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## Best Practices: Modulating Tension Using Contrast Lighting

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# Best Practices: Modulating Tension Using Contrast Lighting: Post-Mortem

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## Abstract

The goal of this thesis is to determine the best practices for modulating tension in a level through the use of contrast lighting. To test their theories, the researcher used variations of high and low contrast lighting when creating the artifact to elicit responses to tension from the player.

## Keywords

Tension, Contrast, Lighting.

## 1 INTRODUCTION

The researcher began this study with the goal of producing a list of best practices for designers showing how to use contrast lighting to modulate tension in their levels. The researcher created a single-player level named “Just Another Day at the Office” for *Dying Light (2015)* to test various methodologies and different uses of light in level design. After researching, the researcher compiled the following list of best practices to study:

- Presenting the player with high contrast lighting followed by low contrast lighting lowers tension.
- Presenting the player with low contrast lighting followed by high contrast lighting raises tension.
- Darkness creates tension by evoking feelings of threat and caution in the player.
- The less fill light that is used, the higher the contrast level will be.
- The more fill light that is used, the lower the contrast level will be.

## 2 RESEARCH

### 2.1 Tension

Tension has two definitions that are relevant to this study. First, “tension” is defined by the Cambridge Dictionary as “a feeling of nervousness before an important or difficult event” [1].

The second meaning of tension, in relation to games, is defined by Jared Mitchell, a blogger for Game Developer (an online resource for game developers around the world). Mitchell defines “tension” as “pressure that occurs when the player experiences a loss of resources, which may prevent them from accomplishing goals” [2].

### 2.1.1 Tension Curve

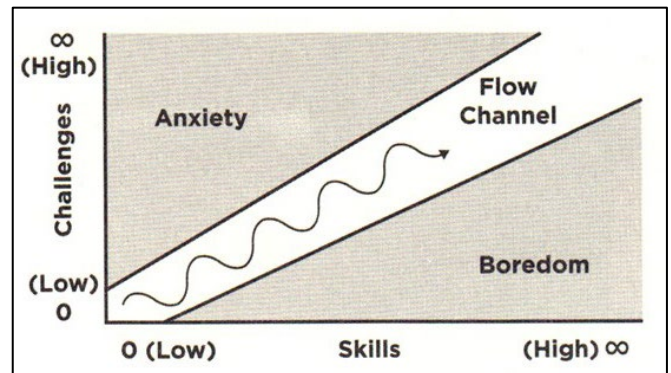


Figure 1: Tension Curve [3]

A certain amount of tension is needed to keep players engaged with a game, but there is a delicate balance between too much and too little. A tension curve explains the amount of tension that should be in a level/game as time goes along. In the center of the chart is the flow channel a.k.a. the ideal fluctuation of tension [3].

### 2.1.2 Flow

The concept of flow was first studied and coined by the psychologist Mihaly Csikszentmihalyi [4]. Flow is a state of mind characterized by the complete absorption in an activity to the point where the outside world no longer matters. It is a state of pure enjoyment, and people will perform the activities that enter them into the flow state just to do so because of that enjoyment [4].

## 2.2 Lighting

### 2.2.1 Contrast

Contrast is something that we encounter in our everyday lives, and it is defined as “the difference between the light and dark areas of an image” in film and photography [5].

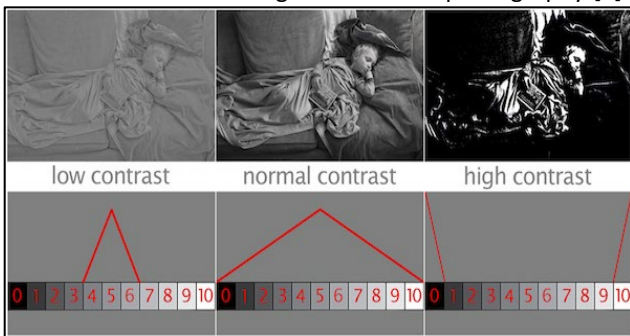


Figure 2: Contrast [14]

When hearing light and dark, most people may think of the shades black and white.

However, contrast can also be created by using color [6]. An example of contrasting colors would be orange and blue, or red and green [6].



Figure 3: Color Contrast [12]

Contrast helps our brains decipher depth and define shapes in our environment. When contrast is extremely low or extremely high, it is hard to discern where one shape begins, and the other ends.

### 2.2.2 Key-Fill Light Ratio

The key-fill light ratio of the lights in a scene directly affects the contrast levels. As implied, it is the ratio between the amount of key light in a scene and the amount of fill light in a scene [7].



Figure 4: Key-Fill Light Ratios [11]

### 2.2.2.1 Key Light

A key light is the main light source in a scene whether it be natural or artificial [7].



Figure 5: Key Light [13]

For example, there’s a room with a ceiling light and a floor lamp. In this context, the ceiling light would be considered the key light because it is the most intense light source, and it lights up the most area of the room.

### 2.2.2.2 Fill Light

A fill light is the secondary source of light in a scene (both artificial and natural) [7].

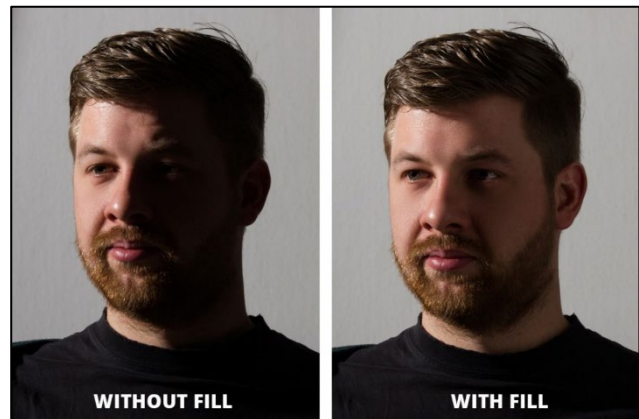


Figure 6: Fill Light [13]

Returning to the example above, the floor lamp would be considered the fill light. This is because it provides a lower intensity of light that does not cover as much area as the fill light does.

### 2.2.3 Contrast & Key-Fill Light Ratio

The key-fill light ratio and the amount of contrast of a scene are directly related to one another. A *high* key-fill light ratio will produce *higher* levels of contrast while a *low* key-fill light ratio will produce *lower* levels of contrast.

## 3 BEST PRACTICES

To build an adequate artifact to test their hypothesis, the researcher investigated the effects and uses of high and low contrast lighting.

From this research, the researcher discovered that low contrast creates less tension while high contrast creates more tension. Based on this, the researcher devised five best practices.

### 3.1 Best Practice 1 – High Followed by Low Contrast Lighting Lowers Tension

The first best practice is to take advantage of the fact that when a player is moving from a high to a low contrast area, their tension levels will lower [8]. Cinema has been using this, and similar techniques, for decades, and it can be applied directly to level/game design.

It is important to note that low contrast lighting is not restricted to well-lit areas. An area with dim lighting can be low contrast since contrast is based on the variation of light and darkness in the scene rather than how bright the scene is [5]. The researcher theorizes that with dim, low contrast lighting, the tension level would most likely rise. However, in relation to the first and second best practices, all examples and references to low contrast lighting are well-lit.



Figure 7: Example of Dark, Low Contrast [16]

Moving back to the reason why high followed by low contrast lighting lowers tension, this occurs because when in a well-lit area of relatively low contrast, the player can take in more information about their surroundings. They can differentiate between shapes and properly gauge the depth of a room. However, when the player is in a high contrast area, they cannot see everything clearly, so they lack information.

Therefore, as the player goes from high contrast areas to low contrast areas, they gain more information about their surroundings leading to less tension [8].

### 3.2 Best Practice 2 – Low Followed by High Contrast Lighting Raises Tension

Pulling once again from the film industry, the second best practice is to use low contrast followed by high contrast lighting to raise the amount of tension felt by the player [8].

As is mentioned above, the player receives more information about their surroundings when in low contrast areas. This leads to the player feeling more tension as they move into an area with less information available to them visually.

### 3.3 Best Practice 3 – Darkness Naturally Creates Tension and Feelings of Fear

Darkness is used in multiple ways in video games, and the way it is used often depends on the genre of the game. For example, in survival horror games such as *The Callisto*

*Protocol*, darkness is used to withhold information from the player [8]. Darkness is used in a different way in stealth-based games. In these games, the player actively utilizes darkness to progress and reach the goal [15]. However, for the purpose of this study, darkness is being approached in the same context as survival horror games.



Figure 8: Example Shot of Darkness Hiding Information from the Player in *The Callisto Protocol* [17]

For the third best practice, the level designer should utilize the player's innate responses to darkness. Humans instinctually approach darkness cautiously assuming there is danger within it [9]. This response from the player can be imitated by intentionally creating dark or high contrast areas in a level.

### 3.4 Best Practice 4 – The Less Fill Light, the Higher the Contrast

The key-fill light ratio is crucial to consider when lighting a space as it directly affects the contrast levels, and contrast levels in a space are tied to the amount of tension a player will feel. Because of this connection, the less fill light the designer uses in a space the higher the contrast will be, and the higher the contrast, the higher the tension [10]. This type of lighting is also known as low key lighting [18].



Figure 9: Example of High Contrast, Low Key Lighting [19]

This happens because the fill light is responsible for filling in the shadows created by the key light, therefore with less fill light the shadows from the key light are deeper, thus creating higher contrast.

Therefore, in practice, the designer should use less fill light in a scene if they want to create higher tension levels.

### 3.5 Best Practice 5 – The More Fill Light, the Lower the Contrast

On the other hand, the more fill light there is in a scene the lower the contrast level will be [10]. This type of lighting is also called high key lighting [18]. This means with more fill light the shadows from the key light are diminished. Thus, in practice, the level designer should use more fill light to create a scene with lower contrast to achieve lower tension levels.



Figure 10: Example of Low Contrast, High Key Lighting [20]

## 4 METHODOLOGIES

To put the best practices to the test, the researcher created a standalone level named “Just Another Day at the Office” for the game *Dying Light* (2015). In the level, the researcher strategically placed lights to create varying levels of contrast throughout exterior and interior spaces.

### 4.1 Establishing Ways to Test

The first step in designing the artifact was the consideration of different ways to test the effects of contrast lighting. The researcher concluded that they should test tension levels while the player is in a space and the fluctuation of tension levels as the player moves from one space to another.

### 4.2 Large Spaces with Consistent Levels of Contrast

In the first half of the exterior portion of the level, the researcher created one main path and two alternate paths. The main path has low contrast lighting, alternate path #1 has medium contrast lighting, and alternate path #2 has high contrast lighting. Designing this portion of the level this way, the researcher aimed to test player tension levels while in a space with consistent lighting and see the contrast’s influence on player decisions.

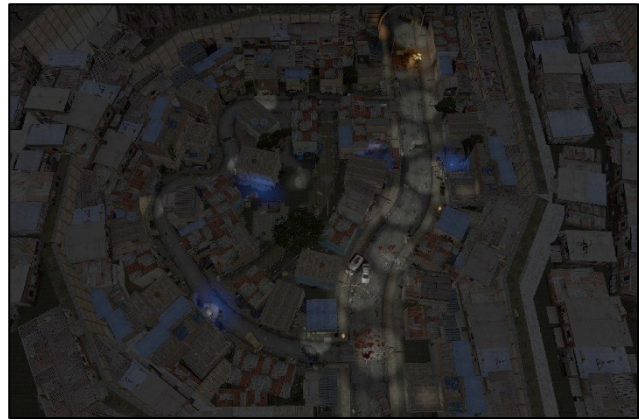


Figure 11: 1st Half of Exterior Portion of the Level [21]

In the second half of the exterior, the researcher created a smaller transitional space, with very high contrast lighting, that opens into a larger space with low contrast lighting. The researcher aimed to begin testing the fluctuation of tension levels as the player moved into one space from another when designing this portion.

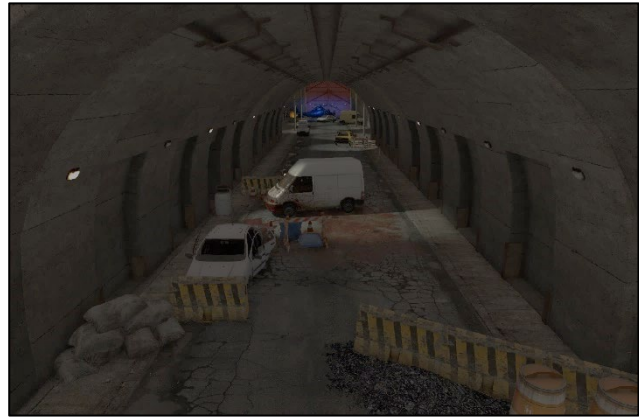


Figure 12: Transition Tunnel Connecting 1st and 2nd Halves of Exterior Portion of the Level [21]



Figure 13: 2nd Half of Exterior Portion of the Level [21]

#### 4.2.1 A/B Testing

Referring to the natural association of darkness with danger [9], the researcher made the difficulty/danger of each space the opposite of what, assumptively, the player would think according to its level of contrast.

In the first half of the exterior, the main path with low contrast lighting is the most dangerous (and difficult) while

the path with the highest contrast is the safest with very few enemies.

### 4.3 Small Spaces with Varying Levels of Contrast

In the interior space, the researcher did the same as in the exterior and provided the player with two paths. One path has low contrast lighting while the other path has high contrast lighting. This is the one space in the level where the player is required to make a choice between two paths. This design creates another chance for the researcher to see how players react when given the choice between choosing to go down a path with low or high contrast lighting.

Throughout the entirety of the interior space, the researcher created several hallways to specifically test how much tension the player feels as they see and move through areas with different levels of contrast.

On the first floor there is a focus on different contrast levels within the same room. The rooms and hallways/common areas on the first floor are also bigger than those on the second floor to achieve this.



**Figure 14: Large 1st Floor Common Area w/ Low to High Contrast Lighting [21]**



**Figure 15: Large Room on 1st Floor w/ Varying Contrast Levels [21]**

The second floor consists of maze-like hallways (short and long) that allow the player to clearly see the changes between high and low contrast. Some portions of the hallways are transitional while others remain at the same level of contrast.



**Figure 16: 2nd Floor Hallway w/ Contrast Levels Going from Low to High [21]**



**Figure 17: 2nd Floor Hallway w/ Contrast Levels Going from High to Low [21]**

Referring again to flow theory, it is important to keep the player from becoming overwhelmed [3], so the researcher created safe rooms (where the player can flee to and recoup) throughout the level.

#### 4.3.1 A/B Testing

For all the interior spaces, the researcher made the difficulty/danger level of each space relative to the player's natural association of tension with darkness.

Thus, the darker, high contrast areas of the interior have more enemies while the lighter, low contrast areas have fewer enemies.

## 5 DATA ANALYSIS

### 5.1 Data Collection Methods

The researcher gathered data on the effectiveness of their best practices by asking participants of the study to take two surveys: one before and one after playing the level.

#### 5.1.1 Pretest Survey

Each test session began with giving the tester a pretest survey. This survey helped to 1) ensure the participants were suitable for this study and 2) understand their previous experiences with horror games and tension. The second reason, in particular, helped the researcher to identify data points that were or were not outliers.

## 5.1.2 During Testing

### 5.1.2.1 Heart Rate Monitoring

Prior to playing, the participants' heart rates were taken at their resting rate to form a baseline. While each participant in the study was playing the level, their heart rate was being measured to quantify their tension levels.

### 5.1.2.2 Gameplay Recording

During the testing, each participant's gameplay was recorded. The time and date of the playtest, plus a stopwatch, overlaid the video to match the Fitbit data to each participant.

### 5.1.3 Posttest Survey

Each participant was asked to complete a posttest survey. The survey asked questions related to how tense the participants felt in 13 key areas of the level all with various levels of contrast. Each area was given a predicted tension rating between 0 and 10 (0 being not tense at all and 10 being very tense) beforehand to later compare with the results of the survey.

## 5.2 Survey Setup

### 5.2.1 Choice Between Paths

As mentioned before, the player encounters areas to make a choice between going down a path with lower contrast lighting or a path with higher contrast lighting. There are a total of 3 path choices the player may make.

### 5.2.2 Tension Levels in 13 Key Areas

To simplify the process of evaluating how much tension was caused by different types of contrast lighting, the researcher chose 13 key areas throughout the level to highlight in the survey. These areas include each path that the player had an opportunity to go down.

Each key area was given a predicted tension level from 0-10 (0 being not tense at all and 10 being very tense). This predicted tension level consists of a combination of two tension scales, one for lighting and one for enemies, each of which were on a scale of 0-5 (0 being not tense at all and 5 being very tense). The graph below shows the predicted tension rating for each key area.

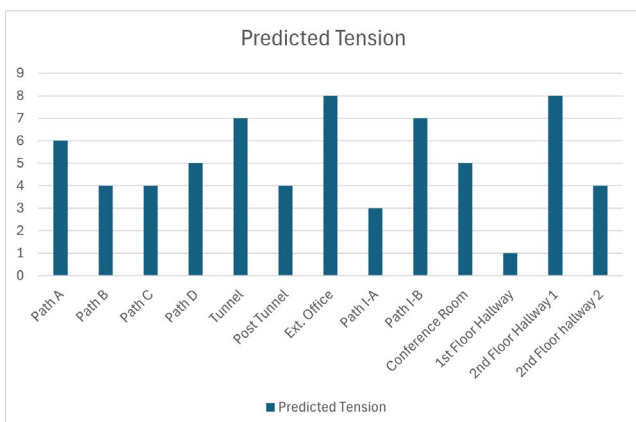


Figure 18: Bar Graph Depicting Predicted Tension Levels of 13 Key Areas [22]

### 5.2.2.1 Area 1: Path A

The first key area is Path A. The researcher assigned this area a tension level of 6: its tension level based on lighting is 1 (because it is very low contrast) and its tension level based on enemy presence is 5 (because it has the highest concentration of enemies in the exterior).



Figure 19: Path A [21]

### 5.2.2.2 Area 2: Path B

The second key area is Path B with a predicted tension level of 4. Because of its high contrast lighting, the half of the tension level based on lighting is 3. However, it has very few enemies, so it is rated a 1 on the tension level based on enemies.



Figure 20: Path B [21]

### 5.2.2.3 Area 3: Path C

Area 3 is Path C (which is further down Path B if the player were to choose it) and it has an overall tension level of 4. Just as with Path B, the tension level based on lighting is 3 and the tension level based on enemies is 1.



**Figure 21: Path C [21]**

### 5.2.2.4 Area 4: Path D

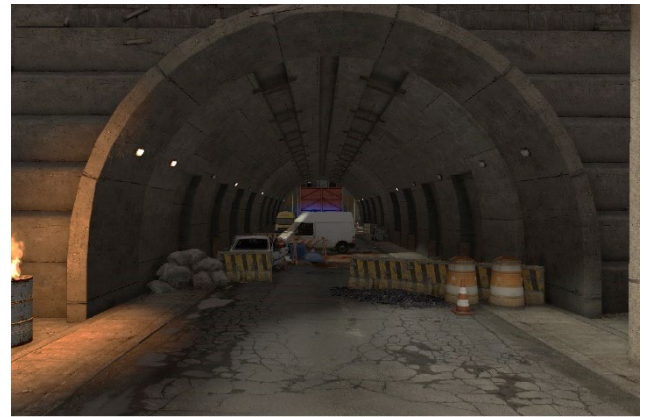
Area 4 is Path D which is the last path option tested in the exterior. It has an overall tension level of 5. It has zero enemies, so the enemy tension level is 0. However, it has very high contrast lighting, so its lighting tension level is 5.



**Figure 22: Path D [21]**

### 5.2.2.5 Area 5: Tunnel

Area 5 encompasses the tunnel that connects the two halves of the exterior. This area has a higher combined tension level of 7. Its tension level based on lighting is 3 because there is high contrast lighting in the center of the tunnel, but the lighting at the beginning of the tunnel's entrance is low contrast. The tension level based on enemies is 4 because there is a cluster of enemies that the player encounters.



**Figure 23: Tunnel [21]**

### 5.2.2.6 Area 6: Post Tunnel

The overall tension level for area 6 is 4. Because of its low contrast lighting the tension level based on lighting is 1, and because of the moderate number of enemies, the tension level based on enemies is 3.



**Figure 24: Post Tunnel [21]**

### 5.2.2.7 Area 7: Office Building Exterior

Area 7 is the exterior of the office building, and it has an overall tension level of 8. The lighting in this area is medium-low contrast, so the tension level based on lighting is 3. However, the concentration of enemies and difficulty of enemies is higher in this area, so the tension level based on enemies is 5.



**Figure 25: Office Building Exterior [21]**

### 5.2.2.8 Area 8: Path I-A

Area 8, Path I-A, is the first area in the interior portion of the level. Its combined tension level is 3. It has a tension



level based on lighting of 3 (because it is low contrast) and a tension level based on enemies of 0 (because there are zero enemies).



Figure 26: Path I-A [21]

#### 5.2.2.9 Area 9: Path I-B

Area 9, Path I-B, is the other path that the player can take upon entering the interior. Its combined tension level is 7. It has a tension level based on lighting of 5 because it is very high contrast, and the tension level based on enemies is 2.



Figure 27: Path I-B [21]

#### 5.2.2.10 Area 10: Conference Room

The conference room (on the first floor) has an overall tension level of 5. Its medium-low contrast levels give it a tension level based on lighting of 2, and the number of enemies gives it a tension level based on enemies of 3.



Figure 28: Conference Room [21]

#### 5.2.2.11 Area 11: 1<sup>st</sup> Floor Hallway

Area 11 is one of the hallways on the first floor. It has a combined tension level of 1 (the lowest in the entire level) because it has few enemies and very low contrast lighting (making the lighting-based tension level 0 and the enemy-based tension level 1).



Figure 29: 1st Floor Hallway [21]

#### 5.2.2.12 Area 12: 2<sup>nd</sup> Floor Hallway 1

Area 12 is one of two hallways highlighted on the second floor. It has an assigned overall tension rating of 8. It is very high contrast lighting, so the tension level based on lighting is 5, while the tension level based on enemies is 3.

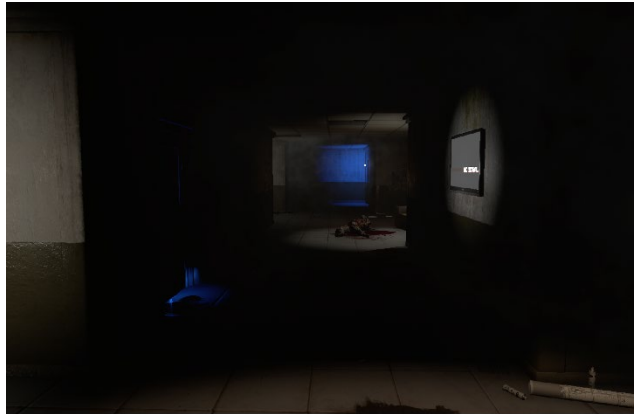


Figure 30: 2nd Floor Hallway 1 [21]

#### 5.2.2.13 Area 13: 2<sup>nd</sup> Floor Hallway 2

The final area is the second hallway highlighted on the second floor. It has a predicted tension level of 4. Both tension levels (based on lighting and enemies) are 2.



Figure 31: 2nd Floor Hallway 2 [21]

### 5.2.3 Open Response Questions

Throughout the survey, the participants were asked to explain why they gave each area the tension ratings they did. Participants were also asked to explain why they chose and did not choose to go down different paths. Finally, at the end of the survey, they were asked about the overall tension ratings in different areas. They were also asked to give their overall impression of high and low contrast lighting and how each type of lighting affected how tense they felt.

## 5.3 Survey Results

The researcher had a total of 15 participants in their study. However, two of the participants' tests were invalidated, so the following data is based on the remaining 13 participants.

### 5.3.1 Pretest Survey Results

All the participants in the study were asked basic demographic questions including: if they played video games, if they played horror games, if they've played any *Dying Light* games, and if they do play horror games, how tense they feel while playing them.

All of the participants are regular video game players, and the graph below shows how often they played.

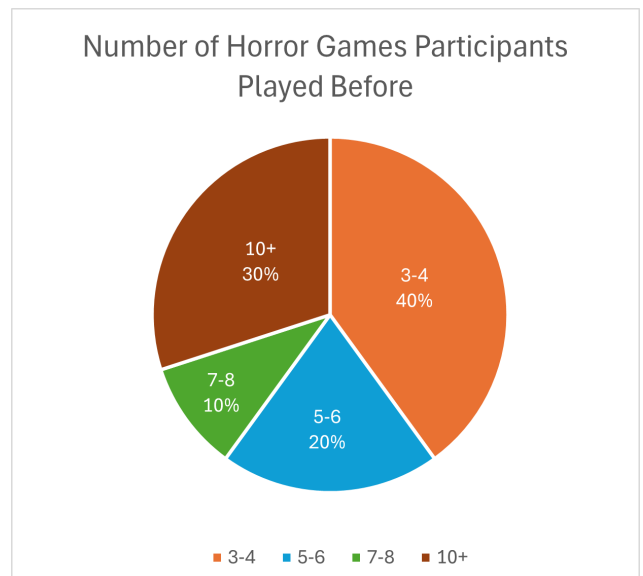


**Figure 32: Pie Chart Showing How Often Participants Play Video Games [22]**

Out of the participants, 77% (10) had played horror games before, while the remaining 23% had not. Of those who did play horror games, the number of horror games they played varied: 40% (4) played 3-4 games, 20% (2) played 5-6 games, 10% (1) played 7-8 games, and 30% (3) played 10+ horror games.

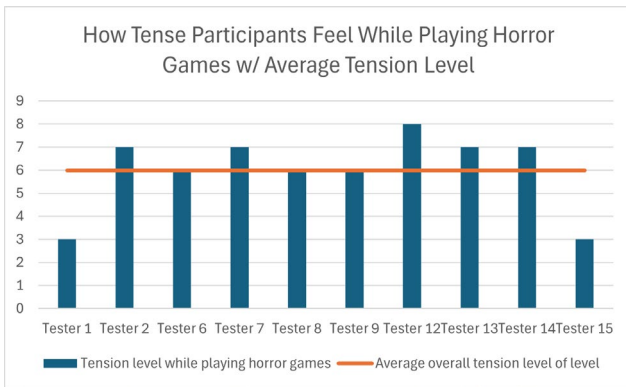


**Figure 33: Pie Chart Showing the # and Percentage of Participants Who Have Played Horror Games [22]**



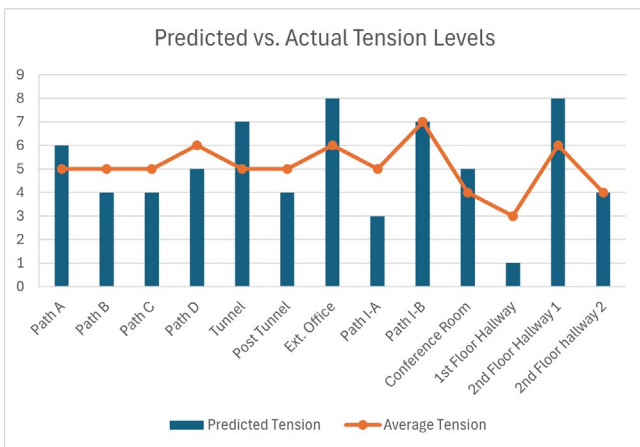
**Figure 34: Pie Chart Showing the # and Percentage of Horror Games Participants Have Played [22]**

The researcher also asked all participants at the end of the survey how they would rate the overall tension level of the game. The overall tension level of the game averaged out to be 6 on a scale of 0-10 (0 being not tense at all, and 10 being very tense). When compared to the data received from participants who had previously played horror games, the level's overall tension matched other horror games.'



**Figure 35: Bar Chart Showing Overall Tension Level of Level Compared to How Tense Participants Feel While Playing Horror Games [22]**

### 5.3.2 Tension Levels in 13 Key Areas



**Figure 36: Graph Showing Predicted vs. Actual Tension Levels in 13 Key Areas Throughout the Level [22]**

Above is a combination of two graphs: the blue bar chart depicts the predicted tension level of each area (which was shown earlier), and the orange line chart depicts the averaged tension level of each area based on survey responses.

#### 5.3.2.1 Predictions That Were Correct

Out of the 13 key areas, the researcher was able to correctly predict the tension level in two areas of the level: Path I-B and 2<sup>nd</sup> Floor Hallway 2.

In other areas the researcher was close to predicting the actual tension level. The predicted tension level was one value too high in the following areas: Path B, Path C, Path D, and Post Tunnel.

The predicted tension level was one value too low in the following areas: Path A and Conference Room.

#### 5.3.2.2 Predictions That Were Incorrect

The researcher grossly underestimated how tense the players would feel in 2 key areas: the 1<sup>st</sup> Floor Hallway and Path I-A.

On the other hand, the researcher grossly overestimated the tension levels in 3 other key areas: the Tunnel, Office Building Exterior, and 2<sup>nd</sup> Floor Hallway.

Some of the responses from the participants suggest that these predictions were off because of other factors the

researcher did not consider (mentioned in the conclusion section at the end).

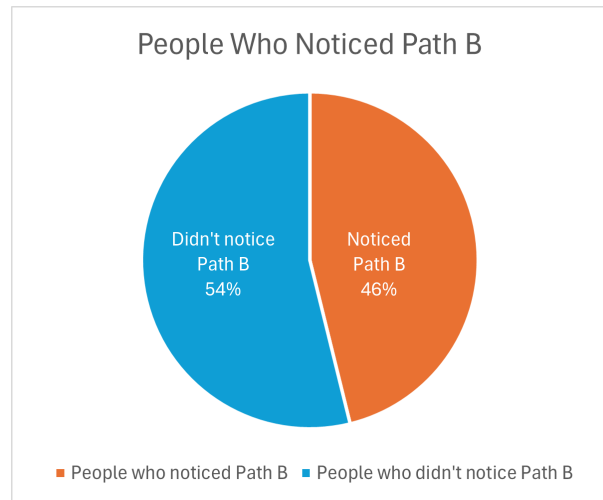
### 5.3.3 Low and High Contrast Paths

As the researcher predicted, the players more often chose to go down the paths with lower contrast lighting rather than the higher contrast paths. This remained mostly true regardless of the high contrast paths being less dangerous than the low contrast paths in the exterior (because of A/B testing).

#### 5.3.3.1 Path A vs. Path B

In the exterior, the lower contrast areas were more dangerous than the high contrast areas. Path A (also referred to as the main path) has very low contrast lighting, but it has a higher number of enemies. On the other hand, Path B (the alternate path) has high contrast levels with very few enemies.

Since the paths are optional, not all players went down each path. Another element to take into consideration is that not all players will notice the different paths. Just under half (46% or 6) of the participants noticed that there was a secondary path at the beginning of the level.



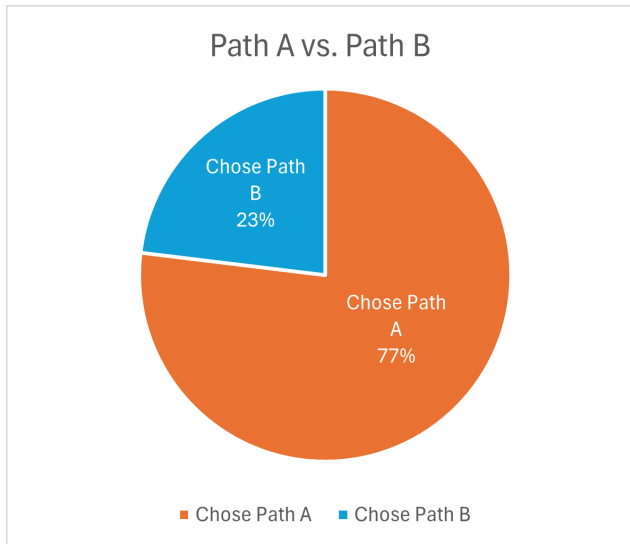
**Figure 37: Pie Chart Showing Percentage of Participants Who Noticed Path B [22]**

Of the 46% (6) who noticed Path B only 50% (3) decided to take the path.



**Figure 38: Pie Chart Showing Percentage of Participants (Who Noticed Path B) Who Took Path B [22]**

Overall, 77% of testers chose Path A and only 23% chose to go down Path B.

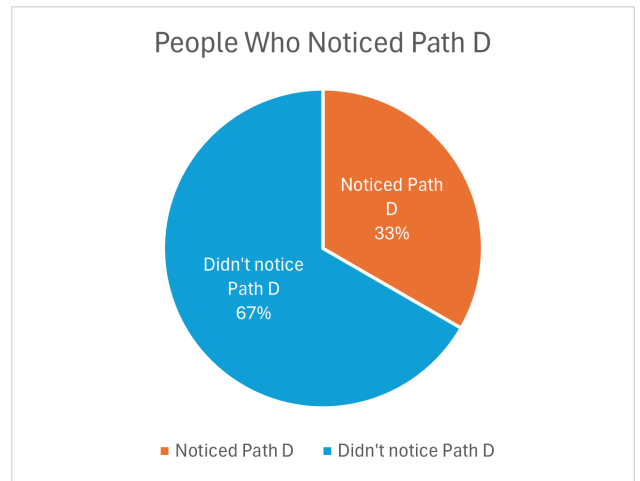


**Figure 39: Pie Chart Showing Percentage of Participants Who Chose Path A vs. Path B [22]**

### 5.3.3.2 Path C vs. Path D

Path C has high contrast lighting with a few enemies, while Path D has very high contrast lighting with no enemies. Since the player would only reach the fork of Path C and Path D if they chose to go down Path B, there were few data points for this area.

As mentioned before, only three participants ended up getting to the Path C and Path D fork. Out of these three participants only 1 (33%) noticed Path D and they initially went down it. However, they changed their mind, so all three of these participants decided to continue down Path C (which had lower contrast lighting than Path D).

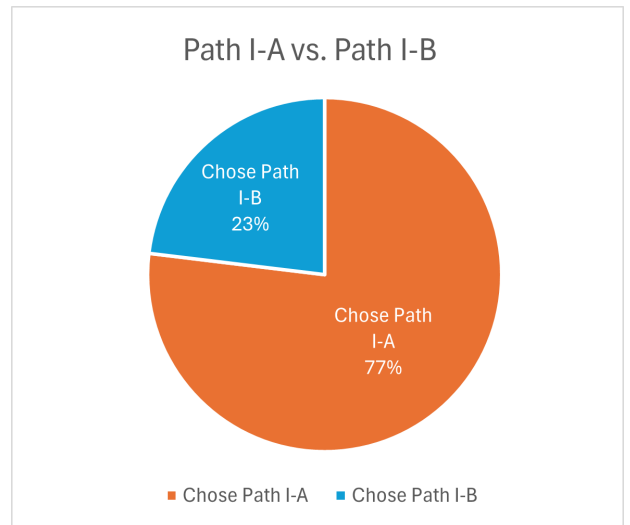


**Figure 40: Pie Chart Showing Percentage of Participants Who Noticed Path D [22]**

### 5.3.3.3 Path I-A vs. Path I-B

Path I-A has low contrast lighting with no enemies, and Path I-B has very high contrast lighting with a couple of enemies. Due to the A/B testing, in the interior spaces, high contrast areas are more dangerous than low contrast areas.

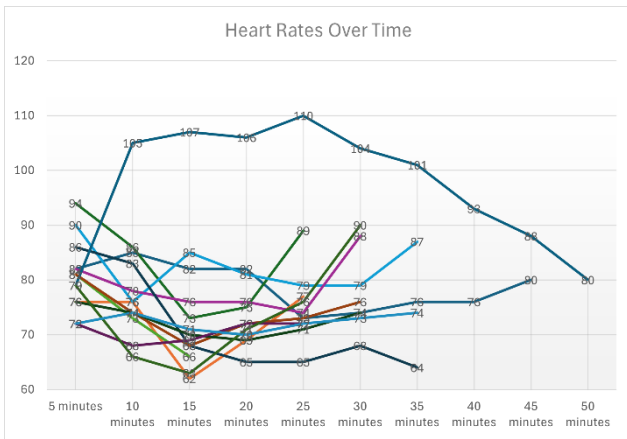
In the end, 77% of participants decided to take Path I-A while the other 23% decided to take Path I-B.



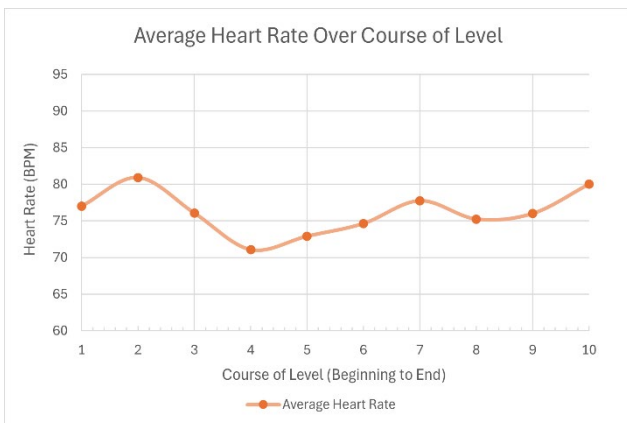
**Figure 41: Pie Chart Showing Percentage of Participants Who Took Path I-A vs. Path I-B [22]**

## 5.4 Results of Heart Rate Monitoring

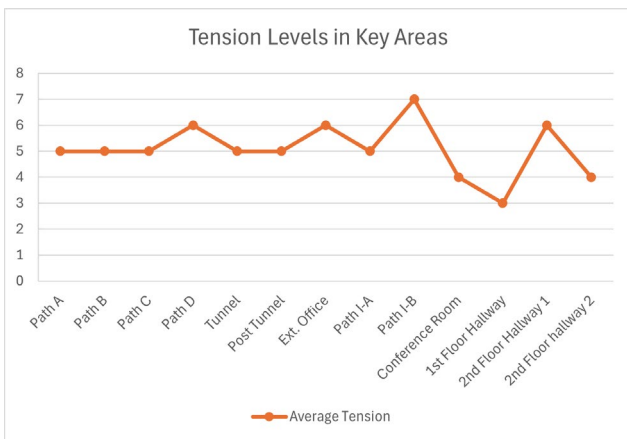
The Fitbit that was used to collect the data returned an average heart rate in five-minute increments. The first graph shows the heart rates of all 13 participants over time while the second graph shows the average heart rate throughout the level. Although this data was not as precise as the researcher initially thought it was, the results still follow along the tension curve.



**Figure 42: Line Graph Showing the Heart Rates of Each Participant Over Time [22]**



**Figure 43: Line Graph Showing the Average Heart Rate Over the Course of the Level [22]**



**Figure 44: Line Graph Showing the Average Tension Levels in Key Areas Going Through the Level [22]**

## 6 CONCLUSIONS

After analyzing the results of the playtests and posttest surveys, the researcher concluded that all the following best practices are effective:

- Presenting the player with high contrast lighting followed by low contrast lighting lowers tension.
- Presenting the player with low contrast lighting followed by high contrast lighting raises tension.
- Darkness creates tension by evoking feelings of threat and caution in the player.

- The less fill light that is used, the higher the contrast level will be.
- The more fill light that is used, the lower the contrast level will be.

However, the researcher does note that there are other design aspects that must be kept in mind when using contrast lighting to modulate tension.

The designer should be aware of how much tension will be caused by 1) the enemies in a space, 2) the decorations in a space (such as gory or scary items), and 3) the size of a space (such as narrow or wide pathways). Had the researcher kept each one of these factors in mind for the key areas as they predicted the tension levels, they theoretically would have been closer to the actual results.

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