BA (Hons) Computer Games- Modelling and Animation

In Game Lighting: Does Lighting Influence Player Interaction and Emotion in an Environment?

2015-2016

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ACKNOWLEDGEMENTS

It is a pleasure to express my deepest gratitude and thanks towards my supervisor, Mr Rob Berry, Programme Leader of Computer Games Modelling and Animation at the University of Derby, for his constant support, guidance, constructive criticism and understanding throughout my study and research, without which this work would not have been possible.

I would also like to extend my gratitude to my teachers who put their faith in me and pushed me to do better and believe in myself.

I am extremely thankful to my mother and father, Mrs. Paula Millington and Mr. Michael Millington for their unceasing support and unconditional love throughout my academic years, I would not have been able to complete this without them, I am truly grateful for your love.

It is my privilege to thank my friend and soul mate, Mr Steven Davies for his constant encouragement and being my main source of motivation by always believing in me.

Finally I would like to extend my appreciation to the rest of my family and everyone who helped me along this journey, including the participants who gave their precious time to aid in this dissertation.
1. Introduction

Lighting is a major element to consider when creating games; it has the power to impact the gameplay experience. Light is mainly used to illuminate a scene but altering the colour, intensity, placement and dynamic or static properties of the lighting can affect a player’s mood and even influence their decisions in the environment. Lighting in games can direct players down specific routes, set atmospheres for the environment and even force certain feelings onto the player. However if these properties are used incorrectly it can cause confusion to the players and affect the gameplay experience.

1.1 Project Description

Colour psychology is the study of how colour can influence individuals; colour can send messages influencing mood and opinions of individuals. Companies utilise colour psychology studies when creating adverts for products, identifying which colours are associated with which emotion and what message they wish to send out with the product and to what target audience. “Younger individuals are attracted to bolder, brighter colour palettes whereas older individuals are attracted to softer, duller colour palettes.” (Kaminska, 2014). By understanding how different individuals react to various colours, the information can be utilised to create engaging game play experience, helping players feel connected to the game with various emotions taking them on a journey.

1.2 The Theory

In-game Lighting: Does Lighting Influence Player Interaction and Emotion in an Environment?

If the lighting colour, intensity and whether the light is static or dynamic, do these properties influence a player’s mood? Do these properties help encourage player’s down particular paths?

1.3 Plan

This study aims to determine whether lighting has a fundamental role in game environments influencing player decisions and emotions, this can be achieved by researching colour and its effect on individuals with different cultures, gender and age, colour intensity and placement of in-game lighting to set certain moods and direct players through an environment influencing their decisions.
The purpose of this study is to examine how light colour, intensity and static or dynamic properties affect player mood and decision-making. If the conclusion proves correct this can push future games to focus on lighting to direct a player encouraging them to make certain decisions or even feel certain emotions. This could also be useful for specific genres of games such as horror where lighting will be a key element to invoke fear and uncertainty.

1.4 Significance of the Study

If game developers and artists can fully understand how lighting influences player’s moods and decisions in an environment, they can use this information to push players down particular paths or even project specific feelings and emotions onto the player in various situations, it will create a more engaging gaming experience.

1.5 Definitions:

- RPG- Role-playing game
- FPS- First-person shooter
- 3D- Three-Dimensional
2. Field and Literature Review

2.1 Literature Review

Lighting was rarely considered a major element in game design; it was either used minimally and was highly unrealistic (The Making of Doom 3, 2010) or overlooked completely as game engines were not able to handle the process. Over the years, recent studies regarding lighting, exploring how it can affect human behaviour and emotion, has also allowed game designers to incorporate some of this information, to create a more realistic experience and solely using lighting to not only illuminate the scene, but attempt to invoke fear or safety into players mainly in horror genre games. Understanding what effect various lighting situations have on people of different ages, gender and cultural background can give game designers enough information to decide when to use specific lighting situations to enhance player emotion or force player decisions throughout an environment, creating a much more engaging experience for players not only in horror genres but all genre of games (Brownmiller, 2012 and Alotto, 2007).

2.2 In-game lighting and its effect on player behaviour and decision-making

(Joy Brownmiller, 2012) Explores how lighting can be employed as a solid source of guidance in games by researching the lighting and dynamic tension, studying its effect on player behaviour and their decisions. The purpose for this thesis was to determine whether lighting placement, brightness and colour could affect a player’s decision through an environment. For the testing process, the author selected participants mainly from within Guildhall University but ensured various ages, genders, and races, the only exclusion was that of participants under the age of 18. Participants were split into multiple categories such as male or female, 18-24 and 25-35 to determine how effective different lighting scenarios are in guiding the player through the environment (Brownmiller, 2012). The author tested the effectiveness of these scenarios by creating six different areas making up an entire level, each area offered multiple path choices to the play each with different lighting, for the data collection the author used a mixed method approach, prior to testing participants filled out a general demographics survey, the author observed each playtest in a controlled environment and after the testing participants filled out a short survey regarding path choices.

Although this study explored methods of guiding a player through an environment with lighting, it did not explore the various colours and how they can have an effect on players with different cultural backgrounds or how individuals perceive certain colours and their
influence, this is important to understand how players react to specific colours as it could be used to invoke fear or safety and be used as player guidance through an environment with these emotions. This study also used basic participant selection and the author states in the conclusion for future work expanding on this topic they’d suggest expanding testing groups to generate a wider range of results which are more effective and reliable.

2.3 Colour in advertising, marketing and design

Colour is powerful and can change mood, advertisers and designers are fully aware how colour can impact various people. (Kaminska, 2014) discusses how disagreements in the perception of colours can depend on an individual’s origin, age and gender. For example, Kaminska states vivid and bright colours are popular amongst younger individuals whereas older people feel more comforted by softer shades and colours. An example of colour perception being affected by origin, In Poland the colour of death and mourning is black whereas in India it is white. Another example, in England red is perceived as a threat or dangerous although in China it is perceived as celebration and happiness. Kaminska also groups colours together categorising warm bright colours, cold bright colours, cold dark colours and so on, each category induces different moods, for example warm bright colours induce a sense of courage and energy. Many companies study colour for advertising their products as it is the first noticeable feature in an advert and has to send the correct message out. (The Psychology of Colour in Advertising, 2013) explores the sub-conscious associations people make with colours in specific situations, for example blue is sub-consciously associated with trust and power. This is demonstrated with various companies such as Dell, JP Morgan, Nasa and American Express. A brief example was shown where the colours of a banking logo were swapped from red and white to pink and yellow to demonstrate that colour is vital for advertising, individuals would be less likely to entrust their savings to a bank with a logo showing bright pink and yellow colours as it is not sending a positive message, whereas when the original red and colour logo is used, individuals are more likely to receive a positive message, red may signify danger in some situations but can be used to project a good effect, red can be a bold colour that shows passion and strength. This is important as it demonstrates how various individuals respond to colours and what associations are made for each colour, thus can be utilised in games of specific audiences to create desired moods.
2.4 The beginners guide to colour psychology

(Wright, 1995) Argues that colour is not taken seriously enough and the author explores what colour is, how colour affects us and also discusses about its influence on behaviour and mood using discoveries and research she has collated over the past years to back up her arguments. The author of the book conducted studies by selecting four groups of colours and four adjectives and each time, participants of all ages, genders and race would be asked to choose which group of colours best captured the group of adjectives presented. The study proved to be successful and the results were overall 77% agreement with the Wright theory. The information provided in this book is important because it associates each colour with specific adjectives and emotions that the author has tested and received successful results, proving people of all ages, race and genders are most likely to feel the same emotion when presented with a colour, which means having a better understanding of colour can be used by game designers to incorporate this for guiding players through environments, using ‘safe’ colours that are calming or even using ‘dangerous’ colours to invoke fear and warn of danger which will create a more engaging and captivating gameplay experience.

2.5 Dynamic lighting for tension in games

(Zupko, J., Almeida, P., Knez, I., Niedenthal, S. and Seif El-Nasr, M. (2009) created an article for the International Journal of Computer Games Research, discussing the effect on game aesthetics using dynamic lighting in 3D environments. The purpose of this article is to explore different lighting patterns and the tension these patterns can produce, mainly looking at film and theatre where these lighting patterns have been exhibited before then implementing them into game environments to create the desired tension, after the observations made in the article the authors identified twelve patterns, categorizing them as;

- Patterns that subject an audience to low contrast images follow by high contrast images (in terms of brightness contrast or warm/cool colour contrast) increase projected tension.
• Patterns that subject an audience to low affinity of colour (in terms of saturation/brightness/warmth followed by high affinity of colour, in terms of saturation/brightness/warmth) increase projected tension.

• Patterns that subject an audience to high contrast images followed by low contrast images (where contrast is defined in terms of brightness or warm/cool colours) releases projected tension.

• Patterns that subject an audience to high affinity of colour (in terms of saturation/brightness/warmth, followed by low affinity of colour, in terms of saturation/brightness/warmth) releases projected tension.

• Patterns that subject an audience to a long duration of high contrast or high affinity of colour (in terms of saturation/brightness/warmth) causes an increase in projected tension.

To test the effectivity of the research the authors conducted a study involving roughly 100 participants and used multiple laptops playing the same game, but one using the TDELE (Temporal dynamic expressive lighting engine) lighting and the other using static lighting, the authors noted that players who were listed as non-first-person shooters (FPS) loved playing the game with dynamic lighting, whereas participants listed as first-person shooters found the dynamic lighting disturbing and explained it gave them too much information which made the game easy, some noted the dynamic lighting game was aesthetically pleasing in comparison to the static lighting game and some participants commented that they saw the lighting as a method of portraying in game state information, nearly all participants stated they avoided areas and choice specific pathing due to the dynamic lighting and tension. The information discussed in this article is important, the identification of these lighting patterns which have been exhibited in film and theatre for creating tension now being implemented into game environments to produce similar tension for players. The authors reviewed the information from participants and noted that players were more likely to avoid certain areas and choose certain paths due to the dynamic lighting and the tension produced, although some players found it disturbing. Game designers can utilize this information to allow player manipulation through an environment generating a more engaging player experience, pushing players down certain paths.
2.6 Field Review

2.7 Until Dawn

This survival horror game, released in August 2015 by Supermassive Games, uses lighting to invoke fear into the player and force them down specific paths, according to Will Byles “The challenge for us was to get that same feel as film, to create a level of fear without just darkening everything down. Unfortunately, if something gets too dark, the game engine will try to brighten it and vice versa. We had to invent some new techniques to get around that.” (Byles 2015). As shown in the picture below, the orange lighting stands out from the plain blue scene drawing players focus in, not only does the colour of the lighting stand out but as the light is dynamic it may draw more attention from the player.

Figure 1: Dynamic light gives player a choice to carry on down the path or Investigate in Until Dawn.

\[4\text{http://guides.gamepressure.com/untildawn/gfx/word/354564813.jpg}\]
2.8 The Last of Us

This action survival horror game, released in June 2013 by Naughty Dog. Lighting is used to not only guide players through the environment but is also used as a gameplay mechanic. In various sections of the game players have to avoid spotlights, navigating through the environment and keep behind cover to stay safe from enemies, players have to plan and utilize the dark shadows to navigate their path through the environment safely without being caught by enemies. The game also pushes players to safely navigate through the environment instead of running through and attacking enemies by giving players minimal ammunition for weapons and players take significant damage from enemies, so stealth and planning is key to the game. “The developers created their own lighting engine to create such realistic lighting for the environment” (Howard, 2013). This game is important because it demonstrates realistic lighting can influence player decision making and path finding choices and can also affect player emotion making players feel on edge or under pressure.

Figure 2: The player hides behind cover before navigating through dark shadows avoiding enemies in The Last of Us.

http://guides.gamepressure.com/thelastofus/gfx/word/118427378.jpg
2.9 Dishonored

This stealth action-adventure game developed by Arkane studios, released in October 2012 again uses lighting as a gameplay mechanic pushing players to take the stealth approach and use the shadows to navigate various paths throughout the environment, taking enemies out one by one. Lighting is also used to create a tense atmosphere. (Mitton, 2012) “We went to Scotland and it enabled us to work with lights in order to use it to create a tense atmosphere.” (Le Baron, 2012). This game is important because it demonstrates the effects of lighting not only on a player’s emotion and decision making but also their path finding choices throughout the environment, using a tense atmosphere and shadows.

Figure 3: Lighting guides the player to the appropriate building in Dishonoured.

http://regmedia.co.uk/2012/10/15/dishonored_bethesda_3.jpg
2.10 Alien Isolation

This action-adventure game developed by Creative Assembly, released in October 2014 uses lighting to invoke fear and guide players through the environment, the game puts the player under constant stress being stalked by a xenomorph (alien creature) and the game being unscripted means that an attack can happen at any point, so players already start the game feeling rather stressed and nervous. The dynamic lighting and shadows invoke fear into the player and can affect decision-making, unsure whether to go down the path with dynamic lighting or no lighting. The lighting also helps players through the environment to get to each objective. This game is important as it demonstrates, in an obvious manner that lighting can influence player emotion and in doing so can also affect player decisions, as players will most likely seek out lighting to feel safe.

Figure 4: Player hiding but can see the shadow of the enemy in Alien Isolation.

http://s.pro-gmedia.com/videogamer/media/images/ps4/alien_isolation/news/41508_1_a990293971.jpg

2.11 Summary

In summary, level designers and artists are already using lighting as a game mechanic and also to portray a specific atmosphere in certain scenes. However, currently lighting is not a sole guiding force for the player it is only used as a simple hint of where the player should be going there are more solid guiding forces such as arrows in the environment and map locations on the players user interface. Advancements in technology have also completely changed lighting in game engines, as now they have much more settings and options to create
specific lighting instead of using lighting to just illuminate the environment. With more research and studies into this area, game designers can understand how lighting can affect a player’s mood or decision through colour intensity or brightness and level designers can then implement lighting as a guiding force to influence decision making as well as player emotion.

3. Methodology

Previous studies have proven lighting can affect human emotion and behaviour, which in theory can also influence decision-making as lighting can encourage a player to investigate an area or feel threatened by the area, avoiding the area and continuing ahead in search for a different path. It can also influence a player’s emotion making them feel threatened or safe using the lighting in the environment to create an atmosphere, using dimmer or brighter lights and altering the colours. Previous studies have not utilised the new lighting technology available which expands the use of lighting instead of just illuminating a scene, there are so many options available which can increase the effect on human behaviour. This information is important as it refers back to the original question and forms the base of this research: how can difference in lighting intensity, colour and dynamic in a game environment influence a player’s emotions and decisions in the environment?

This project creates small areas with multiple paths using the Unreal engine 4 (Epic Games 2012). Each area in the environment is just a small room with multiple path choices, each path with different lighting. The lighting varies in intensity, colour and can be dynamic or static which players navigate through choosing one path or another. Participants were presented with a consent and debriefing letter before participating in the test (see appendix c), then asked to fill in a demographics survey (See appendix a) before participating in the session, a series of questions asking age, gender and how many games played a week. Participants then had their actions observed whilst navigating through the environment level and after the session participated in a brief questionnaire (See appendix b) explaining path choices. The researcher collected and studied the data provided using IBM Watson analytics. Determining whether the results of the study answered the question proposed, analysing all of the data to find any correlations between the participant’s choices, age group, race and amount of games played as well as lighting.
3.1 Data

Participant selection

Majority of the participants were students at the University of Derby, three participants were not students. The participants were various genders, ages and races and all had various game experience. The only exclusion was that of participants under the age of 18.

Test setting

All of the sessions took place at University of Derby, in a small room designed for team meetings or individual work. The individuals played the level alone in the designated testing room to ensure no external interference took place and the participant could not ask for guidance or advice which kept the individuals choices more realistic.

Before the testing sessions took place, the level map and lighting were tested and verified to be working correctly. At the start of the session, participants were given the consent and debriefing withdrawal letter (See appendix c) to sign before being allowed to begin the session, once completed participants filled in a quick demographics survey (See appendix a) to categorise age group, gender and game genres individuals play the most, the demographics will be one of the main focus points as it will be easier to find correlations related to age group, race and gender in the results.

Participant’s only instructions once starting the session were to play through the level and go down whichever path they desire, but they cannot go back through a path once chosen as each path leads to the same area in the level. Once the participant finished navigating through the level and reached the end, individuals were then required to fill in a post-test questionnaire (See appendix b) to explain each decision made during the session, which will be a focal point in the results as it will be a deciding factor to go against or for this study.
Data analysis

The aim of producing all this data is to collect information on which participants felt repelled or attracted to certain pathways, if the lighting influenced their decisions and which participants chose random selection ignoring the lighting entirely. Information gathered from the demographic surveys allow this study to compare player decision with other players who are of the same age group, gender, race or even game genre experience. This information will help clarify whether players of the same age group, race, gender or game experience make similar choices or whether each age group has distinct choices, this can help game designers understand what audience to aim for when creating a game and keep in mind how lighting can affect these individual players in an environment.

3.2 Level Abstract

3.3 Quick summary

Eight small different areas make up the entire level, each area offers multiple paths to the player, each path has a different lighting setup, it does not matter which path the player chooses as the environment itself is not important, just the player decision. Players are informed before the test that each path reaches the same destination and not to worry about going back and trying different paths, I was hoping to implement blueprints to allow doors to close after the player has exited but unfortunately due to lack of blueprint knowledge I just used black doors with no collision so players could at least tell where they came from and to avoid going back down the same path.

3.4 Gameplay overview

Players navigated through an environment made up of small areas each with multiple path choices in which the player has to decide which path to go down, each path has different lighting. Players can choose which ever path they desire as both paths lead to the next segment in the level.

3.5 Major Elements

Each small area in the environment offers players multiple path choices each with different lighting, varying in colour as well as some being dynamic and others being static lighting.
3.6 Major Objectives

The only objective is for the participant to move through each area and reach the end of the level.

3.7 Technical Overview

Mission Location

Setting: Interior of corridors and basic rooms.

Time: Afternoon.

Season: Late spring.

Weather: Clear sky but sunny.

Mission Metrics

Play time: Around 5 minutes (depending on player speed).

Physical Area: 3200 x 2100 unreal units.

Characters: Player character only.

Visual Themes: Basic corridors and rooms, plain but nice.

3.8 Details

Theme/Mood

The level is set in a basic room with carpet and wallpaper but nothing of huge interest. The main focus of the player is on the decisions in each small area, what paths are chosen and why, the environment is not important at all.

Gameplay Mechanics

Prerequisite skills: understanding player movement in Unreal engine 4.
3.9 Visual references

Figure 5: Basic corridors and room concept

http://www.theemptyset.co.uk/images/bg-fitness.jpg
Figure 6: Basic room concept

3.10 Level Map

Figure 7: Level map

3.11 Data collection and procedures

Qualitative and quantitative data was collected via three different methods, participants were required to fill out a demographics survey before participating in the session to identify gender, age group and game experience, each participants session was observed thoroughly and participants once finished the level were then required to fill out a post-test questionnaire explaining each decision made in the environment.

3.12 Summary

To study the effects of lighting dynamic or static, colour and intensity on player’s emotions and decision-making, participant’s actions were observed thoroughly in a controlled environment to exclude any external interference or distraction. The participants played through a level with small areas, each with multiple path choices with different lighting scenarios on each path, to test the reactions and decisions with different lighting setups. The participant’s session was observed as well as taking the participant’s demographic survey and post-test questionnaire, this data collected can be analysed using IBM Watson analytics and can either support or go against this study.
4. Results and Analysis

Of all the data provided in the demographic survey only the participant favourite genre are used for analysis purposes, all data is analysed using the IBM Watson analytics.

Figure 8: Participant Age
Figure 9: Participant Gender
Figure 10: Participant Race

Figure 11: Participant Favourite Genres
4.1 Area 1

Figure 12: In game screenshot of Area 1 from player’s perspective.

Figure 13: Comparison of participant colour choice in area 1
Description

The first area in this map puts participants in a basic area with two doors leading to the next area, each door has a different light above it.
Results

The highest percentage was the Green light and the reason being 'safety', looking at the players who chose the green lit path and listing their favourite genre, there is not much correlation however I noticed action, horror and RPG, these genres could suggest the green lit path was chosen as horror games tend to be dangerous down red paths and players avoid the dangerous path, similar to action and RPG games.

Analysis

The players who did not choose the green path but chose the red path instead, their favourite genres again did not suggest much except the popular choice being adventure which could suggest the player chose the seemingly dangerous path for an ‘adventure’ this is justified by the reasons the individuals gave in the post-test interview, some stating they chose the red path knowing it is considered dangerous but wanted the gameplay from it. Reflecting on the literature review, colour theory (Wright 1995) explains how individuals are more likely to choose ‘safe’ calming colours instead of dangerous colours, which proves correct considering the greater portion of participants chose the green lit path.

Conclusion

Since people are conditioned to feel green is a safer colour and red as a dangerous colour it isn’t surprising that 54% chose to go through the green lit path, some participants picked up what the map was testing straight away so some individuals may have chosen to be different and walk down the red path purposefully. This area achieved the intended outcome with green being the popular choice for safety, game designers could take into account players will most likely follow the green ‘safe’ path when in a horror genre specifically, but will not take much notice of it in other genres such as RPG.
4.2 Area 2

Figure 16: In game screenshot of Area 2 from player’s perspective.

Figure 17: Comparison of participant colour choice in area 2
Figure 18: Comparison of participants who selected white path, favourite genre

Figure 19: Comparison of participants who selected black path, favourite genre

Description

The second area in this map is again a basic room with two doors to choose from each with a different colour light, both doors leading to the next area.
Results

Black is the highest result with 61% but there were two different reasons for choosing the black unlit path, one being a random decision and the other being to go down the dangerous route for more gameplay experience.

Analysis

The players who chose the black unlit path all seemed to favour the RPG, strategy and FPS genre, suggesting the unlit and eerie path would be a good place to find items in an RPG or FPS game as it is usually a path avoided. The participants stated in the post-test interview the reasoning for choosing the black unlit path was due to being aware of the danger but interested in the gameplay that could be there. Whereas participants who chose the white lit path seemed to favour horror and action which could suggest the player avoids the unlit path due to fear of danger and uncertainty.

Conclusion

While most participants chose the black unlit path, reflecting on the individuals favourite genres and noticing RPG is the highest, it is understandable why the decision was made as the individuals stated in the post-test interview the dark unlit path suggested interesting gameplay which would be most likely found in an RPG genre, where there are plenty of places to explore, including dim caves. Whereas with the white lit path, the favourite genres seemed to be action and horror, which suggests the player avoided the unlit path due to fear of awaiting danger. In the post-test interview a few individuals stated they preferred the natural light from the white lit path, which suggests it is more inviting than the unlit path. This result is interesting as it differed from my prediction of player’s choosing the lit path, the comments given in the post-test interview still prove that lighting can effect a player’s decision, the participants chose this path even though it looked dangerous but chose to proceed as they wanted more gameplay experience and to see if items would be available.
4.3 Area 3

Figure 20: In game screenshot of Area 3 from player’s perspective.

Figure 21: Comparison of participant colour choice in area 3
Figure 22: Comparison of participants who chose orange, favourite genre

Figure 23: Comparison of participants who chose blue, favourite genre

Description

The third area in this map is a basic room with two doors to choose from, each with different light colours but both leading to the next area in the level.
Results

Orange was the popular choice in this area with 69%, participants commented the orange lit path was much more inviting and ‘warm’ whilst the participants who chose the blue path felt it was a ‘safe’ route.

Analysis

Participants who chose the orange lit path all favoured RPG, FPS, horror and adventure genres and all commented saying the orange lit path was much more inviting than the blue path. Participants who chose the blue lit path favoured the RPG and action genre, majority of the participants who selected blue commented on how the blue path felt safer than the orange path. There isn’t much correlation in the data gathered for this area.

Conclusion

The orange path is the favoured choice with 69% however all the participants’ reasons on the post-test interview gave similar feelings towards the colours, participants stated orange felt warm and inviting and other participants stated blue felt trusting and safe. Previously in the literature review colour in advertising was discussed and these results have matched completely with the article, exploring what messages colours send to individuals. Proving that colours sub-consciously project certain emotions onto individuals. These findings could help game designers understand which colours project what messages to individuals and how to utilise them in specific situations. Participants were quite aware of what was being tested from the beginning of area 1 but after reaching area 3 some were a little confused as to what was being tested with such different colours being used, so the participants were thrown back into the deep end and not quite understanding what impact their choices would make.
4.4 Area 4

Figure 24: In game screenshot of Area 4 from player’s perspective.

Figure 25: Comparison of participant colour choice in area 4
Figure 26: Comparison of participants who chose purple, favourite genre

Figure 27: Comparison of participants who chose yellow, favourite genre

**Description**

The fourth area in this map is in a basic room with two different doors, each with a different colour lighting but both leading to the next area in the level.
Results

Purple is the highest result with 54% and yellow just behind with 46%, from the chart above you can see the colours are divided into reasons why the participants chose them, these colours were mainly chosen due to being favourite colours or a random selection.

Analysis

Participants who chose the purple lit path favoured strategy and adventure genres, whereas participants who chose the yellow lit path preferred RPG and horror genres. There aren’t many correlations in this data gathered although horror genre is more popular in the yellow colour suggesting as previously it is more warm and inviting than purple, which a few participants commented on in the post-test interview.

Conclusion

Although purple is the highest result with 54%, yellow isn’t far behind with 46%. There isn’t much correlation with the data gathered. However the favoured genre of the participants who picked the yellow path is horror, which suggests the yellow colour is inviting and ‘safe’, some participants commented on the post-test interview saying the yellow tone was more inviting. Whereas the participants who selected the purple path seemed to favour adventure and RPG genre which suggests that purple may be considered a little more exotic and exciting. Most of the comments on the post-test interview for this area were just participants selecting their favourite colour. However these results still support the aims in this study, the colours in this area participants chose because they ‘favoured’ that colour or found it inviting. This shows participants still feel influenced for the decision of which colour they chose, it wasn’t quite a random selection.
4.5 Area 5

Figure 28: In game screenshot of Area 5 from player's perspective.

Figure 29: Comparison of participant colour choice in area 5
Figure 30: Comparison of participants who chose flickering green, favourite genre

Figure 31: Comparison of participants who chose red, favourite genre

Description

The fifth area in the map has two doors both with different light colours, but one of the doors is a dynamic light which flickers on and off and the other light is static. Both doors lead to the next area in the level.
Results

The flickering green light was the highest with 54% and the red static light with 46%. The red static light had various reasons for the decision whereas the flickering green light had the same reason from every participant who had chosen this route, stating it was eye-catching and compelled them to investigate.

Analysis

The dynamic green light was quite popular among the participants, all stating that it was eye-catching and compelled them to investigate the path. Whereas with the red static light participants commented saying it was either a random choice, their favourite colour or to go the dangerous route and see the possible gameplay.

Conclusion

This area was successful as it demonstrates majority of players will feel compelled to go down the route of a dynamic light which grabs their attention, mainly out of curiosity. The dynamic lighting seems popular in participants who favour horror, FPS and strategy genres whereas participants who chose the static lighting favour RPG the most. These results support the aims in this study, this has definitely proved that dynamic lights influence participants more than a static light. Game designers could take some of this information into account when creating games to utilise static lighting, enticing a player and drawing their focus in to that specific route or area, it seems this lighting effect would work best in horror and FPS where players will be on edge and attentive.
4.6 Area 6

Figure 32: In game screenshot of Area 6 from player’s perspective.

Figure 33: Comparison of participant colour choice in area 6
Figure 34: Comparison of participants who chose flickering white, favourite genre

Figure 35: Comparison of participants who chose black, favourite genre

**Description**

The sixth area of the level has two doors each with different light colours, one is dynamic and flickers whereas the other light is static. Both doors lead to the next area of the level.
Results

77% of the participants chose the flickering white light path and only 23% of the participants chose the unlit path. The reasons given for participants choosing the unlit path were random and not sure. Participants who chose the flickering white path commented saying it grabbed their focus and compelled them to investigate the path.

Analysis

Participants who chose the flickering white light path favoured RPG and FPS genres. Participants who selected the unlit path favoured RPG. There isn’t much correlation with this data gathered, but judging by the reasons given by the participants on the post-test interview the white flickering light path was chosen because it was eye-catching whereas the unlit path was chosen at random and quite quickly.

Conclusion

In conclusion this area has been quite successful; it demonstrates again that dynamic lighting can be more eye-catching whereas the static lighting can easily be ignored, 77% of the participants were compelled by the dynamic lighting which is quite a high percentage. This doesn’t necessarily correlate with the specific genres but it shows that dynamic lighting can grab a player’s attention and encourage them to investigate the specific area which could push game designers to utilise this feature in future. These results support the aims in this study, this has definitely proved that dynamic lights influence participants more than a static light especially as this is the second area to have participants favour the dynamic light.
4.7 Area 7

Figure 36: In game screenshot of Area 7 from player’s perspective.

Figure 37: Comparison of participant colour choice in area 7
The seventh area of the level has two doors each with different lighting colours, one is a dynamic flickering light and the other is a static light. Both doors lead to the next area of the level.
Results

69% of the participants chose the flickering blue path and only 31% of the participants chose the orange static lit path. The participants gave various reasons for choosing the orange path such as random selection and it feeling warm and inviting. Participants who chose the dynamic blue path all commented the same reason, the dynamic light is eye-catching and they felt compelled to investigate.

Analysis

Participants who chose the flickering blue path favoured the FPS, action and RPG genres and participants who selected the static orange light favoured FPS. Again there isn’t much correlating data gathered, but like the previous dynamic light results, the post-test interview comments state the flickering light is much more eye-catching and pulls the player in and grabs their attention.

Conclusion

In conclusion this area has been quite successful; it demonstrates again that dynamic lighting can be more eye-catching whereas the static lighting can easily be ignored, 69% of the participants were compelled by the dynamic lighting which is quite a high percentage. This doesn’t necessarily correlate with the specific genres but it shows that dynamic lighting can grab a player’s attention and encourage them to investigate the specific area which could push game designers to utilise this feature in future. These results support the aims in this study, this has definitely proved that dynamic lights influence participants more than a static light especially as this is the third area to have participants favour the dynamic light.
### 4.8 Area 8

Figure 40: In game screenshot of Area 8 from player’s perspective.

Figure 41: Comparison of participant colour choice in area 8
The eighth area in the level has two doors each with two different colour settings, one is a dynamic flickering light and the other is a static light. Both doors lead to the end room of the level.

**Description**

The eighth area in the level has two doors each with two different colour settings, one is a dynamic flickering light and the other is a static light. Both doors lead to the end room of the level.
Results

69% of the participants chose the flickering purple path and only 31% of the participants chose the orange lit path. Again it is quite a popular choice for the flickering dynamic light instead of the static light.

Analysis

Participants who chose the flickering purple path favoured RPG the most and participants who chose the orange light favoured horror and adventure, like a previous area horror genre seems to find orange colours warm and inviting. Participants commented on the flickering light stating it is eye-catching and again pulls the attention from the player encouraging them to investigate.

Conclusion

In conclusion this area has been quite successful; it demonstrates again that dynamic lighting can be more eye-catching whereas the static lighting can easily be ignored, 69% of the participants were compelled by the dynamic lighting which is quite a high percentage. This doesn’t necessarily correlate with the specific genres but it shows that dynamic lighting can grab a player’s attention and encourage them to investigate the specific area which could push game designers to utilise this feature in future. These results support the aims in this study, this has definitely proved that dynamic lights influence participants more than a static light especially as this is the fourth area to have participants favour the dynamic light, which proves it is definitely influencing a player’s decisions in an environment.
5. Conclusion

5.1 Limitations

I encountered some limitations during the testing phase of this study, noticeably some participants could tell what was being tested and this could’ve generated unreliable results, this is mainly down to using a plain, empty environment to focus solely on colours. Another limitation was blueprint knowledge, I struggled to find tutorials on relevant blueprints to aid in making the doors close behind the player, physically stopping them from returning to the previous area. Unfortunately due to lack of blueprint knowledge I chose to make the doors black materials with no collision and no lighting, so the door was at least identifiable as the previous area and explained to the participants in the briefing stage, that the environment itself is not important and not to bother returning to the previous area as each path leads to the same area. Another limitation faced during this study was the lack of participants with varied race, having planned to gather participants with varied race backgrounds so the results reflect back to the literature review, confirming whether race affects an individual’s colour perception and whether this information can be used in future for creating games.

5.2 Recommendations for Future Research

Carrying on from the limitations of the study, during the testing it became noticeable that some participants could identify what was being tested almost instantly and this may have generated unreliable results. I tried to push players to focus solely on the colours instead of the environment by making the environment very plain and empty. For future research to overcome these limitations, I feel the lighting elements should be tested in a game environment where the lights are noticeable but not the only focal point and see if participants respond similarly. Future research could also include looking at using a game environment with multiple paths but using the ‘safe’ lighting on a path that visually looks dangerous and putting ‘danger’ lighting on a path that looks pleasant and recording how players respond, if they focus more on the lighting or the aesthetic of the path itself, this could generate interesting results. Another suggestion for future research is to try and collect participants with varied race, as stated previously in the limitations, I did not gather enough participants to conclude whether race determines different colour perception, this is important as in the literature review studying colour perception and psychology, it is suggested that race can affect an individual’s perception of colour, this information could be useful for game developers in future. Finally another suggestion which could be useful for future research, is different hues, these could influence individuals, as Kaminska discussed lighter tones being
calming and favoured by older people and brighter tones being favoured by younger people, so different hues could influence people.

5.3 Final Conclusion

This research tested a level with eight areas, two path choices in each area using a different lighting set up, to determine whether lighting can influence a player’s mood and decisions in an environment. The lighting set ups tested in the eight areas were different colours, intensity and varied in dynamic or static lighting. Out of the eight areas, six areas which equates to 75% returned results which support this study, where players went down the intended path. Only two areas, 25% returned results which didn’t support the study as players went down different paths instead of the intended path. This study not only defines success through whether the participants chose the intended path, but also through the reasons stated on the post-test questionnaires for choosing the specific path, majority of participants shared the same reasons for choosing a path which shows the lighting produced the desired effect on participants. In the two areas where players chose a different path instead of the intended path, the participants justified their reasons stating the colours chosen were warm, inviting and dangerous yet exciting for gameplay experience, even though participants did not go down the intended path, the colours of the other path still influenced them.

Overall, the study was relatively successful, majority of the participants chose the intended path and gave similar reasons regarding the lighting in the area to justify their decisions. Whilst participants did not all choose the intended path, nearly all participants shared similar reasons for choosing their paths, demonstrating that lighting can in fact influence a player’s decision and encourage them towards a path, which also reflects back to the findings in the literature review regarding colour psychology and how individuals assign emotions to specific colours. Dynamic lighting has proven to be relatively successful in encouraging players down specific paths, in every area that utilised dynamic lighting over 50% of participants chose the dynamically lit path and the other participants made random decisions. All participants stated the dynamic light was eye-catching and compelled them to investigate the path. Referring back to the literature review, the dynamic lighting for tension gives players in game state information and is more aesthetically pleasing, making it a popular choice. However the reason for the lack of success is due to scarcity of participants with varied race, which meant I could not determine whether colour perception changes according to different race or culture.
Another reason for the lack of success is due to a small handful of participants choosing paths at random, this could be down to participant’s gameplay style, as on the charts displayed in the results a lot of the players favourite genres are RPG’s which focuses a lot on exploration which could explain exploring impulsively through environments and down various paths, whereas some player’s prefer tactically planning which path is safer to venture through. However, game developers should take this information into consideration when designing environments, majority of players will seek out the path which is less likely to lead to danger and a handful of players will prefer to head explore the dangerous path for gameplay experience, it is important to cater for both groups.

In conclusion, this study has proved that lighting is fundamental and has the power to influence player decisions and emotions in an environment, intensity of the lighting didn’t seem to effect the player whereas dynamic lighting received staggering results and has the ability to encourage players down specific paths, but seems less useful in player’s who favour RPG games and prefer exploration as these players tend to brave the dangerous routes as well, in hopes of more gameplay and better items. Most players choose their paths through the environment based on the colours presented, leaning more towards the safe and inviting tones, although a handful of players prefer being adventurous and exploring the more ‘dangerous’ tones in hopes of finding better items in the game or exciting gameplay, which refers back to the literature review, colour in advertising, proving that individuals seem to have similar perceptions of colour and associate emotions with these colours, thus producing either good or bad reactions when presented with this colour in a game or advert. These findings suggest that lighting for emotion and decisions would be best utilised in horror, action and FPS genres instead of RPG and adventures genres, purely because the player will be more on edge and pay attention to small details such as flickering lights, light intensity and colour of the lights, using their perception of colour to determine which routes they deem safe and inviting. However it may not work as well in RPG genres as a handful of players seem to enjoy venturing down seemingly dangerous paths to search for exciting gameplay experiences like battles, or even to find better items. Colour palettes have been proven to influence a player’s emotion, using these specific colour palettes to project the emotions across, referring back to the literature and results, Kaminska discusses the feelings that are usually associated with each colour and this was reflected in the results of this study as well. Orange, green, red and blue were most successful influencing the individual’s emotion and even pushed the player to decide which path to choose based on these feelings. Game designers can take all of these points into consideration and utilise this information to create more engaging gameplay.
experience, whether it’s guiding a player through the environment using specific colours for the lighting and environment, also using various colours to portray an atmosphere in the environment or presenting a player with dynamic lighting grabbing their attention and encouraging them to explore down a specific route or area.
6. References


APPENDIX A: DEMOGRAPHICS SURVEY

What is your age group? (Circle one)
18-21  22-25  26-29  30+

What is your gender?
Female
Male
Prefer not to say

To which racial or ethnic group(s) do you most identify?
African American/African/Black/Caribbean
Asian/Pacific Islander
White/Caucasian
Hispanic/Latino
Native American
Other: ____________________
Prefer not to answer

What genre of video games do you prefer? (Circle)
Action
Adventure
First-person shooter
Simulation
RPG/MMO
Strategy
Survival horror
Sports
Other: ____________________
APPENDIX B: POST-TEST QUESTIONNAIRE

**Area 1**
Which path did you choose? (Circle one)

RED  GREEN

Why did you choose that particular path?

**Area 2**
Which path did you choose? (Circle one)

BLACK  WHITE

Why did you choose that particular path?

**Area 3**
Which path did you choose? (Circle one)

ORANGE  BLUE

Why did you choose that particular path?

**Area 4**
Which path did you choose? (Circle one)

YELLOW  PURPLE

Why did you choose that particular path?
Area 5
Which path did you choose? (Circle one)

RED  GREEN (FLICKER)

Why did you choose that particular path?

Area 6
Which path did you choose? (Circle one)

BLACK  WHITE (FLICKER)

Why did you choose that particular path?

Area 7
Which path did you choose? (Circle one)

ORANGE  BLUE (FLICKER)

Why did you choose that particular path?

Area 8
Which path did you choose? (Circle one)

YELLOW  PURPLE (FLICKER)

Why did you choose that particular path?
Dear Participant,

**BA Computer Games- Modelling and Animation – Participant Briefing and Consent Letter**

I am Sophie-Louise Millington and I am collecting data from you which will be used in my dissertation for In-game Lighting: Does Lighting Influence Player Interaction and Emotion in an Environment? As part of my BA Computer Games- Modelling and Animation at the University of Derby.

The objective of the dissertation research is to determine whether lighting has a fundamental role in game environments influencing player decisions and emotions. The information you will be asked to provide will be used to help to provide insights to achieve this objective.

The data you provide will only be used for the dissertation, and will not be disclosed to any third party, except as part of the dissertation findings, or as part of the supervisory or assessment processes of the University of Derby.

The data you provide will be kept until August 2017, so that it is available for scrutiny by the University of Derby as part of the assessment process.

If you feel uncomfortable with any of the questions being asked, you may decline to answer specific questions. You may also withdraw from the study completely, and your answers will not be used.

And, if you later decide that you wish to withdraw from the study, please write to me at Sophie-Louise Millington; s.millington4@unimail.derby.ac.uk no later than March 22nd 2016 and I will be able to remove your response from my analysis and findings, and destroy your response.

Sign your name here (the researcher)

I have read and understood the contents of this consent and briefing form, and freely and voluntarily agree to participate in this research.

I am happy to be identified as a participant in the research by my position at work (eg as a member of the executive committee).

Signed (the participant):

Please print your name: Date:
Dear Participant,

BA Computer Games- Modelling and Animation – Participant Debriefing and Withdrawal Letter

Thank you for agreeing to participate in my research, your help was much appreciated and I can confirm the following:

• The information I collected from you will be used in my dissertation In-game Lighting: Does Lighting Influence Player Interaction and Emotion in an Environment? As part of my BA Computer Games- Modelling and Animation at the University of Derby.

• The objective of the dissertation research is to determine whether lighting has a fundamental role in game environments influencing player decisions and emotions, and the data you provided will be used to help to provide insights to achieve this objective.

• The information you provided will only be used for the dissertation, and will not be disclosed to any third party, except as part of the dissertation findings, or as part of the supervisory or assessment processes of the University of Derby.

• The data you provided will be kept until August 2017, so that it is available for scrutiny by the University of Derby as part of the assessment process.

• If you later decide that you wish to withdraw from the study, please write to me at Sophie-Louise Millington; s.millington4@unimail.derby.ac.uk no later than March 22nd 2016 and I will be able to remove your response from my analysis and findings, and destroy your response.

Please do not hesitate to contact me if you have any queries relating to this study.

The contact at the University of Derby is the BA Computer Games- Modelling and Animation programme co-ordinator, Dave Voorhis who can be reached by telephone: +44 1332 591410 or email: d.voorhis@derby.ac.uk

Kind Regards

Sign:  
(Date):

Print Name: