qué tan bien crees que te desempeñaste en el juego?por favor seleccione sólo una de las siguientes opciones
¿En qué medida te sentiste emocionalmente apegado al juego?por favor seleccione sólo una de las siguientes opciones
¿En qué medida estabas interesado en ver cómo se desarrollarían los eventos del juego?por favor seleccione sólo una de las siguientes opciones
¿Qué tanto querías "ganar" el juego?por favor seleccione sólo una de las siguientes opciones
¿Estabas en suspenso acerca de si ganarías o perderías en el juego?por favor seleccione sólo una de las siguientes opciones
¿En algún momento te sentiste tan envuelto que querías hablarle al juego directamente?por favor seleccione sólo una de las siguientes opciones
¿ En qué medida disfrutaste de los gráficos y las imágenes del juego?por favor seleccione sólo una de las siguientes opciones
¿Qué tanto dirías que disfrutaste jugando el videojuego?por favor seleccione sólo una de las siguientes opciones
Si te interrumpieran ¿Te sentirías decepcionado de dejar de jugar?por favor seleccione sólo una de las siguientes opciones
¿Te gustaría jugar nuevamente esta videojuego?por favor seleccione sólo una de las siguientes opciones
¿Qué actividad te tomó más tiempo realizar?por favor seleccione sólo una de las siguientes opciones a)videojuego b)cuestionario c)duraron lo mismo

D. APPENDIX D

Interview schedule

1. Can you confirm that you are happy for the interview to be recorded?

- This is to get the interviewee's approval on the process of recording the whole session

2. What kinds of games do you like playing?

- To identify what sorts of games that the interviewee preferred - It could be more than 1
- Later we can see either different type of games affect the way gamer perceives time differently or not

3. Why do you like to play them?

- To identify the personal reason from gamer perceptive why does gamer like to play them.
- ✓ *Why is that?*
- ✓ *Do you ever play to relax?*
- ✓ *To let out frustrations?*
- ✓ *To kill the time?*
- ✓ *To achieve something? If yes, what do you want to achieve?*
- ✓ *What else? Compare with other games.*

4. What do you have to do in these games?

- *To identify the activities gamer has while playing them*

5. How does it make you feel?

- *To identify gamer's feeling while playing them*
- ✓ *Are you happy?*
- ✓ *Are you feel satisfy?*
- ✓ *Are you feeling energetic?*

6. What console do you use to play these games?

- *To identify the console used to play games*
- ✓ *Playstation, XBox, Wii/ PC computer/ Handheld*
- ✓ *Keyboard/ Mouse/ Joypad/ Steering wheel/ Gun*
- ✓ *Arcades: Dance mats, simulators*

7. What games that you do not like playing?

- *To identify what sorts of games that gamer does not preferred to play*

8. What time do you usually playing game during the day?

9. Where do you usually play them?

10. How long do you usually play in one session?

11. How many times do you play during the week?

12. Do you usually play one game continuously until you finish it or do you play several games at once?

13. How do you fit your gaming session with other activities?

14. Some people talk about "time flies when you are having fun". Do you think time flies when you are playing games?

- ✓ *Have you ever had this experience? If yes, which games?*
- ✓ *What is it like? What does it feel like?*
- ✓ *Does it seems like a long time has passed or a short time?*
- ✓ *To what extent do you notice things around you including the time?*
- ✓ *Have you ever forgot something important (i.e.: lecture, meeting, catching a bus) while playing games?*

15. Do you really lose a sense of time?

17. Have you ever spent whole night playing games without realising it?

- ✓ *What were you playing?*
- ✓ *What is it like?*
- ✓ *What does it feel like?*
- ✓ *What did you do after realising you have spent the whole night playing games?*

18. Did you feel guilty if you spent more time playing games?

19. How do you feel about time whilst playing digital games?

- ✓ *Time drag? Why keep going?*

19. Have any of your friends, families, lecturers ever complained about your habit spending too much time playing games?

- ✓ *Do you care about it?*
- ✓ *Did you change your habit while playing games after that?*
- ✓ *Did you do anything to reduce your time spent on playing games?*
- ✓ *How about your social activities?*

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