The Effect Of Surroundings On Gaming Experience

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ABSTRACT

Today, digital games are available on a variety of mobile devices, such as tablet devices, portable game consoles and smart phones. Not only that, the latest mixed reality technology on mobile devices allows mobile games to integrate the real world environment into gameplay. However, little has been done to test whether the surroundings of play influence gaming experience. In this paper, we describe two studies done to test the effect of surroundings on immersion. Study One uses mixed reality games to investigate whether the integration of the real world environment reduces engagement. Whereas Study Two explored the effects of manipulating the lighting level, and therefore reducing visibility, of the surroundings. We found that immersion is reduced in the conditions where visibility of the surroundings is high. We argue that higher awareness of the surroundings has a strong impact on gaming experience.

Categories and Subject Descriptors

J.4 [**Social and behavioral sciences**]: Psychology; K.8.0 [**Personal Computing:**]: General—*Games*

General Terms

Experimentation

Keywords

digital game, immersion, mixed reality games, lighting

1. INTRODUCTION

With the proliferation of easily portable computing power in the form of small tablets, smartphones and portable gaming consoles, gaming is able to move away from the fixed context of sitting in front of a television screen and into almost any context in which players find themselves. In many cases, the digital games are traditional games but played in a new context, for example *Need for Speed* and *Battlefield: Bad Company 2* have previously been played on console or pc but can now be played on iPhone/iPad. Further, basic digital games like *Tetris* or *Super Mario* have long been available on portable game consoles such as on Nintendo Gameboy. Clearly these games, amongst others, can be played almost any where at any time!

However, there are also increasing numbers of games that utilise GPS and cameras within smartphones and tablets to create mixed reality experiences. These games introduce the surroundings of the player as an explicit part of the gameplay. A notable success is *Zombies, Run!* but other games have enjoyed some success for example *SpekTrek*, *Parallel Kingdom* and *Can You See Me Now?*. The latter is a location based game that uses GPS, it is played by walking around a specific gaming area and involves avoiding other players. If other players are too close, you are caught and knocked out of the game. Another example is *Gbanga*. This game requires you to walk in the real world to collect virtual points–it also has been used in the Zurich Zoo for edutainment purposes. Such games are offering new gaming experiences and sometimes with ulterior motives: *Zombies, Run!* for example is intended to support physical exercise.

This new context of play provides a new variable on the experiences offered by digital games. Of course, playing digital games is all about the experience [15]. In some sense portable gaming may simply mean that the game can be played at a player's convenience, to pass an idle moment at a bus stop, say. However, existing research by Brown and Cairns [4] suggests that when players desire good gaming experiences, they tend to take control of their gaming environment in order to reduce their awareness of anything except the game. It is however, clearly impossible to take control of every context in which one might play a portable game, and this notion of control is somewhat at odds with the very essence of mixed reality games, in which reality plays such a crucial role.

The question is therefore: what is the effect of a player's awareness of their surroundings on the gaming experiences of digital games? There are many aspects of gaming experiences that are regularly considered both by gamers and researchers of gamers. These include flow, presence, immersion, fun and so on [7, 4, 2]. However we decided to focus on one particular aspect of gaming experience, immersion, that is known to be an important constituent of gaming experiences [4, 12, 20, 19] to allow a clearer picture of the effect of different gaming contexts on digital games.

So the refined purpose of the work reported here is to understand the effect of context on the immersive experience of playing digital games. We therefore report two studies: the first looks at the contrast between playing the same game in a mixed reality style as opposed to a desktop style; the second tries to take more explicit control both over the awareness of surroundings and the gameplay by controlling the lighting level in which the game is played. The results suggest that in both cases, decreased awareness of surroundings increases immersion, as might be expected. Of course, immersion is not the only reason players play games but it may be important in understanding how to take digital games into the wider world.

1.1 Mixed reality games in the mobile environment

Having a mobile version of a digital game is not as simple as it sounds. Issues include the effect of the mobile devices themselves on gaming experience. Mobile devices come in different sizes and shapes and therefore playing games on different devices produce different experiences. Thompson et. al [25] conducted a study to investigate the effect of different touch screen size on immersion. They argue that a different size of touch screen produces a different gaming experiences. They found that gamers are more immersed when they play with a bigger screen (iPad) size compare a smaller one (iPod Touch). This study was done by changing only the touch screen size, while the other attributes of the devices were similar.

Calvillo-Gamez et al. [6] argue that the control of a game is fundamental to good game experience, as without control no positive experience will possibly be gained from games. Indeed, control in games has been reported as an explicit aspect for good gaming experiences by gamers both generally [13] and in immersion specifically [4]. Therefore, it is important for designers and developers of games to consider designing better methods of control for mobile games. Clearly, the examples above describe some of the challenges occur in designing mobile games.

As designers and researchers are focusing their interest to attend to these challenges, the enhancement of technology allow "Mixed Reality" technology to be applied in the mobile devices. It combines both the real world environment and the virtual world in the gaming session. The emergence of this new form of gaming has been predominantly on mobile devices and mixed reality games often require gamers to physically walk around in the real world. Therefore, the current challenges of mobile gaming are merged with the new characteristics of mixed reality games. Unlike other mobile games, mixed reality games are not only a transformation of a traditional game onto a mobile device but it uses a different game mechanics for its gameplay, utilizing the novel collection of technologies found on modern mobile devices.

Mixed reality gaming is also not without its problems, one problems is that a player can be forced 'out of game'. In games played on a smart phone interface such as *Zombie, Run!*, the virtual content can only be accessed via the screen of a smart phone, however due to issues of practicality when navigating the real world, players cannot constantly view the screen and thus cannot access the virtual elements of the game. [26] reports this issue during a study used a mixed reality game, stating that the key element of the game was the connection between the virtual and the real game elements, and that "users actively searched for virtual content and would often find themselves "outside" the game experience when walking between locations.

Mixed reality games use augmented reality (AR), where the artificial objects are added on the real environment using the AR mediated tools, and augmented virtuality (AV) where physical world objects are added into a fully immersive virtual environment [24]. The enhancement of the technology provides a platform for new gameplay where it connects both the virtual and real environments.

Studies conducted by Jennett et al. [15] suggest that being increasingly immersed in a game would decrease one's ability to re-engage with the real world, the question now is what would happen to immersion if the real world surroundings were part of the game? Arguably immersion could increase because the whole world is now part of the game and so players are literally in the game or, it may decrease because the restrictions of the real world, and non-game related activity within it, distances people from the game.

2. CAPTURING IMMERSION

When we consider studies of the experience of playing digital games, there has been substantial research in to gaming experience from a variety of perspectives including the role of aesthetic factors [1], social context [10] and even narrative [20]. Immersion is recognised to be an important constituent of gaming experience. Colloquially, immersion is understood to be the sense of being "in the game". This is in a cognitive sense and it is a graded experience that represents the level of involvement with the game [4]. It consists of three stages namely engagement, engrossment and total immersion [4].

This formulation of immersion was operationalised by Jennett et al. [15] into a questionnaire, the Immersive Experience Questionnaire (IEQ). This was validated in a large scale survey as well as experimentally and has been used as a measure of immersion in a number of other studies, for example immersion and time perception, addiction and effect of touch screen size [21, 22, 25]. While immersion can be viewed as a unidimensional construct, in accordance with other research into engagement [3], the initial validation survey suggested five constituent components of immersion: Cognitive Involvement, Emotional Involvement, Real World Dissocation (RWD), Challenge and Control. Though distinguishable and could conceivably be manipulated separately by games, in practice they are expected to correlate and serve to help in interpreting the effects of experimental manipulations on the general experience of immersion.

Understandably there is interest in a range of phenomena, such as immersion, that relate to people's engagement in video games, like presence and flow, though these are clearly distinguishable concepts [15]. However, there are also other formulations of immersion specifically. Ermi and Mäyrä [9] suggest that gameplay and immersion in a game are multi-dimensional phenomena. They proposed a model called the SCI-model that represents the key elements that structure the experience which could be distinguished by the genre of the game. They identified three types of immersion: Sensory, Challenged-based and Imaginative. It also describes that all games consist of these three types of immersion but one of them has the strongest effect based on the type of the game. For example, the sensory immersion is experienced as particularly strong in the *Half-Life 2* game based on its design.

Additionally, they [9] state that digital games have evolved into three-dimensional (3D) stereophonic audiovisual worlds that surround their players in a very comprehensive manner, easily overpowering real world information causing players to focus entirely on the game. While Lombard et al. [17] found that larger screen sizes produced a greater sense of presence. Therefore, if sensory immersion applies similar mechanisms to presence, we can simply say that sensory immersion is similar to presence. However, this is not true.

However while one might assume immersion and presence are analogous concepts this is not the case. Presence allows people to to feel a sense of being in a virtual environment [23] where a player may feel they are in some sense actually located in the virtual world. Presence is distinct from immersion as some games simply do not offer a virtual world for the player to be present in (Tetris for example) and similarly players may feel present in a virtual world but not immersed in the activities they have to do there. The studies show how presence is affected by the mediation of the virtual environment but not necessarily by the task, whereas immersion is clearly influenced by the task that players engage in but it is not clear to what extent the mediation of the game influences immersion.

Recently [5] proposed a model called the player involvement model to explain immersion. He describes that immersion is caused by the aspects of the games which engage gamers while playing digital games. With six dimensions namely kinesthetic, spatial, narrative, shared, affective (emotional) and ludic involvements, immersion is argued to directly interact within these dimensions which then leads to incorporation, a richer account of gaming experience which is superordinate to immersion. With incorporation [5] a player is able to integrate (incorporate) the gaming environment into their conciousness and thus be incorporated into the environment as an avatar. This therefore suggests immersion then appears as a component of incorporation together with the sense of transportation (presence) into game environment. It also suggests that attention is shared across this model and changes in the games influence the type of involvement with the games.

However, the notion of incorporation is only concerned with the dimensions in the game. The model suggests that immersion is about the attention that moves within these dimensions. It also appears that immersion is only influenced by the elements and the components in the games. In contrast, the study about screen-size revealed that the different touch-screen size does influence immersion [25]. This result is hard to account for with the player involvement model [5]. This is because the model refers attention as being augmented within the games, but it does not include the external factors that might be affecting immersion.

Therefore, Study One was founded on the premise that if we bring the real world environment to be part of the game then immersion level should decrease. This is because the high visibility of the surroundings increases player awareness of their surroundings, thus, decreasing immersion. Study One did seem to indicate that this is the case but as will be discussed, it is not clear if such mixed reality games reduce immersion because the player's awareness of the surroundings is high, or because of other factors.

Considering the physical activities required to play the game and the high awareness of the surroundings in Study One, Study Two is founded on the premise that the lowest lighting level (dim condition) in the surroundings while playing digital games should increase immersion level. This is due to the lack of visibility of the real world and it helps to reduce the awareness of the surroundings. The result supports the hypothesis and also shows that the external factors are influencing immersion.

The work reported here then is to demonstrate that the immersive experience can be influenced by external elements which influence the mediation of the game. This will help to differentiate between the different accounts of immersions, in particular, supporting the SCI-model of Ermi and Mayra [9] and suggesting how the idea of incorporation [5] may be augmented to provide a better account of immersion. Also, we suggest several findings on immersion in mixed reality games.

3. STUDY ONE

3.1 Aims and Hypothesis

Engaging experiences cause people to be less aware of their surroundings. Similarly it has been found that people are not aware of their surroundings when they are immersed in the digital games [11]. Most digital games take place in a virtual environment in which gamers focus their attention as opposed to on their surroundings. In contrast, what happens to user experience in mixed reality games, where the real world environment becomes part of the game? Does it change immersion level? The aim of this study is to investigate the effect of introducing real world surroundings as part of a digital game, and the effect this has on immersion. Our hypothesis was that the immersion level would be lower for the mixed reality game because the player's visibility of their surroundings was high and thus they would experience less real world disassociation.

3.2 Participants

The total number of participants was 29, all of whom were from the Universidad Politecnica de San Luis Potosi, Mexico. All of the participants were recruited by opportunity sampling around the campus, and all were undergraduate students in the university. Of the 29 participants, 12 were female. 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 desktop and on iPad. On average, the participants stated that they played digital games at least once a week. All of them were counterbalanced and assigned randomly to either condition first.

3.3 Design

The experiment was a within-subjects design. The independent variable was the game implementation: the experimental group played the mixed reality version of the game on an iPad, whereas the control group played the game on a standard desktop PC. The dependent variable was the immersion scores gathered from the IEQ questionnaire [15]. To aid in interpreting the results, the five components of immersion were also separately considered with explicit expectation of a change in Real World Dissociation (RWD) because of its particular relevance in this context.

3.4 Materials

The device used for the mixed reality game was a first-generation Apple iPad. The screen size of the iPad is 250mm diagonally, with a resolution of 1024 by 768 pixels. A desktop computer with 21" monitor size (resolution 1366 x 768) used in the desktop environment. The game used was developed for this study. It ran as a native app on the iPad (rather than inside a browser). The game was called *'Catcha-Zombie'*. In this game, zombies ran across the screen and the player had to shoot them by touching their finger over it on the iPad, or using mouse click in the desktop environment to shoot the zombies.

The background of the game for the mixed reality version on the iPad was the real surrounding in the lab. Participants needed to move around with the iPad, the zombies would appear and they had to shoot by tapping the screen. In desktop environment, the background was created virtually and participants needed to use the arrow buttons to move around and mouse to shoot the zombies. This game suited this study due to the simple nature of its gameplay, requiring no prior gaming knowledge or experience.

A stopwatch from a mobile phone was used to measure the time taken playing the game. Immersion was measured using the Immersive Experience Questionnaire (IEQ), consisting of 31 questions related to game immersion. The questionnaire was translated into Spanish and uploaded as a Google form for participants to fill in online after they had played the game. There was also a short demographic questionnaire covering factual matters such as age, gender, occupation and participant gaming history, including frequency of play, average playing duration per gaming session and experience playing games using iPad. 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 with the same lighting conditions each time, and window blinds shut to avoid distractions.

3.5 Procedure

The experiment was conducted in the User Experience Lab, Centro de Nuevas Tecnologias (CNT) Building, Politecnica de San Luis Potosi Mexico. The lab was setup as a living room with complete furniture. A complete desktop computer was placed in one corner of the lab, and participants were observed through a glass window from an observation room. Each participant was tested individually in the lab.

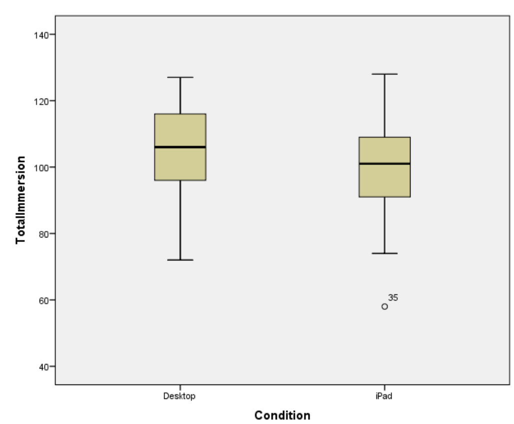
Participants were given a consent form to read and sign. They were then asked to sit at the desktop computer if they were in the PC condition. Whereas, they were told to stand up to allow them to move around for the iPad condition. A brief explanation and demonstration of how to play the game followed. Then the experimenter left to leave the participant alone in the room with the game. In the first session, participants were asked to play the game, whether on the desktop or iPad, and the next day they came again and play the game on the other device. To avoid any bias and learning effect, the order of play was fully counterbalanced. Once the experimenter left the room, the timer started. After seven minutes, the experimenter returned to the room and asked the participant to fill in the IEQ and demographic questionnaires online.

3.6 Results

Table 1: Mean (and Standard Deviation) for Immersion and Each Component of the IEQ in Both Conditions

	iPad	**Desktop**
Immersion	98.97 (15.14)	104.14 (14.05)
RWD	19.48 (5.12)	20.62 (4.75)
Emotional	18.03 (4.09)	19.62 (4.17)
Cognitive	32.48 (5.02)	34.41 (4.77)
Challenge	12.86 (2.83)	12.79 (2.80)
Control	16.10 (2.82)	16.69 (3.19)

Figure 1: The Box Plot of Immersion Score between Condition



To see if there was any effect of type of game genre on immersion, the total immersion score was calculated from the IEQ. Table 1 shows the mean and standard deviation for the total immersion score in both conditions. Using paired samples t-test from the SPSS 20 statistical software, the results were tested further to investigate if the difference was significant. The test shows that there was a significant difference in the scores for iPad and Desktop conditions, $t(28)= -2.104$, p =0.043. Using *Cohen's d*, the effect size was calculated with the d=0.395 indicates medium effect across conditions. Figure 1 shows the boxplot of the relationship between gaming environment and immersion level. 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 the participants and there was no effect ($t(28) = 0.664$, $p = 0.183$).

To test whether the real world dissociation (RWD) had an effect on the immersion score, the RWD component from the questionnaire [15] was compared between the two conditions. From Table 2 the mean (and standard deviation) for the immersion components score in both conditions are listed. There was no significant difference in RWD between the two conditions ($t(28) = -1.051$, $p < 0.05$). The other components were therefore further tested to see where the difference in immersion might be strongest. The tests show that there was a significant difference between the conditions on only in emotional involvement($t(28) = -2.087$, $p = 0.046$) and cognitive involvement ($t(28) = -2.221$, $p = 0.035$) though as these are multiple tests on the same data, they should be interpreted with caution.

3.7 Discussion

The results support our hypothesis that immersion is lower in the mixed reality 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 real world dissociation. Instead, immersion seems to be reduced in the level of emotional and cognitive involvement that players feel in the pervasive condition.

Mixed reality games increase the visibility of the surroundings and make the real world more visible. When participants move around with the iPad, they see everything in the surroundings and this increases their awareness of what is happening around them. The clear visibility and better awareness of the surroundings decreases their attention on the games. They are perhaps attending to the world around them as they play and though not noticing this (otherwise RWD would differ), it is taking the 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 [5], this study provides an insight that immersion could also be affected by the surroundings.

Moreover the nature of mixed reality games in comparison to PC games is different. Mixed reality gaming brings the real environment into the game and to play with iPad changed the whole gameplay. This is because, the input used to control the games are different, one with touch input and another is with mouse click, one uses physical movement, the other uses the arrow keys. Clearly, participants had to walk around with the iPad whereas those who play the desktop game just sit on a chair while playing game. In regards with this issue, obviously more physical activity is needed to control and play the game in the mixed reality environment. Thus, participants could be getting tired holding the iPad while touching the screen to kill the zombie. This then reduces their general level of engagement and immersion [4]. While the gameplay period was quite short and unlikely to cause fatigue but this cannot be ruled out. Therefore due to the different hardware used in each condition, in addition to an awareness of surroundings the issues affecting immersion in Study One may to related to control, or even screen size [25].

4. STUDY TWO

4.1 Aims and Hypothesis

Clearly, the physical action which is often required to play mixed reality games makes the gameplay different to PC games. We can see in Study One that compare the experience between both type of games is rather bias and difficult as one is completely different to the other. As our main hypothesis is focused on the awareness of the surroundings, in Study Two we decided to manipulate the awareness of surroundings in a way that did not alter how people played. We therefore looked to adjust the lighting level of the room in which players were. This draws on [4] 's finding that gamers prepare themselves and the surrounding before they started playing the game by turn off the light, increase the volume of the game to allow them to achieve immersion. It may not be just a ritual.of the interplay between an awareness of one's surroundings and immersion in digital games. We manipulated the lighting levels in the room from dim, neutral to bright. Based on the stereotypical gamers who prefer to play games in the dark, we argue that lighting levels affect the visibility of the surroundings and influence their immersive experience. The hypothesis for this study is immersion level decreases when the lighting level the room increases. Gamers would get less immersed in the bright room.

4.2 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, UK except for one participant who was a visiting research student in the department. Their age range was between 18 and 40 years old with a mean age of 25.52 (SD=5.57). In order to avoid gender politics and to reduce any uncomfortable situation between participants in a dark room with a male observer, all of the participants in this study were male. 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.

4.3 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 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 [15]. Participants were also asked to write down their estimation of the time spent in the session in minutes.

4.4 Materials

The experiment was conducted in the living room, of the HCI interactive home lab, Department of Computer Science, University of York, UK. 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 within the experiment. This game is about Mario's journey from one galaxy to another galaxy. The display used in this experiment was a 21" flat screen monitor and the distance from where the participant sat on the sofa to the display was 1.5 m.

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 maximum resolution is 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 started 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 ambience for participants and to ensure the atmosphere was similar to the home environment. The stopwatch function on a smartphone was used to measure the playing time. 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. Immersion was measured using the IEQ [15].

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, which were 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 game 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. During that time, the experimenter came into the room to inform participants when 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=1.67m). Playing duration lasted for 20 minutes. Participants were required to stop playing after 20 minutes and they had to complete the immersion and demographic questionnaires. They were also required to write down the time they spent playing for their session (the analysis of this data is not reported here).

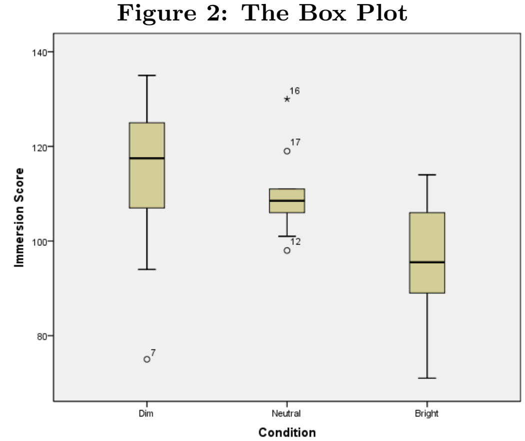
4.6 Results

To confirm that the experimental manipulation was having a significant effect on immersion, the immersion score was compared in each condition. Table 2 summarises the means and standard deviations for the immersion scores and each component of immersion in the IEQ for the three different conditions.

Table 2: Mean (Standard Deviation) for Immersion and each Component of the IEQ in Study 2

	Dim	Neutral	Bright
Immersion	113.30 (18.46)	109.80 (9.09)	95.00 (14.41)
RWD	23.80 (4.16)	22.90 (4.23)	20.00 (4.35)
Emotional	20.80 (5.73)	19.60 (2.63)	15.90 (4.15)
Cognitive	37.40 (4.97)	36.50 (4.93)	31.20 (5.55)
Challenge	13.50 (3.06)	12.20 (1.99)	11.70 (3.13)
Control	17.80 (3.33)	18.60 (2.32)	16.20 (3.12)

Figure 2: The Box Plot



As hypothesised, the mean for immersion score decreased as illumination increased. Figure 2 shows a boxplot of the relationship between lighting effect and immersion level. There is no *a priori* reason to exclude the outliers nor do they affect significance. Therefore, they are included in our analysis. A contrast was used to test if the change in means supports the directional experimental hypothesis. The contrast was highly significant, $t(27) = 2.821$, $p = 0.009$ which means that the hypothesis is supported by the difference in 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).

Relationship to components of immersion particular RWD in the IEQ was tested using contrast test to evaluate the trend relating lighting level and immersion and it does shows that the difference in RWD is approaching significance, $t(27) = 2.002$, $p = 0.055$. As this is not significant though, similar to Study 1, 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.

4.7 Discussion

This study shows a strong significant effect of lighting level 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 surroundings 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 them to prepare their gaming environment before playing. It seems then that in the 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. The use of a between participants design also rules out that participants were deliberately comparing conditions of play. This finding has some consistency with results in other contexts, for example in [8], drivers' vision is better when they receive sufficient light on the street 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 surrounding they are becoming more aware and less immersed in the game.

It may be that in the very bright condition, 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 the bright surroundings were not glaring or uncomfortable nor preventing them from seeing the screen clearly. It seems it really was awareness of the surroundings that was influencing their ability to become immersed. The only issue that we could not avoid in this study was to conduct the experiment with female participants. We can only conclude here that the level of brightness has a significant effect of mood among males. Males find themselves more relax and happier in the dim condition [16]. The result could be different if we consider female participants and how they become immersed in different level of brightness.

5. GENERAL DISCUSSION

Both experiments exhibit differences in immersion as a consequence of the relationship to the surroundings in quite different contexts. Overall, it seems that the immersive experience of playing digital games decreases if players are made more aware of the surroundings in which they are playing the game. It is also notable that this is not because of substantial change in their sense of dissociation (or not) from the real world as might be expected but rather as a change in their emotional and cognitive involvement in the game, at least as measured by the IEQ. In Study One, the input style, the gameplay, the different screen size, amongst others were the major confounds that could have influence the result. For Study 2 we learned from these errors and controlled all the possible confounds that could influence the result.

These two studies strongly indicate that whether players know it or not, they are always attending to their surroundings. It may be useful to demonstrate this explicitly. For instance, by introducing stimuli such as faces or interesting objects into the area around the players, to see if players are able to recall or recognise these stimuli once playing has finished. This corresponds to the work of [14] which showed that more immersed players were less aware of auditory and visual distractions when playing games. However, there, the games were substantially altered to influence immersion whereas it may be that the changes in lighting levels may simply have a generic effect on attention that does not result in increased processing of surrounding stimuli.

Turning to the theoretical accounts of immersion, this work perhaps supports the importance of sensory immersion in the SCI-model [9]. 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 large screen, 3D visuals and sophisticated sound systems aim to do. Interestingly though, the notion of incorporation [5] can't really account for the change in immersion described here as the experimental manipulation is entirely outside of the game. In Calleja's model though, incorporation has a certain amount of what he calls attention that is able to move between the different dimensions of incorporation but not simultaneously occupy all of them. Incorporation, then, is rather like a segmented bowl full of water. The water is able to move into the different segments in the bowl but the total amount of water does not change. We propose that immersion is the water, the quantity of attention that is filling the incorporation model and that the external influences are able to increase or reduce the total amount of water in the bowl. Just as a dry, hot environment causes water to evaporate, well-lit surroundings cause immersion to evaporate from the game.

Further work is needed to better relate these different accounts of immersion in digital games. These could draw on specific dimensions of the different models and see if they can be demonstrated to be influenced by different factors in different ways. Ideally, the goal would be to produce a unified account of immersion that covers the concerns and emphases of all the different existing models. It is interesting to note that the results of these studies are not able to directly inform game design but rather the design of game spaces which are largely outside of game designers' remit. However, it does suggest that systems such as ambient lighting which is now appearing on televisions, may be able to significantly enhance immersion and possibly other aspects of the gaming experience if used well. It may also be worth considering what other aspects of the surroundings games might influence for instance the use of scents which are known to have a strong link to memory and mood [18]. These are currently, at best, emerging developments in games but this research suggests they could have important implications in the design of game technology.

6. ACKNOWLEDGEMENTS

We would like thank to the William Gibbs Trust for the award sponsoring the research trip to Universidad Politecnica de San Luis Potosi (UPSLP), Mexico. Also many thanks to Nurul and Ishak for the support.

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