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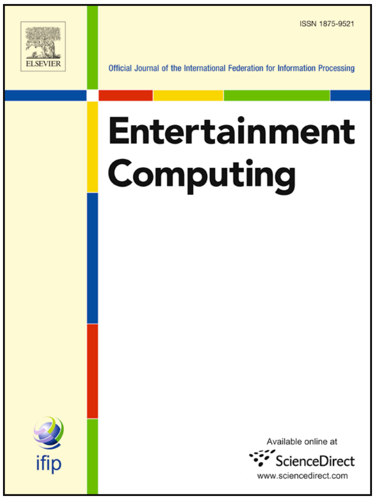

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Player Experience and Deceptive Expectations of Difficulty Adaptation in Digital Games

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Abstract

Increasingly, digital games are including adaptive features that adjust the level of difficulty to match the skills of individual players. The intention is to improve and prolong the player experience by allowing the player to have the feeling of challenge without it being overwhelming and leading to repeated failure and frustration. Previous work has shown that player experience is indeed improved by such adaptations but also that the player experience can be improved also by simply claiming such an adaptation is present even when it is not. It is therefore possible that claims about adaptations and the actual adaptations could interact and not lead to the intended outcomes for the players or worse disappoint players. This paper reports on two studies that were conducted to experimentally investigate the interaction between game adaptations and player information about adaptations on the player experience, specifically their sense of immersion in the game. For this, two games were developed using two different kinds of adaptations to adjust difficulty based on players' performance in the game. Participants were provided with information about game adaptations independently of whether the adaptations were present. The results suggest that players felt more immersed in the game when told that the game adapts to them, regardless of whether the adaptation was present in the game or not. This effect was observed in both games despite their different adaptations and it remained prominent even during longer gaming sessions. These findings demonstrate that players' knowledge of adaptations influences their experience independently of adaptations. In this particular context, the knowledge reinforced the experience of the adaptations. This suggests that, at least in some circumstances, developers do not need to be concerned about negative effects of telling players about in-game adaptations.

Keywords: Digital games, information, adaptation, difficulty adjustment, deception, immersion, player experience.

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1. Introduction

Experience of playing video games is multi-faceted and, undoubtedly, differs depending on the game you play: living through a year as a school boy defeating shadows in the dungeons of *Shin Megami Tensei* games is rather different from playing *Monument Valley* or *Counter Strike* games. Whether it is the types of challenge that the games offer (Denisova et al., 2017), game controllers players use (Cairns et al., 2014b), or even camera point of view (Denisova and Cairns, 2015b), in-game factors can have a significant effect on one's gaming experience.

Player experience of challenge differs not only between games, but also within the game. It does not solely depend on the difficulty setting players choose, but also the amount of experience players have and skills they bring with them. In order to cater for different abilities of players and varied play styles, some contemporary video games use adaptive difficulty adjustment to match the difficulty in the game according to the player's performance and behaviour. In return, this allows any player to experience and enjoy the game regardless of their previous experience and skills. This feature is often perceived and discussed as a positive phenomenon that improves player experience. Balancing game challenge to the skills of players is one of the contributing factors toward the flow state (Chen, 2007) and it helps players to become more immersed in the game (Cox et al., 2012).

Despite the evident benefits of adaptive difficulty adjustment, it is not always clear to what extent one's gaming experience is shaped by the game or by the player's expectations about the game. Recent work (Denisova and Cairns, 2015c) has shown that the mere expectations of adaptive behaviour in a video game can lead to an increased immersion and heightened enjoyment, even if the feature is not present in the game. Of course, where adaptations are complex, it is possible that players cannot, from their own experiences, evaluate whether the adaptations are present or not. Thus, being told about a non-existent adaptation is not falsifiable and so players "go along" with it. When the adaptation is actually present, it may be that their expectations are not met and so the adaptation leads to a negative experience. Or it may be that adaptation does contribute to the experience beyond simple knowing that the adaptation is there. The question is therefore: to what extent does the adaptive technology affect player experience and is this experience influenced by the player's expectations or knowledge of this feature?

To address this question we conducted two studies that demonstrate how different levels of information available to the players about adaptive features in the game affect player experience while playing a game with or without this feature. In particular, we focused on the player experience of immersion since this is one of the most common terms used to describe a feeling of being highly involved in a digital game (Jennett et al., 2008) both by the video game researchers and video game players.

In the studies, we also explored the durability of this effect by measuring immersion at two points of a typical casual gaming session. These studies support the previous research that the information that players receive does indeed influence their experience but that this effect occurs in addition to the effects of adaptive technology in the game. Interestingly, there was no interaction between knowledge of the adaptation and whether the adaptation was present. That is, the knowledge of an adaptation never reduced or interfered with the benefit to player experience brought about by the adaptation. This is potentially useful to game developers to know that telling players about adaptive difficulty does not interfere with player experience and that it can actually help to enhance the experience. However, it does reinforce earlier findings that simply telling players about adaptations, even when they are not present, can influence the experience (Denisova and Cairns, 2015c) and hence raise issues for playtesting and evaluation, specifically for difficulty adaptation algorithms.

2. Adaptation in Digital Games

Challenge in digital games is believed to play a crucial role in shaping player experience. Matching players' skills to the challenge in games has been viewed as an important requirement in order to achieve positive experiences, such as flow (Csikszentmihalyi, 1991) and immersion (Ermi and Mäyrä, 2005; Cox et al., 2012). This belief is widely shared amongst game designers and developers (Adams, 2014; Rouse III, 2010; Sweetser and Wyeth, 2005) who want to ensure players are satisfied.

Naturally, players learn and adapt to the game as they play. Some players learn faster than others and often players tend to excel in different aspects of the game – each player plays and progresses in their own unique way. Therefore, having a difficulty that rises as one progresses through the game regardless of their learning curve could hinder one's experience of the game.

Players find the game boring if it becomes too easy for them, and other players can get stuck while trying to advance in the game (Newheiser, 2009). So, to account for the variation on players' skills and abilities, various methods and techniques exist that allow players with any level of expertise to enjoy the game.

Typically, games have either a gradually raising difficulty level from the beginning to the end (Larsen, 2010), and in some cases players can choose from a pre-set range of difficulty levels. A better way to do it may be to have an adaptive AI or, specifically, difficulty adaptation, where players' behaviour in the game is analysed and then used to adjust the difficulty based on threshold heuristics (Hunicke, 2005), or on machine learning models (Drachen et al., 2009). Such adaptations have been used in several digital games, including *Fallout 3* and *Half-Life 2* (Adams, 2014), in which difficulty adaptation changes the number or frequency of spawning enemies, amount of resources available to the player, the enemies' advancement levels.

Adaptive technologies can be incorporated into digital games using various approaches (Missura, 2015). One way to adapt a game is through the player's character: the actions that the player takes have implications, for example, if the character levels up, their weapons and attacks become more powerful. Another widely used technique alters non-player characters' (NPCs) behaviour and characteristics: depending on the players' performance in the game, the enemies' health and strength changes, they may become less or more aware of the characters' presence, and even vary in terms of items they carry on them. Finally, the game environment itself can be altered when the player's performance changes: for example, if the character levels up, the enemies they encounter change and become more varied in their quantities, the character might also find specific items and locations, which might not have been accessible beforehand. These approaches are more common for role-playing games, however difficulty adaptation algorithms have also been extensively used in games like *Tetris* (Lora et al., 2016; Spiel et al., 2017) and *Pac-man* (Hao et al., 2010), where the typical adjustments affect the moving parts in the games, such as tetrominos in Tetris and ghosts in Pac-Man. Difficulty adaptation has also been explored for games with continuous gameplay, e.g. Nagle et al. (2016) describe a game in which the player fights off zombies whose spawn rate and distance is controlled by the algorithms.

Another way to adjust difficulty in a game is through time pressure, i.e. adjusting the amount of time a player spends working towards a goal can be adapted to vary game difficulty. Time pressure is one of the key challenge types, as identified by Adams (2014), which makes it a suitable game attribute to be manipulated in order to adjust the perceived difficulty. This adaptation was studied experimentally by Denisova and Cairns (2015a), who modified a digital game to incorporate a simple adaptive timer, which changed the countdown rate according to the players' performance. The players were unaware of the adaptation, but the group who played with the modified timer felt more immersed overall than people who played with the standard timer, largely due to players' perception of challenge.

3. Perception of Adaptive Technology in Digital Games

Generally, difficulty adaptation is perceived as beneficial to one's gaming experience (Chen, 2007), as it leads to a more balanced gameplay. Recent work in the area of games user research has provided evidence that suggests that adaptive features in games also have a positive effect on the gaming experiences in shooting games (Bateman et al., 2011; Vicencio-Moreira et al., 2015), MOBA games (Silva et al., 2017), racing games (Cechanowicz et al., 2014), and casual games (Smeddinck et al., 2016): resulting in higher levels of enjoyment and fun (Newheiser, 2009), experiences of autonomy (Smeddinck et al., 2016; Klarkowski et al., 2016), and competence (Vicencio-Moreira et al., 2015). Though the effect of adaptive technologies on more generic player experiences, such as immersion and engagement, has not been explored to the same extent. Immersion is one of the most desired gaming experiences nowadays, according to players and researchers (Cairns et al., 2014a), so studying how adaptive technologies can be used to create a sense of immersion would benefit both game creators and players.

Adaptive technologies are often invisible in the game design. As the game AI adapts to the player's individual approach, the player feels moderately challenged, and as a result feels increasingly immersed in the game. However, if the players become aware of another player having an assistance from the adaptive technology, it can be perceived as an unfair advantage by more experienced players, like in the case of *Mario Kart* (Newheiser, 2009). It is particularly evident in a situation when the player does not need to improve on their skills to improve their performance, because it is done for them. Similarly, scaling the level of difficulty in the game based on one's progress can deprive the player of their sense of achievement (Bostan and Öğüt, 2009).

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

However, despite the obvious benefits of this technique, there is little empirical evidence to support the idea that adaptive technologies in games have an effect on player experience (Karpinskyj et al., 2014). Research into the effect of game balancing in multiplayer games on player experience has become more prominent in recent years, identifying the perception of unfairness as one of the main issues when it comes to the implementation of such features in games that are played by several players at once (Hunicke, 2005). Single-player games could benefit from having such systems: they can prevent players from getting stuck and allow anyone with any level of skill and previous experience to enjoy the game equally. Unfortunately, little research has been done to explore players' perceptions of these features. Gathering more empirical data could help game user researchers understand this phenomenon in more detail and learn about how player experience is affected when playing with such features while being aware of them and when adaptation is hidden away.

4. Immersion and Player Expectations

Our experience of a game does not solely come from the game conventions alone, players' perception of the game environment also affects their immersion (McMahan, 2003). Meeting players' expectations of a game world is rather important in order to achieve immersion. While creating false expectations could work short-term, it would ruin players' impression of the game after they realise it does not conform to the expectations set originally. As many games rely on their players' continuous engagement with the game, it is important to explore how players' expectations of game features affects their experiences of the game. Players build these expectations based on a variety of factors: their previous experiences, their individual characteristics (Bartle, 1996; Park et al., 2011), and the information available to the players about the game. These, in turn, affect players' experience and perception of the game.

The idea that players themselves have an effect on their game play is not novel, and some recent evidence suggests that players' interpretation of a game can change their experience significantly. Reading game reviews (Livingston et al., 2011) and referring to the ratings from external sources (Jenkins et al., 2010) affect the enjoyment of the game. Many players form an opinion about the game even before playing it, and this opinion may change their first encounter with the game.

Immersion is an experience that many players seek in digital games. The general experience of being immersed in a digital world is dependent on the player, as much as it is on the game. Their perception and interpretation of the game can play an important role when shaping their experience. According to Jennett et al. (2008), immersion is comprised of five components: cognitive and emotional involvement, real world dissociation, perceived challenge and control in the game. Unlike many other gaming experience theories, which mainly focus on the game factors influencing players' experience, this theory also takes the player into account as a factor, which affects immersion. The first three components are based on the individual differences between players, while the other two factors are related to the game itself. The researchers also created the Immersive Experience Questionnaire (IEQ), which allows to measure an overall immersion level of a player in a digital game.

It is evident that understanding how players form their expectations of a digital game is rather important not only for game experience researchers, who wish to contribute to the theoretical field of player experience, but also to the game manufacturers, who are interested in attracting players to their games, keeping them continuously engaged, and then delivering the experiences that the players were seeking. Expectations of adaptive AI has recently been studied by Denisova and Cairns (2015a), who explored the idea of 'the placebo effect' that occurs as a result of deceptive perception of adaptivity in a game. It appears that having a feature in a digital game is not always a concrete requirement for causing high immersion. Interestingly, players attributed any changes in the game play to being monitored by the AI, and felt like their experience of playing with it greatly improved their performance and enjoyment during play.

The studies described in Denisova and Cairns (2015a), however, were conducted using a game that did not adapt to the player in order to investigate whether the placebo effect exists. Players in these studies may have been looking for evidence of adaptation but, of course, there was no such evidence to be found. It may be that the engagement required to seek out evidence was what caused the increased immersion. It may also be that players simply took the adaptation on trust and the idea that the game may be more balanced towards them was sufficient to increase immersion. Care was deliberately taken to avoid giving the players details of the adaptation in order to avoid any form of confirmation bias. It is possible that if the players knew the exact detail of how the AI adapts its behaviour according to the players' decisions in the game, it could reduce the sense of immersion instead, as players might doubt the fairness of such adaptation or its usefulness to their game play. Knowing that a game is adapting its behaviour based on your choices could also make people change their tactics, and it is possible that the players might explore the game world in a different way than when someone is playing the game just as it unfolds to them. All of these interactions between adaptation and knowing that there is an adaptation may also depend on what players have been told about how the adaptation works.

Overall then, there are many ways in which knowledge of an adaptation could interact with the player experience, specifically immersion, both when it is absent and when it is present. Therefore, to investigate how players' expectations of adaptive technology in games affects immersion, we conducted two studies. The main aim was to explore how the accuracy and the precision of information players know about adaptivity in the game affects their experiences and behaviours when playing the game with or without the feature present in the game.

5. Hypotheses

Based on the review of the relevant literature, we generated some hypotheses with regards to the effects of adaptation and information about adaptation on player immersion. The first two hypotheses were based on the work of Denisova and Cairns (2015a,c) (**H1**,**H2** respectively).

- **H1:** Playing an adaptive digital game leads to higher immersion than playing the same game without difficulty adaptation.
- **H2:** Players who believe that the game has an adaptive feature feel more immersed than the players who are not aware of the feature when the feature is absent.
- **H3:** The more players know about the adaptation, the less immersed they will be when the adaptation is present.

- **H4:** The effect of information about adaptation on immersion becomes weaker with game play time.

6. Study I: Information Precision and Accuracy

The aim of the first study was to investigate how immersion is affected by the presence of adaptation and players' expectations of adaptation based on varied levels of information precision (the first three hypotheses). We used a mixed-method approach to gain further insight into how players' perceptions of the adaptation and the game are affected by their expectations of adaptive game behaviour. For this, we recruited 120 participants who were split into six groups based on two conditions: the presence of the adaptive timer or a standard timer, and the information about the timer (no information, partial information, or full information).

6.1. Method

A 2 x 3 factorial between-subject design study was conducted in order to gather information about players' immersion levels and their performance in a time-constrained gaming session, during which players were asked to play a modified game, *Nightmares*[1].

Overall, players were split into six independent groups based on the experimental condition. Half of the participants had their timer adjusted based on their performance in the game (**'adaptive timer'** condition), while the other half played with a standard timer displaying the amount of time left until the end of the session (**'standard timer'** condition). One third of each of these groups were not aware of the timer adaptation (**'no info'** condition), another third of the players were told that timer adjusted based on their performance but were not told what exactly this adaptation did (**'partial info'** condition), and the rest of the players were told how the adaptation changed their gameplay based on their performance in the game (**'full info'** condition).

6.1.1. Participants

Overall, 120 participants (38 women) took part in the study. Recruited participants had varied levels of gaming experience, from casual players to

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[1] 'Nightmares – a Survival Shooter': `https://unity3d.com/learn/tutorials/projects/survival-shooter-tutorial`, accessed on 29 May, 2018.

Figure 1: Nightmares: an isometric-view shooting game.

dedicated gamers. The average age of the participants was 24.15 (SD = 4.79), mix/max = 18/50.

6.1.2. Materials

The game used in this experiment was *Nightmares* (Figure 1), which was modified to have an adaptive timer, as described in Denisova and Cairns (2015a). The general idea was that the player controls a little boy in a nightgown, who is dreaming of his toys becoming zombies and attacking him. The player has to avoid being hit by the zombie bunnies, bears, and elephants while trying to shoot them. Different enemies are worth different number of points, and spawn at a different rate through the game. Similarly, players lose points depending on the zombie toy attacking them.

The score and the time left until the end of the gaming session were visible to the player at all times. The timer had two options. In the 'standard' option it counted down at a rate of one second at a time, for 90 seconds. In the 'adaptive' version of the timer, the time sped up or slowed down based on player's performance at discrete points in the game. Each player's performance was evaluated dynamically against the mean score at different points in the game. Depending on the player's performance, the countdown rate changed to one of the three possible modes (speed up, slow down, or remain unchanged). The time passage changes were not perceptible.

The player experience data was collected using the Immersive Experience Questionnaire (IEQ) (Jennett et al., 2008). Additionally, players who were told about adaptation, either partially or fully, were given an additional questionnaire at the end of the experiment, asking if they noticed the time change, how they thought the timer changed, whether it affected their performance in some way, and whether they thought that knowing about the adaptation changed their experience in any way. This qualitative information was primarily used to make sense of the quantitative data.

6.1.3. Procedure

At the beginning of each session, participants signed the informed consent form. The experiment started with a practice round of the game. Participants then filled out a demographics questionnaire, providing information about their gaming background and their perceived expertise level in this game, rated from 1 (novice) to 5 (expert). This was then followed by the main part of the study, during which participants played the game for 1.5 minutes (in the standard condition) or what appeared to be 1.5 minutes (in the adaptive condition). The aim was to get the highest score they could within the time limit. At the end of the gaming session their score was recorded. Participants then filled in the IEQ, and the additional questionnaire, if applicable.

A two-way ANOVA was performed to test for the main and interaction effects of the manipulations. Tukey post-hoc test was used for multiple comparisons at a significance level of $\alpha = 0.05$.

6.2. Results: Adaptation and Information

This section presents the results of how immersion of players and their in-game scores were influenced by the experimental manipulations. Players' perceived levels of expertise were also used to determine whether any additional factors outside the controlled manipulations were affecting their immersion.

6.2.1. The Influence on Immersion

With regards to the timer adaptation, the difference between immersion scores in the 'standard timer' condition and the 'adaptive timer' condition was highly significant: $F(1, 114) = 22.37$, $p < 0.001$, with a medium effect size – $\eta_p^2 = 0.164$, supporting **H1**.

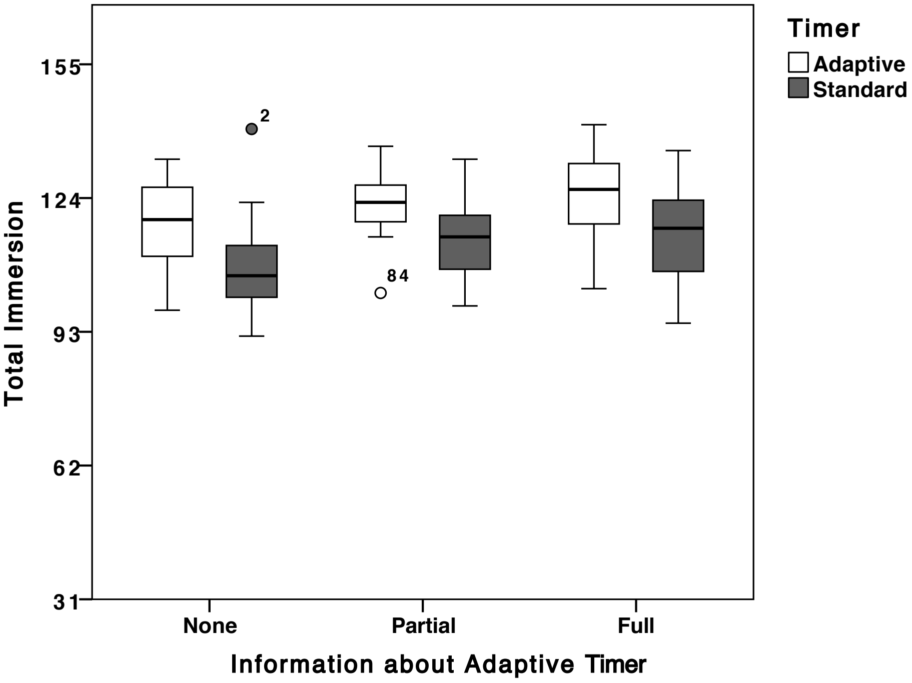


Figure 2: Immersion based on adaptivity and information precision.

Participants with time altered during their game play felt significantly more involved cognitively and emotionally with the game, and were significantly less aware of their surroundings, and felt more in control while playing the game. However, there was no significant difference between the two groups in terms of their perception of challenge in the game (Table 1).

The effect of information about adaptation on the level of immersion in the game was also significant: $F(2, 114) = 5.08$, $p = 0.008$, $\eta_p^2 = 0.082$. Tukey's HSD showed no significant difference between immersion of player who did not know about the adaptation and immersion of those with partial knowledge of adaptation ($p = 0.093$) or between the groups with partial and full knowledge of the manipulation ($p = 0.745$). However, players who received a full description of the adaptive timer felt significantly more immersed in the gaming session than players without this knowledge ($p = 0.015$). This means that **H3** is rejected and **H2** is supported, based on the collected data.

Out of all five components, three differed significantly between the three groups of players: cognitive involvement, real world dissociation, and control (Table 1).

Components	Effect of Adaptation			Effect of Information			Interaction Effect		
	$F_{1,114}$	p	η_p^2	$F_{2,114}$	p	η_p^2	$F_{2,114}$	p	η_p^2
Total Immersion	22.37	0.000***	0.164	5.08	0.008**	0.082	0.13	0.879	0.002
Cognitive Involvement	15.64	0.000***	0.121	5.38	0.006**	0.086	0.87	0.420	0.015
Emotional Involvement	11.68	0.001***	0.093	0.66	0.520	0.011	0.35	0.706	0.006
Real World Dissociation	7.08	0.009**	0.058	3.89	0.023*	0.064	0.63	0.533	0.011
Challenge	1.22	0.273	0.011	0.03	0.971	0.001	0.65	0.523	0.011
Control	9.36	0.003**	0.076	3.14	0.047*	0.052	0.31	0.734	0.005

Table 1: Interaction and main effects of timer adaptation and information about it on immersion. $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

The interaction effect of the adaptive timer and the information provided to the players about it on immersion was not significant: $F(2, 114) = 0.13$, $p = 0.879$, $\eta_p^2 = 0.002$. Similarly, there was no significant interaction effect of information and adaptation on immersion and its five components.

6.2.2. The Influence on Scores

As expected, the scores were higher and varied less in the group of players who had the timer adapting to their game play. The scores of players in the 'standard timer' condition varied between 103 points and 490 points ($M_s = 345.57$, $SD = 103.55$), while players in the 'adaptive timer' group got between 169 and 647 points ($M_a = 406.18$, $SD = 90.78$). The difference between scores in these two groups of participants was highly significant: $F(1, 114) = 11.63$, $p = 0.001$, $\eta_p^2 = 0.090$.

The information provided to the players also had an effect on players' scores. On average, players, who were not informed about the adaptive timer, scored $M_{none} = 335.63$ ($SD = 109.58$), while players with only partial knowledge about the timer scored $M_{part} = 407.85$ ($SD = 80.05$). Players, who were fully briefed about the adaptation, scored an average of $M_{full} = 384.15$ points ($SD = 101.57$). The difference between the scores obtained in all three groups of players was highly significant: $F(2, 114) = 5.66$, $p = 0.004$, $\eta_p^2 = 0.08$.

Interestingly, the pairwise Tukey test showed that the players who were not aware of the adaptive timer, regardless of its presence in the game, scored

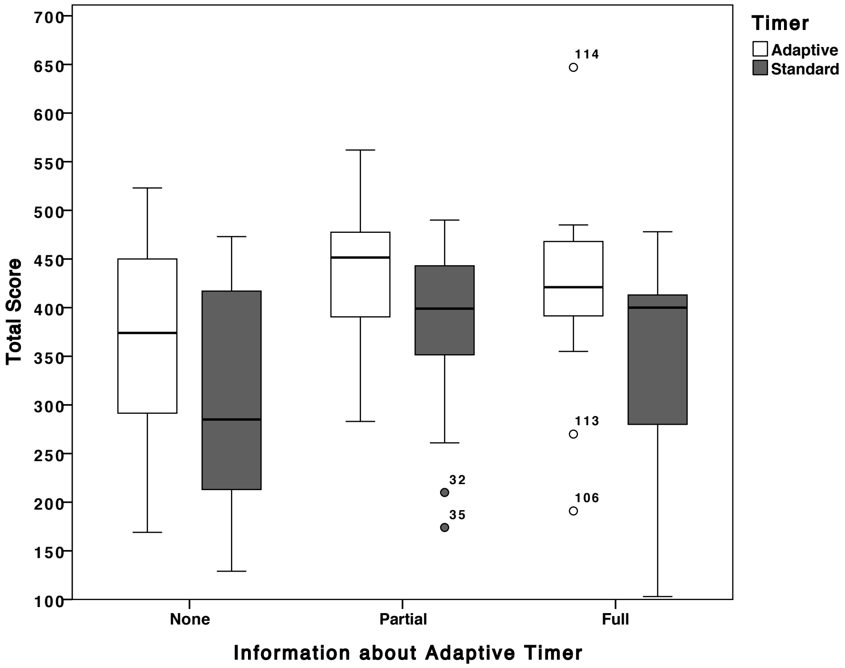


Figure 3: The influence of adaptation and information on in-game scores.

significantly less than the players who only received partial information ($p = 0.003$). However, the scores were not significantly different from those participants who received the full description of the adaptation ($p = 0.069$). Similarly, the scores of the players who were aware of the adaptation and the group given the full detail about its functionality did not differ significantly either ($p = 0.787$).

There was no significant interaction effect of adaptation and information about it on players' scores: $F(2, 114) = 0.05$, $p = 0.947$, $\eta_p^2 = 0.001$.

6.2.3. Perceived Expertise

The players rated their expertise with this particular game after the practice session on a scale from 1 to 5, based on how competent they felt using the controls and their understanding of the gameplay, where 1 being 'Novice' and 5 – 'Expert'. Players' perceived levels of expertise had an effect on their immersion level, which was highly significant: $F(4, 115) = 5.66$, $p < 0.001$, $\eta_p^2 = 0.165$. Generally, players who estimated themselves as more proficient at playing the game, were more immersed than those players who thought they were not as good at shooting zombie toys.

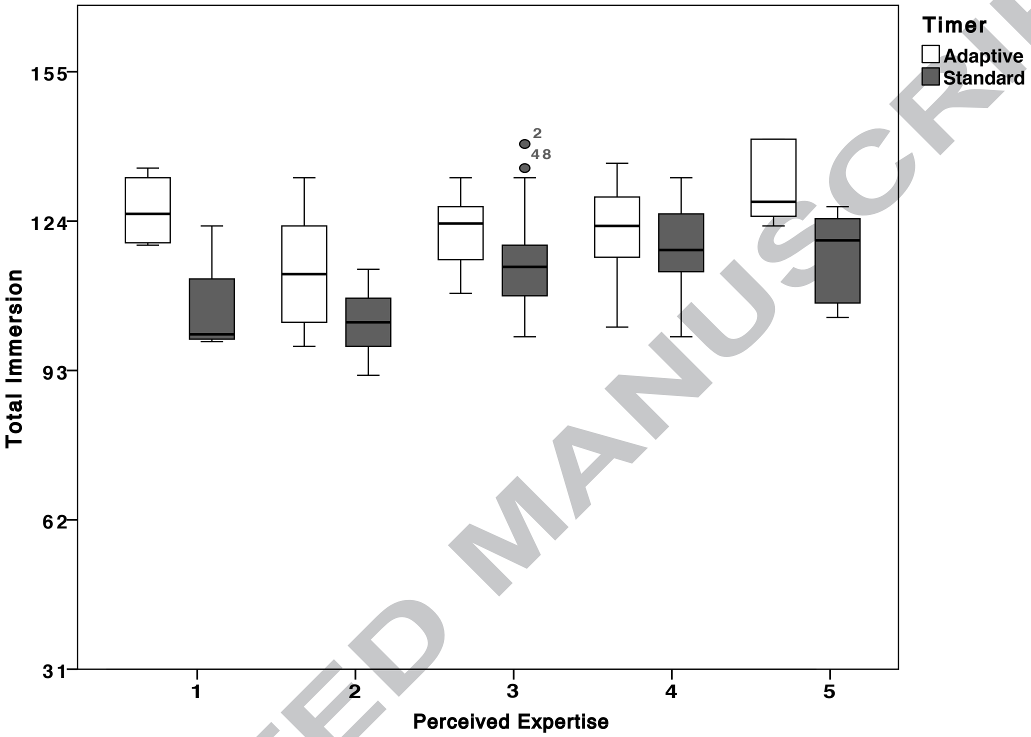


Figure 4: Immersion based on players' perceived level of expertise and the presence of adaptation.

Components	$F_{4,115}$	p	η_p^2
Total Immersion	5.66	0.000***	0.165
Cognitive Involvement	4.60	0.002**	0.138
Emotional Involvement	2.99	0.022*	0.094
Real World Dissociation	3.83	0.006**	0.118
Challenge	1.27	0.288	0.042
Control	7.57	0.000***	0.208

Table 2: Mean (SD), and the effect of players' perceived level of expertise in the game on immersion and its components. $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$

There was no significant interaction effect between perceived level of expertise and adaptation on players' immersion: $F(4, 110) = 1.76$, $p = 0.143$, $\eta_p^2 = 0.060$. Similarly, there was no significant interaction effect between perceived expertise and the information about adaptive timer on immersion: $F(7, 106) = 1.38$, $p = 0.223$, $\eta_p^2 = 0.083$.

Four out of five immersion components differed significantly between the five groups of players: cognitive involvement – $F(4, 115) = 4.60$, $p = 0.002$, $\eta_p^2 = 0.138$; emotional involvement – $F(4, 115) = 2.99$, $p = 0.022$, $\eta_p^2 = 0.094$; real world dissociation – $F(4, 115) = 3.83$, $p = 0.006$, $\eta_p^2 = 0.118$ and control – $F(4, 115) = 7.57$, $p< 0.001$, $\eta_p^2 = 0.208$ (Table 2).

As expected, players' perception of challenge in the game was inversely proportionate to their perceived level of expertise. Player with 'novice' ratings felt more challenged by the game than the 'expert' players. However, the difference between the challenge scores was not significant: $F(4, 115) = 1.27, p = 0.288, \eta_p^2 = 0.042$.

A similar pattern emerged in the in-game scores of participants based on their perceived level of expertise. Based on players' perceived expertise, the scores obtained in these five groups differed significantly: $F(4, 115) = 6.94$, $p< 0.001$, $\eta_p^2 = 0.194$. There was no significant interaction effect between perceived level of expertise and adaptation on the scores players obtained in the game: $F(4, 110) = 0.33$, $p = 0.857$, $\eta_p^2 = 0.012$. Similarly, there was no significant interaction effect between perceived expertise and the information about adaptive timer on immersion: $F(7, 106) = 1.30$, $p = 0.259$, $\eta_p^2 = .0079$.

6.3. Discussion

Overall, the results demonstrate that the expectation of adaptive technology in the game affects player immersion regardless of whether the game contains this feature or not, supporting **H2**. The results found in this study replicate the findings in Denisova and Cairns (2015c), who demonstrated that those players who engaged with a game without an adaptive AI were more immersed when believing that the game is changing based on their performance than the players who were not aware of such 'adaptation' or when they believed it was not present.

In Denisova and Cairns (2015c), players were not provided the full detail about what adaptive AI did in order to avoid confirmation bias. However, it was evident that players who were not familiar with the concept were more likely to feel more immersed in the game than those players who were not motivated by the novelty. Therefore, an assumption was made that if the

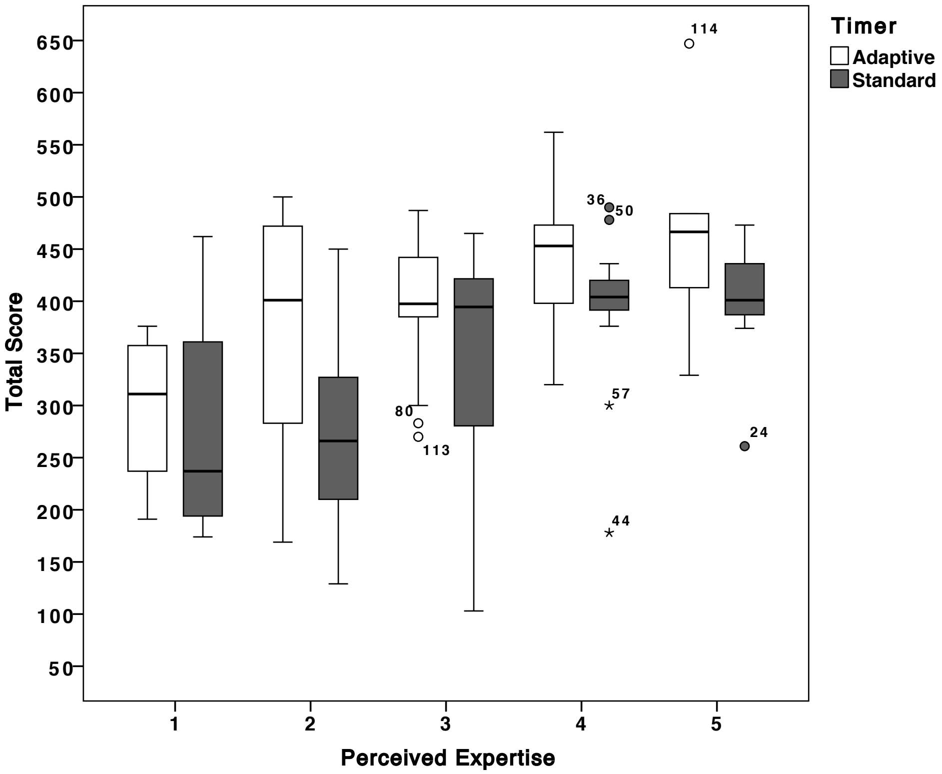


Figure 5: The game scores based on players' perceived level of expertise and the presence of adaptation.

players knew the full details about mechanics behind the adaptation, they might feel less immersed. This could be either due to the perceived fairness of the feature or simply because having more comprehensive understanding of the mechanics may decrease the novelty effect or pro-innovation bias. Similarly, players who are only aware of the presence of this potentially beneficial feature would have more room for interpretation, and would generally perceive it more positively due to this, which was the basis for **H3**.

The data obtained in this study shows that this was not the case: players felt more immersed when knowing about what adaptive timer did than the other participants who were either unaware of this feature or were just simply told that the game had an adaptive timer without the explanation of what it did, which contradicts **H3**. Participants' comments collected at the end of the experiment shed some light onto this: in some cases, players evidently used the information about the adaptation to their advantage, i.e. some of them tried to incorporate the feature into their gameplay by trying to extend the time and beat as many zombie toys as possible. This is also reflected in the scores of the players: participants who were aware of the timer adaptation scored significantly higher than the players who were not told about it. Similarly, although not many players did so, some of them kept the track of the timer by looking at it, which they would not necessarily do otherwise, according to their responses. It is possible that the increase in their cognitive involvement was due to their increased focus on the timer.

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

An additional goal of the study was to explore the effect of the presence of the adaptive timer on immersion of players. The adaptive timer was found to be beneficial to player experience, as seen in Denisova and Cairns (2015a), and the findings in this study also confirmed this hypothesis (**H1**). Overall, players felt more immersed when the timer was changing its countdown rate based on their performance in the game regardless of whether the players knew about it or not.

These findings support the idea of adaptive features having a positive effect on gaming experience: an adaptive timer that matched the challenge in the game to the players' skills. The weaker players were provided with extra time to catch up due to the implemented adaptation. Thus, the players who knew about this assistance perceived this feature as fair. On the other hand, players who were more experienced could aim for higher scores without the help from the game. With the implemented adaptation, players felt moderately challenged, however they were not able to score much higher than the players with lesser expertise. Interestingly though, contrary to the findings from (Gerling et al., 2014; Cechanowicz et al., 2014) the stronger players did not perceive this feature as limiting. This can be attributed to the fact that, although players were competing against the clock, there were no other players to compare their performance against, as this was a single-player game. Therefore, as seen in the comments of the participants, players felt they enjoyed themselves while playing the game, and more time pressure did not have a negative effect on their gaming experience. The implementation of the adaptation was aimed to increase challenge and not to deprive players from opportunity to obtain high scores. That explains why the stronger players did not feel disadvantaged by the adaptation.

The implemented timer adaptation provided an effective balance between the in-game challenge and the skills of the players, which is supported by the results of the challenge component of immersion and the players' estimated expertise level. The perceived challenge did not differ significantly between players with different expertise levels, which was also observed in the comments collected at the end of the study that suggest that players felt moderately challenged.

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

The presence of the adaptive timer had an effect on the players' scores: those players who experienced the adaptation achieved higher scores than the players who engaged with the game in the standard condition. The analysis, however, demonstrated that despite the adaptation having an effect on both the in-game scores and the immersion levels, immersion in the game was not directly dependent on the in-game scores.

Interestingly, there was no interaction effect of the timer condition and what players knew about it on their immersion in the game. As the amount of detail players received about the adaptation increased, so did the immersion level of players. However, whether the adaptive timer was present or not did not affect this. The presence of adaptation increased immersion regardless of the information precision, yet the effect of information was not linked to the effect of adaptation. Players felt more immersed when knowing about the adaptation than the players who were not aware of it regardless of whether it was present in the game or not and regardless of the precision of information given to them prior to their engagement with the game.

This study, however, has several limitations. The used adaptation was not a part of the main game mechanics, which could have lead to many players not noticing it. More conventional adaptations change the number of enemies in the game, their strength and abilities, or the number and values of collectible objects. This means that the players' interaction with the game has a direct effect on the adaptation and can be more obvious to the naked eye, which could impact player experience.

Moreover, as the gameplay was somewhat repetitive and the sessions were short, it is possible that the players' positive perception of the adaptation could change with longer play, as the players' interest in the game would decrease with time. Therefore, longer gaming sessions should be used to evaluate whether the effect of players' perception of the adaptation is durable. Furthermore, as players make progress in the game, their attitude toward the adaptation might change. The initial boost they experience from knowing that that game has adaptive technology might wear off, and the effect of the actual adaptation would take over their experience. Finally, as they play for longer, this kind of assistance might become more useful longer term with difficulty of the game rising with players' progress.

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

7. Study II: Durability of Information

In order to replicate and extend the findings from the previous study, we conducted another experiment in which we used a different game with a different, more conventional, kind of adaptation to examine the durability of the effect of information on immersion. This time, players were engaged with the game for a longer period of time and their immersion was recorded twice after each gaming session.

7.1. Method

A (2 x 2) x 2 mixed-measures design study was conducted to test the hypotheses **H1, H2, H4**. The experiment was designed around four conditions, addressing two independent variables: the presence of the implemented difficulty adaptation (**adaptive condition** and **standard condition**), and the information players receive about the adaptation (some (**information**) or no information about the concept of adaptation (**no information**)).

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

7.1.1. Participants

Overall, 60 participants took part in the study (19 women). The mean age of the players was 25.60 (SD = 6.61), ranging from 18 to 50 years. Majority of the participants were frequent game players and, on average, they had played digital games for just over 15 years, generally between 3 and 35 years.

7.1.2. Materials

Based on this data and set up used in the previous studies and a pilot study, it was decided that the game for this experiment should provide sustainable engagement for at least 20 minutes. Additionally, this was a suitable opportunity to explore the effect in a different game with a different kind of adaptation. Some of the most widely used adaptive technologies in games nowadays adjust parameters, such as the speed, power, and health of enemies, their number and frequency of spawning, and the power of the player (Adams, 2014). Hence, to follow the conventions of the existing difficulty balancing techniques, a level-based game was developed, in which the difficulty of each level is adjusted based on the performance of the player in the previous levels.

A digital game chosen for this study was 'Trick or Treat' (Figure 6), a halloween-themed game, developed specifically for the study using Unity 5.2. In the game, a player controls a little girl, who collects candy scattered around the game world and stolen by monsters in a time-contained environment. The game has five levels, where each level increases in difficulty based on the number of sweets required to collect and the speed, health, and attack strength of monsters. To make the game more challenging, the character has a limited amount of health on each level: if she gets hit by the enemies, she loses some health. When her health reaches 0, she dies, triggering the restart of the same level. There are no items available at any point to restore the health, so the player has to keep the character alive in order to make progress.

Figure 6: Trick or Treat: a Halloween-themed shooting game.

The difficulty of the game increases with each level, which is calculated based on the number of enemies, their health and attack strength. These parameters are fixed, however the enemies' radius of player detection, player's health and attack strength are varied based on the difficulty adaptation implemented in this game. Unlike the adaptive timer in the previous study, this more conventional kind of difficulty adjustment is often used in contemporary games. The number of sweets collected on each level is used to adapt the difficulty for the following level. For example, if the player collects most of the candy available on the level, the difficulty mode increases to 'hard', while collecting the minimum of candy needed to level up decreases the difficulty to 'easy'. Otherwise, the difficulty remains at a 'normal' level. Additionally, each restart of the level would decrease the difficulty of the level by one, i.e. the 'easy' level would be given to a player who died while playing at the 'normal' difficulty, and the 'hard' difficulty mode would become 'normal'.

Level-based design was chosen for several reasons. Firstly, progressing from a level to another provides players with a sense of moving forward. If a player fails to keep the character alive, not all progress is lost. This allows for the difficulty adaptation algorithm to adjust difficulty at specific points in the game, which could not be necessarily possible if the game was open-world, in which the player continuously fights off the monsters and collects candy, like they did in the 'Nightmares' game. Moreover, having different levels allows to vary the content of the game, which should potentially keep players interested in exploring the game further for longer periods of time.

The reasons for choosing a game specifically built for this experiment over a commercial one were as follows. Having a non-commercial digital game meant that players would not be familiar with it, and all players would have the same initial response. Secondly, being able to modify the game provides a greater control over its static and varied parameters, which can be adjusted based on the difficulty of each level, as well as depending on the difficulty set by the difficulty adaptation. And finally, having a level-based game meant that players' engagement with the game could last longer due to its less repetitive nature.

The data about players' perceived level of immersion was collected using the IEQ. Participants also answered some questions about their experience of the difficulty adaptation implemented in the game at the end of the session, if they were in the condition in which information was presented to them about it at the beginning of the session. This qualitative information is not reported in full in this paper, however relevant results are discussed below.

7.1.3. Procedure

Participants were provided with a consent form, followed by a demographics questionnaire about their personal details and gaming habits. This was then followed a more detailed description of the study procedure. After that, participants played a short introductory tutorial to the game to familiarise themselves with the controls. This was followed by the main part of the study, which consisted of two 10-minute gaming sessions. Participants were stopped by the experiment facilitator after 10 minutes to fill in the first IEQ, after which they continued playing the game from the point where they paused the game at. Participants then filled in another IEQ after the second part of the game. Those players who were explicitly told about the adaptation at the start of the experiment filled in an additional questionnaire about their experience of the difficulty adaptation.

7.2. Results

Overall, participants became significantly more immersed in the game after playing the game for longer, i.e. the difference between immersion scores collected after the first 10-minute session and after the second round lasting 10-minute was highly significant: $F(1,58) = 24.54$, $p< 0.001$, $\eta_p^2 = 0.305$.

There was a significant effect of information about the difficulty adaptation on immersion for both sessions: $F(1,56) = 9.46$, $p = 0.003$, $\eta_p^2 = 0.146$; and the presence of the difficulty adaptation also had a significant effect on immersion: $F(1,56) = 10.66$, $p = 0.002$, $\eta_p^2 = 0.160$. However, the interaction effect of the difficulty adaptation and the information about it on immersion was not significant: $F(1,56) = 1.81$, $p = 0.180$, $\eta_p^2 = 0.031$, as also observed in the previous studies.

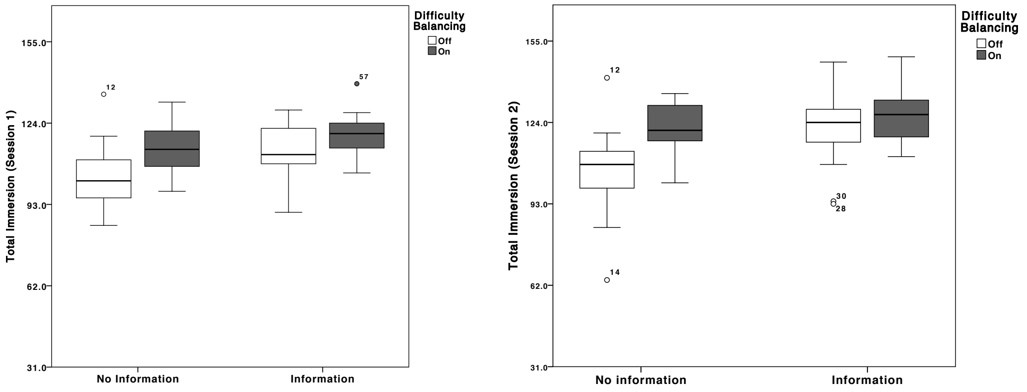
The interaction effect of the information players received about difficulty adaptation in the game and the game play session was not significant: $F(1,58) = 1.69$, $p = 0.199$, $\eta_p^2 = 0.029$. Neither was the interaction effect of the adaptation and the game play duration: $F(1,58) = 0.96$, $p = 0.332$, $\eta_p^2 = 0.017$. The interaction effect of the two independent variables and the game play duration on immersion was not significant: $F(1,56) = 1.08$, $p = 0.304$, $\eta_p^2 = 0.019$.

All but one immersion components (real world dissociation) differed significantly between the two gaming sessions. Cognitive involvement: $F(1,58) = 12.36$, $p = 0.001$, $\eta_p^2 = 0.173$, emotional involvement: $F(1,58) = 19.42$, $p< 0.001$, $\eta_p^2 = 0.257$, real world dissociation: $F(1,58) = 3.20$, $p = 0.079$, $\eta_p^2 = 0.054$, challenge: $F(1,58) = 14.58$, $p< 0.001$, $\eta_p^2 = 0.207$, control: $F(1,58) = 24.35$, $p< 0.001$, $\eta_p^2 = 0.303$.

Components	Effect of Information			Effect of Adaptation			Interaction Effect		
	$F_{1,56}$	p	η_p^2	$F_{1,56}$	p	η_p^2	$F_{1,56}$	p	η_p^2
Total Immersion	9.46	0.003**	0.145	10.66	0.002**	0.160	1.81	0.184	0.031
Cognitive Involvement	3.17	0.008**	0.054	6.67	0.012*	0.106	0.01	0.917	0.000
Emotional Involvement	6.66	0.012*	0.106	8.44	0.005**	0.131	0.81	0.372	0.014
Real World Dissociation	6.27	0.015*	0.101	5.68	0.021*	0.092	4.76	0.033*	0.078
Challenge	3.91	0.053	0.065	5.94	0.018*	0.096	3.91	0.053	0.065
Control	6.71	0.012*	0.107	2.79	0.100	0.047	0.72	0.400	0.013

Table 3: Interaction and main effects of difficulty adaptation and information about it on immersion. $^{**}p<0.01$, $^{*}p<0.05$

Overall, the component-wise analysis of immersion revealed similar findings to the ones observed in the previous study: the information about the



(a) Immersion during the first 10-minute gaming session.

(b) Immersion during the second 10-minute gaming session.

Figure 7

adaptive technology had a significant effect on the players' cognitive involvement with the game and their real world dissociation. However, there was also a significant difference in players' emotional involvement with the game and their perceived sense of control in addition to the other two factors.

The implemented adaptation also influenced the cognitive and emotional involvement of the players, and their perceived dissociation from the real world surroundings. Somewhat surprisingly though, the perception of challenge was significantly different between the groups of participants who played the game with the difficulty adaptation and without it.

Considering the first 10-minute session, there was a significant difference in immersion scores of participants based on the presence of the adaptation: $F(1, 59) = 9.49$, $p = 0.003$, $\eta_p^2 = 0.145$. The information about the adaptation also had a significant effect on immersion: $F(1, 59) = 7.55$, $p = 0.008$, $\eta_p^2 = 0.119$. However, the interaction effect between the two independent variables on immersion was not significant: $F(1, 56) = 1.02$, $p = 0.316$, $\eta_p^2 = 0.018$, which was on par with the results observed in the previous study.

During the second 10-minute session, participants also felt significantly more immersed in the game when playing with adaptation than those players, who had a standard difficulty increase: $F(1, 59) = 9.39$, $p = 0.003$, $\eta_p^2 = 0.144$. The information about the adaptation also had a significant effect on immersion: $F(1, 59) = 9.05$, $p = 0.004$, $\eta_p^2 = 0.139$. However, the interaction effect on immersion was not significant: $F(1, 56) = 2.05$, $p = 0.148$, $\eta_p^2 =$

SESSION I	Effect of Information			Effect of Adaptation			Interaction Effect		
	$F_{1,59}$	p	η_p^2	$F_{1,59}$	p	η_p^2	$F_{1,56}$	p	η_p^2
Total Immersion	7.55	.008**	.119	9.49	.003**	.145	1.02	.316	.018
Cognitive Involvement	1.73	.193	.030	4.92	.031*	.081	.12	.730	.002
Emotional Involvement	7.23	.009**	.114	8.99	.004**	.138	.35	.559	.006
Real World Dissociation	3.12	.083	.053	2.63	.110	.045	2.18	.145	.038
Challenge	5.08	.028*	.083	11.13	.002**	.116	4.30	.043*	.071
Control	2.14	.149	.037	.54	.467	.009	.30	.585	.005

Table 4: First 10-minute session: The effects of information and adaptation on immersion. $^{**}p<0.01$, $^{*}p<0.05$

0.037.

SESSION II	Effect of Information			Effect of Adaptation			Interaction Effect		
	$F_{1,59}$	p	η_p^2	$F_{1,59}$	p	η_p^2	$F_{1,56}$	p	η_p^2
Total Immersion	9.05	0.004**	0.139	9.39	0.003**	0.144	2.05	0.148	0.037
Cognitive Involvement	3.83	0.055	0.064	6.60	0.013*	0.105	0.02	0.903	0.000
Emotional Involvement	5.49	0.023**	0.089	7.08	0.010**	0.112	1.25	0.268	0.022
Real World Dissociation	6.40	0.014**	0.103	6.06	0.017*	0.098	5.11	0.028*	0.084
Challenge	1.54	0.219	0.027	1.22	0.274	0.021	1.91	0.173	0.033
Control	11.47	0.001**	0.170	5.73	0.020*	0.093	1.08	0.303	0.019

Table 5: Second 10-minute session: The effects of information and adaptation on immersion. $^{**}p<0.01$, $^{*}p<0.05$

Familiarity with the concept of difficulty adaptation did not have a significant effect on immersion in the two gaming sessions: $F(1,28) = 2.89, p = 0.100, \eta_p^2 = 0.093$.

7.2.1. Performance in the Game

Overall, the number of levels players fully completed within the required time ranged between two and five, out of the five levels in the game. Majority of players (33) completed all five levels, 17 participants completed four levels, 9 participants made no further progress after completing three levels in the game, and only one participant was unable to make further progress after completing level two.

The number of levels players completed within the 20-minutes limit did not have a significant effect on immersion during the two gaming sessions: $F(3,56) = .082, p = 0.489, \eta_p^2 = 0.042$. Immersion during the second gaming session was expected to be affected by the number of levels completed in the game, however the difference was not significant: $(F(3,56) = 0.66, p = 0.583, \eta_p^2 = 0.034$. Similarly, players who completed the game and those who did not finish the game within the time limit did not have a significant effect on immersion: $F(1, 58) = 0.18, p = 0.675, \eta_p^2 = 0.003$.

Not all players were able to keep the main character alive at all times: only 18 participants played the game without dying once, while the other 42 players had to restart the level during which the character lost her life. The largest number of deaths in the game was seven. However, the difference between immersion scores in the two gaming sessions was not significantly influenced by the death of the main character in the game: $F(1, 58) = 0.83, p = 0.368, \eta_p^2 = 0.014$.

There was no significant difference in the number of levels completed by players who had difficulty adaptation and those who did not: $U(60) = 335, p = 0.059$. Similarly, the information about the difficulty adaptation did not have a significant effect on the number of levels players completed: $U(60) = 435, p = 0.805$. The presence of the difficulty adaptation did not have a significant effect on the number of the main character's deaths in the game: $U(60) = 369, p = 0.220$.

7.3. Discussion

The study was designed with an aim to explore the durability of the effect of the players' expectations of the adaptation in a digital game based on the information they know about it on immersion. An additional goal also set up at the start of the experiment was to test the effect of a different type of adaptation and the information about it on players' perceptions of the feature in a different game.

It was hypothesised that the effect of information about adaptation in the game might not be durable (**H4**). That is, knowing that the game contains a potentially beneficial feature might enhance the player's first impression, but as the player engages with the game for longer periods of time, they might forget about the presence of the feature and instead focus on the game mechanics. Alternatively, they might not perceive it as useful or fair, which could potentially decrease their sense of immersion.

Hence, we anticipated that the effect of information about adaptation would decrease with time. This would weaken immersion of players especially for those who were deceptively told about playing with the difficulty adaptation, as with time they could observe that the game's difficulty increase is static, and not based on their performance. However, regardless of the gaming session, the information about the adaptation increased players' immersion, which was on a par with the results shown in the previous study.

Interestingly, this effect did not change with longer game play, specifically, after 20 minutes of playing. Hence, **H4** was rejected. Despite the different nature of the adaptation in this game compared to the one used in the previous study, the effect of information on immersion remained significant.

Same as in the previous experiment, the players' immersion increased when expecting the adaptive feature (supporting **H2**). This effect was observed both after the first gaming session, and at the end of the experiment, regardless of the overall immersion levels increasing as the players made progress in the game. These findings suggest that the effect of information about adaptation on immersion is durable in a casual gaming session, i.e. players felt consistently more immersed when being aware of the adaptation after playing the game for 10 and 20 minutes, regardless of whether the game contained the difficulty adaptation or not.

The players who did not experience the difficulty adaptation, but were told that they played with the feature being present in the game, felt more immersed and, generally, had a more enjoyable experience than the players who were not aware of the existence of such feature. This is somewhat surprising, considering some qualitative responses suggesting that players often did not notice the changes to the game done by the adaptation. These results, therefore, provide additional support to the argument that simple adaptations that are not obvious to the players have the potential to lead to a more positive gaming experience.

Knowing that the effect of information is consistent for different adaptations and is not dependent on the presence of adaptation indicates that, although players may not actively think about the game changing its behaviour according to their actions, reading about its presence prior to the start of the game can provide players with initial boost in enjoyment and increase their immersion. As seen in this study, this boost appears to be consistent throughout the entire duration of play for the players who knew about the adaptation.

Interestingly, the perception of the adaptation implemented in this game was generally positive, even though the players were not told the precise details about its implementation. As the qualitative data suggests, the players believed that this adaptation would be beneficial to their game play due to the fact that it would allow them to experience the game and enjoy it regardless of their level of skill and expertise.

Additionally, the findings in this study suggest that players' immersion in the game increases when playing with the implemented difficulty adaptation (supporting **H1**). The nature of this adaptation was more fitting with the conventions of a typical game adaptation than the one implemented in the previous study. Changing the main character's health and their attack power, while varying the enemies' radius of player detection on each level, matched the skills of the players fairly closely leading to a heightened sense of immersion. These results, therefore, provide additional support for the claim that adaptive features in games lead to an improved immersive experiences of players.

'Nightmares', used for the previous experiment, is a quick engagement shooting game, which was only played for 1.5 minutes. Therefore, there was no opportunity to test whether the positive effect of adaptive features changes with longer game play. As difficulty in the game increases with further levels, players with different experience and skill levels may experience challenge in the game differently. Some might get frustrated if the difficulty is too high, while others might get bored if the challenge is not matched with their skills (Csikszentmihalyi, 1991). Adaptive digital games have a potential to be played for longer, as players would get assistance when being stuck in the game, while making progress through levels in a much smoother fashion. The difficulty adaptation implemented in this second game improved immersion of players not only short-term, but the effect lasted until the end of the experiment. This is an interesting discovery, as it suggests that the adaptation used in this game was effective in balancing the challenge based on the performance of the players.

During the debriefing of participants, some of them questioned whether having the difficulty adaptation would lead to different performance in the game by players in the standard condition and the players with this assistance. This hypothesis was put to the test, but showed no significant difference between the results of the two groups of participants. In general, this kind of adaptation was perceived as fair, and many participants stated that having such assistance could improve many single-player games, however they had their reservations about adaptive multiplayer games.

8. General Discussion

The main aim of these studies was to explore how players' perception of adaptivity in the game is affected by the information they know about it and how that, in turn, affects their immersion. Both studies demonstrate that the mere awareness of a digital game containing adaptive features that players might perceive as beneficial to their game play is enough to significantly increase their immersion (see Table 6).

	Hypotheses	**Studies**	**Support**
H1	Playing an adaptive digital game leads to higher immersion than playing the same game without difficulty adaptation.	S1, S2	Yes
H2	Players who believe that the game has an adaptive feature feel more immersed than the players who are not aware of the feature when the feature is absent.	S1, S2	Yes
H3	The more players know about the adaptation, the less immersed they will be when the adaptation is present.	S1	No
H4	The effect of information about adaptation on immersion becomes weaker with game play time.	S2	No

Table 6: A summary of hypotheses for Study 1 (S1) and Study 2 (S2).

Somewhat against our expectations though, there is no interaction between players' information on the adaptation and whether the adaptation is actually present. Both the information and the adaptation itself can separately positively increase the immersion that players experience. The gathered evidence suggests that players' awareness and expectations of adaptive features in single-player digital games can have a positive effect on their immersive experiences alongside the benefits of the adaptations themselves. This evidence was gathered using different types of adaptive features in different games and varied levels of precision and accuracy of information players knew about these features.

The findings demonstrate the importance of first impressions based on the expectations of players of a supposedly beneficial feature like adaptive technology. The first several minutes of game play are crucial to the overall gaming experience, as at that point many players decide whether they want to continue playing the game. There are many ways in which players' impression of the game during the first encounter can be affected by factors outside the actual gameplay: reading reviews, watching trailers and playthroughs, recommendations from friends. However, it had not been previously shown whether the players' perception specifically of adaptive features changes their opinion about the game, their performance, and their gaming experiences.

The qualitative data gathered indicated that players also perceived the idea of having adaptive technologies in single-player digital games positively, which contributed to their increased immersion when playing a game with the feature (or even without it). Previously, the perception of fairness of adaptive features has been studied in multiplayer games, while our research here provides additional contributions to the knowledge about players' perception of this technology in single-player games.

This research also provides empirical evidence which supports the claim that adaptations in digital games, even simplistic, can enhance player experience in single-player games, as also mentioned by (Hunicke, 2005). This effect appears to be durable beyond the first few minutes of play and the adaptations implemented in the games were generally received positively by players with different expertise levels.

We, however, are not suggesting that digital games creators should not implement adaptive features in their games. Instead, the findings should be used as a supporting evidence for the idea that the players' expectations, when met, can positively influence gaming experiences of players. These expectations should be nurtured not only solely through the effective game mechanics, but also via a realistic and truthful explanation and advertisement of these features.

8.1. Implications

This work has various implications for several areas of research from both academic and industrial points of view. These findings provide further insight into the theoretical understanding of immersion and contribute towards the development of an immersion model. According to the definition of immersion by Jennett et al. (2008), cognitive involvement is one of the five factors that contribute towards the feeling of immersion. Interestingly, cognitive involvement was consistently higher for those players who believed that they played games with adaptive technology, and it was the only factor that was consistently observed in both studies to change, alongside immersion, as a result of the information manipulation. This could be due to the fact that what players know about a digital game feeds back to their cognition of the experience: players think about the gameplay more and possibly analyse their play according to this knowledge. This was observed in the qualitative responses gathered at the end of these sessions: players frequently mentioned how they tried to incorporate the adaptation into their game play, whether the adaptation was present in the game or not. Therefore, it is possible that players think about their actions in the game more actively when using this information during their game play.

Considering that cognitive involvement in this context means curiosity and interest, according to Jennett et al. (2008), it is evident that players who were told about the presence of adaptivity felt more involved with the game and, as a result, felt more engaged with it. As cognitive involvement is measured as a part of immersive experience using the IEQ, the difference in immersion scores was evidently related to the difference in the scores for this component. These findings contribute to our understanding of immersion and the factors it is dependent on: information about potentially beneficial features in the game leads to higher cognitive involvement of players as a result of their increased interest and curiosity.

Previous research in this area has focused primarily on exploring the effects of game features on player experience. While the effects of players' expectations and perceptions of these technologies has not received as much attention, it evidently contributes to these experiences, as demonstrated in these studies. Studying the expectations and perceptions of players can help researchers form more advanced understanding of gaming experiences, which in turn can help design and develop games that can be enjoyed by players with diverse previous experiences and personal skills.

This work has several important implications not only for the digital game user researchers who wish to reduce bias in their experiments, but also for game developers and testers. Any experimental investigation into the influence of new features in a game, such as adaptive technologies, on player experience must be made carefully, without any opportunity for players to second guess what the investigation is about. For example, a study in an artificial intelligence lab that uses an existing game may trigger the expectation of 'something good'. The mere expectation of a difference can be sufficient to change the experience. This becomes even more challenging in the context of play-testing where surely players called in for play-testing must be expecting something new even if it is not explicitly communicated what. As this work suggests, players are able to experience features in the game when told about their presence, even if the game does not provide this functionality.

When playing digital games, many players rarely look beyond the game world they directly interact with. Procedural generation of levels and content, e.g. (Hendrikx et al., 2013), as well as teaching AI to behave more naturally, e.g. (Lidén, 2003), are some of the most widely researched topics in digital games research nowadays. The general assumption is that these technologies improve our experiences of playing games. However, as more complex systems are being developed, players are not always able to objectively say if the technology is improving their game play or it is their own perception that affects their experiences.

Deceptive adjustment of features has been proposed as a design suggestion previously. van Dijk et al. (2016) suggest that due to players' interpretation of their own performance and results, it is possible to use ambiguity to personalise visualisations of one's personal informatics data. Colusso et al. (2016) explored the concept of closeness to increase players' performance in a digital game by adjusting the visual representation of their performance in such a way that the player's scores appear closer to the comparison target. Similarly, Bowey et al. (2015) manipulated leaderboards in a game to induce the sense of failure or success in players. This kind of deception encourages competition, and as Bateman et al. (2011) and Klarkowski et al. (2016) demonstrated, players enjoy games more when the level of skills and challenge as perceived by the player is higher than the subjective difficulty offered by the game.

The effect of deception does depend on the context in which it is used. In design of persuasive systems deception has to be subtle. As Adar et al. (2013) point out, benevolent deception could enhance one's experience as long as the user is not aware of such functionality. This could be applied to designing serious games for behaviour change and educational purposes, where players' skills and behaviour could only be manipulated using deceptive functionality if it is hidden from the user. On the other hand, this work demonstrates the opposite effect: explicit information about adaptive features does have a positive effect on players. It may be that in the context of serious games, such adaptations are seen to be "sneaky" ways to influence people whereas in the context of mainstream games, such adaptations may be seen to be fair ways to provide a good game.

The boundary between an ethical use of deception in design and marketing and unethical and illegal use is, however, rather blurred. While designing a system that encourages players to perform better in a digital game is within the acceptable ethical norms, deceiving players into purchasing a digital game by claiming that the game has features it does not come with would be malicious and would certainly damage the reputation of the game and the developer. This work was aimed at exploring the effects of information about the game on player experience, with the intention not to encourage false advertisement. Instead, the goal was to explore whether information about certain features could impair the experiential improvements that the features are intended to provide. Incorporating benevolent deception in designs of serious games could have a great potential. However, with regards to marketing of digital games, this kind of deception could be rather questionable.

8.2. Limitations and Future Work

While research described in this paper provides evidence to confirm or reject the explicit hypotheses, it leaves other alternatives open for continued research which is outside the scope of these studies. To gain further insights into how players' perceptions of adaptive technology changes their gaming experiences, we propose exploring the effect of in-game suggestions about the presence of the feature, as opposed to the explicit information, as used in the context of this work.

Curiosity could be invoked in different ways to the ones explored in this paper. The information players were given about the adaptation in the game was neutrally and generically phrased. Depending on the phrasing of the information about the game and its features, certain other components of immersion could be studied as well. For example, a more subjective description could be used to evaluate how players' emotional involvement with the game is affected. Perceived challenge can be studied using information of different precision that focuses more on the difficulty aspects of the game and the skills of the player.

More research should be done to explore other types of single-player games. Perception of narrative-driven games, as opposed to the games that test mostly players' dexterity, could potentially be different depending on players' expectations of adaptive technology. Similarly, games that require longer engagement, such as role-playing and strategy games, could lead to different experiences too.

Although the adaptations used in the studies lead to higher immersion in the games, they were somewhat simple. More rigorous research is needed in order to explore the effect of more sophisticated algorithms on gaming experiences of players in games that provide opportunities for longer engagement.

Finally, the durability of the effect of players' perceptions of adaptivity on immersion during a casual gaming session provided an initial insight into the nature of the effect. Ideally, more research is needed over longer periods of time and potentially over multiple gaming sessions in order to gain additional evidence for the claims.

9. Conclusions

In this paper, we examined how players' expectations of difficulty adaptation in digital games affects their immersion based on the accuracy and precision of information they know about the adaptation. Over two studies, with different games and different types of adaptation, we found that players consistently feel more immersed and enjoy the game more when expecting the presence of adaptation in a game, regardless of whether the adaptation is implemented in the game or not. In particular, telling players about an adaptation did not reduce the immersion that the adaptation itself brought about.

Moreover, varying the amount of information players were subjected to before playing the game led to different levels of immersion. Players felt most immersed in the game when provided with a more detailed description of adaptation implemented in the game than the players who were merely aware of its existence. Interestingly, even after being subjected to the game for longer periods of play, the effect of players' knowledge about adaptation remained, both when playing with the implemented adaptation and without.

The outcome of this work represents a contribution to the theoretical understanding of immersion in digital games. In particular, the results provide evidence that supports the notion of immersion not being solely dependent on the physical dimensions of video games. Players' expectations contribute to their experience of games too and, as seen in this research, this contribution is not always directly linked to the physical dimensions of the game. The mere expectation of a game feature that is perceived positively by the player is enough to increase immersion of the player.

This work also has some potentially useful implications for game developers, testers, and games user researchers with regards to the design of unbiased games evaluations and research studies into player experience. When evaluating games in experimental investigation into the influence of game features or while playtesting games, it is important to keep the language used to describe the game as neutral as possible to avoid players second guessing what the investigation is about. This work also demonstrates that even a casual reference to specific game factors could bias the results of playtesting and games user research.

In addition to the main focus of this research, our work also provides additional support for the argument that adaptive technologies in single-player games improve player experience, which could be of interest to game developers who seek to increase engagement of their players through balanced gameplay.

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Highlights

- Two game experiments using different kinds of adaptive difficulty adjustment (n = 180).
- Playing an adaptive digital game leads to higher immersion than playing the same game without difficulty adaptation.
- Players who believe that they are playing a game that is adapting its difficulty based on their performance feel more immersed than the players who are not aware of the feature regardless of the presence of this feature in the game.
- Players feel more immersed in the game when knowing about the adaptation regardless of the precision of information given to them about the feature prior to their engagement.
- The effect of information about adaptation on immersion is durable in a casual gaming session.