INDUCING EMOTIONAL RESPONSE IN INTERACTIVE MEDIA

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ABSTRACT

Inducing Emotional Response in Interactive Media

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Video games, and entertainment media have been developed for many years, and eliciting emotional experiences is an integral part of that process. Producing and editing game content in order to affect desired emotional experiences can be expensive and cumbersome to developers. This paper presents a study intended to show that such experiences can be affected with simple after-the-fact audio-visual effects. As subjects of the study, participants experience three different emotional states, fear, peace, and none, over three rounds and in three different game environments. They are given a simple narrative in each environment that directs them to gather various objects.

The fear and peace emotional states are represented by carefully designed sets of simple audio-visual effects, while the none state represents the absence of any additional audio-visual effects. That states are randomly and non-repeatedly applied to the game environments for each participant. Over 50% of responses indicate proper emotions across emotion states for all levels, and rounds, and there are statistically significant effects between most emotional state comparisons. This means that it is indeed possible to induce emotional response with after-the-fact audio-visual effects, and it hints at future possibilities for drag-and-drop emotional experience filters

Keywords: Unity, Video Games, Emotion, Fear, Peace.

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1. Introduction

In the minds of Jesse Schell (2015) and other great thinkers in the entertainment industry, it is a primary goal of video games to induce emotional responses. Yet, in modern game development environments there are no direct methods for achieving that goal. Their focus is largely on the physical game content and it is left to the individual developer to create unique assets for each emotional experience they wish to install in their game. This is not ideal as assets are expensive and successful games need to be emotionally dynamic and complex.

Would it not be great if there were an effective, low-commitment way to add emotional experiences to video game content after it is already rendered to the screen? This is the fundamental question that inspired the work presented in this thesis and ultimately the answer is yes. By applying emotional experiences after-the-fact, the issue of having to create expensive and time-intensive assets is avoided. A simple base set of assets is sufficient and their appearance to the player can be altered as needed while the game is running. While this may seem intuitive, the ability to capitalize on it in a meaningful way is surprisingly inaccessible to the development community.

Many modern games are produced with multi-million dollar budgets, high fidelity environments, and realistic effects. All of this spending achieves the level of quality that is expected in today's market; however, this demand has skewed focus away from the entire purpose of developing video games in the first place: providing an emotional experience. If it were easier to install emotional experiences into existing and new game content, then the market would certainly be open to dedicating more resources to the task. Perhaps as a consequence of this work it will become easier for game developers to focus more on which emotions they would like to affect in their products, instead of hassling over unwieldy game content.

The ability to dynamically create experiences that are highly customizable on an individual user basis has been a long-term aim of digital entertainment, education, and training media development (McQuiggan et al., 2006). Inducing tailored, dynamic emotional responses is a critical component of that intent, yet there exists little by way of methodology for doing so (Callele et al., 2008). Standardization of the emotional design process would open doors for creators of interactive experiences (with a wide range of design experience) to easily tailor their products to particular subject matters. It would also enable them to work on projects that are emotionally dynamic, meaning they aren't rooted in providing a single static emotional experience, and allow them to save time by modifying existing work to provide new experiences. The objective of this study is to test whether it is possible to dynamically affect specific feelings or psychological states in diverse interactive video game environments. Prior work has shown that interactive media is indeed capable of affecting emotional state (Villani and Riva., 2008), and when combined with the motivating factors above, leads to the following hypothesis:

It is possible to affect emotional responses by making after-the-fact audio-visual adjustments to video game content.

In this study, the hypothesis is tested by presenting participants with two sets of simple audio-visual effects that have been tailored for affecting the emotions of fear and peace. The goal is to find significant differences in the number of participants that report feeling each emotion between the two sets of audio-visual effects and the absence of any audio-visual effects. Participants are not made aware of the nature of the study at any point, meaning that should they respond with some concept of fear or peace, it is completely of their own volition. Significance is measured by Fisher's exact test of population proportions ($P\text{-value} < 0.05$), and conclusions are limited to 3D open world

environments being navigated by first-person users that are actively performing some sort of gathering task. Further study may be necessary for other interactive experiences.

A pilot study served as an initial check to the validity of the hypothesis (Reimer and Khosmood, 2016). Simple audio-visual effects were used to test the effectiveness of the technique in a 3D open-world environment where players are given the task of gathering various objects. It was indicated that the technique may be valid, but the scope of the experiment was too narrow. This study uses the same methods but broadens the scope by testing over multiple game environments, a larger sample size, a wider range of participants, and the inclusion of the none (no-emotion) state. As this paper details, the results are positive and the above hypothesis is strongly supported.

2. Related Works

Games have implicit or explicit emotional requirements (Callele et al., 2008). Despite this, there are no accepted methodologies for inducing various emotional responses independent of physical game content. It is possible to install emotional responses as hard coded features in the game environment (Chittaro et al., 2014), but this kind of static development does little by way of empowering developers to create highly customized dynamic experiences. Projects become locked into providing specific emotional experiences. They become constrained by the very assets that have been painstakingly designed for them, and plot lines have the same issue. A given scene can be tailored to induce one emotion, only for the designer to later realize that it would have been interesting another way. By that time it is already too late and that static scene is now a constraint to the designer's total creative freedom. What's more, the market's expectation of high fidelity game content makes it fiscally challenging, neigh impossible, to have dynamic experiences built into the same game. When the assets themselves incur large development costs while remaining tied to providing a single emotional experience, implementing the ability to change said experience becomes unfeasible

Emotional flexibility would be useful across all digital entertainment, education, and training environments; however, it is especially useful in the MMORPG genre, where emotional response is tightly coupled with immersion, and it is critical that the right emotions are consistently induced (Suárez et al., 2013). In order for a player to feel like they are a part of the world that they are experiencing they must be emotionally invested in it. Another factor is that games in the MMORPG genre are typically quite large and anything that empowers developers to create content faster and with more automation would be well received. Emotional response audio-visual effect filters would also require less maintenance than separate game assets for each experience. Less maintenance

equates to more development time to spend on providing the best game possible. This in turn promises an improved experience for users and better margins for studios.

In the FPS genre, it has been shown that a correlation exists between emotional characteristics and user-specific preferences about games (Merkx et al., 2007), indicating that different users have different emotional responses to the same content. This may be true for all emotions, which means that dynamic emotional experience is not only convenient, but necessary for designing consistent experiences across a diverse body of users. If an experience is meant to be scary, and not every player responds to the experience in the same way, then the only way to consistently induce fear is to change the experience for each player. Correlations between player actions and preferences could be discovered. Once discovered they can be programmed into a game to automatically adjust experiences for an individual user based on their actions within the game. Not only can this be used to provide a consistent experience across a variety of players, it can also be used to change the experience based on user choices and give them a sense of responsibility in the world. Many studios have already implemented such systems in their games, but their effectiveness and depth has been hitherto capped by resource limitations. In order to do it comprehensively a low-cost, highly effective methodology must be decided upon and explored. Sufficiently, effective emotional response audio visual-effect filters could greatly help with this effort.

Evidence from the film industry suggests that emotional experiences in entertainment media have the capability of being universal across demographics (Sato et al., 2007). This may also be true for interactive media, and if so, games can be published on massive scales with the confidence that each emotional experience is being correctly affected across age, nationality, sex, and more. If this does not hold true for interactive media, then information about individual user demographics could be used to alter each experience to help ensure that the correct emotion is being affected.

In the gaming industry, the importance of lighting on the game experience is well understood (El-Nasr, et al., 2005). Drawing on principles of cinematography lighting can be used to set mood and atmosphere, which are critical for inducing emotional engagement (Donati, 2008). Brightening and darkening a scene is a simple task in modern game development environments and the capability is often used. Many scary games are dark and creepy, where happy games are typically bright and peaceful. Patterns like this are essential for defining sets of emotion-tailored audio-visual effects, and this one is so prevalent that there is no reason any developer should have to re-create it from scratch.

Color is also an essential tool. As far back as 1935, when the first feature film in Technicolor was released, it has been shown that color can be used in digital content for dramatic and emotional effectiveness (Stump, 2014). This may seem intuitive, but color is a powerful tool that game developers have at their disposal. Its usefulness is evident in the highly stylized games that tend to come from independent game development. Essentially, smaller studios with fewer resources often tap into the capabilities of color to provide unique game experiences, as color is easily manipulated and inexpensive to develop with. SUPERHOT¹ is a good example of a game where color has been used to dramatic and stylized effect. Modern work on the effect of color on emotional response has shown that a relationship exists between saturation and brightness, and positive emotional response (Suk and Irtel 2010). This is already utilized in many well-known games to provide happy, calming experiences to users. Zelda Breath of the Wild² is an upcoming game with extreme levels of saturation and good use of brightness. The entire Zelda franchise is known for providing a certain experience and Breath of the Wild is building on that experience by utilizing the emotional capabilities of color.

¹ SUPERHOT. <http://store.steampowered.com/app/322500/>

² Zelda BotW. <http://www.nintendo.com/games/detail/the-legend-of-zelda-breath-of-the-wild-wii-u>

Providing compelling visual experiences is the hallmark of modern game development, but audio experiences are just as important and not to be neglected. In fact, audio is so important that some games rely on it entirely and abandon the attempt to provide a compelling visual experience. A study on the effect of audio on emotional response suggests that capturing the 'essence' of a sound is more important than the sound's fidelity. It is better to have a sound that matches our perception of the real sound than to have a high quality recording of the actual sound itself (Grimshaw et al., 2008). This is the reason that sound effects are often created with unusual and surprising methods as opposed to direct recordings of each sound.

Additionally, it has been shown that the integration of spatial sound in immersive virtual environments has a significant influence on the intensity of presence experienced by the user (Poeschl et al., 2013). This is relevant because other work has shown that the degree to which a user is feeling present in a virtual environment can have an effect on the magnitude to which they experience fear (Peperkorn et al., 2015). In this context, presence is defined as being in a normal state of mind and having the experience of being inside a mediated virtual environment (Brockmyer et al., 2009): or in short, the experience of "being there." It is reasonable that in order for users to feel scared, they need to feel like they are actually in the environment and exposed to the source of the fear. Like color and brightness, audio is clearly another tool for affecting emotional response and fortunately modern game development environments are quite apt at handling it.

3. Experimental Design

3.1 Development

This work is developed in Unity³ 64-bit for Windows, which is a modern game development environment for creating multiplatform 3D and 2D games and is used to create the testing environments for this experiment. It has been used to create many successful games such as Kerbal Space Program, Cities Skylines, Firewatch, and many more⁴.

The Unity platform has built-in tools which encompass multiple aspects of game design such as environment and asset creation, backend scripting, and post processing image effects. The latter of those is used to great extent to tailor emotional states in this work. Unity is a convenient choice for developing the game environments in this study, as it provides a way to easily layer prototypes; however, nothing about this study is unique to Unity and the driving technologies are available in other game engines and design tools.

Three high fidelity digital environments are used to host this experiment. The first is a post-apocalyptic city⁵, the second is a fantasy themed forested valley, and the last is a large futuristic building set on an alien world⁶. The forest valley is entirely created for this study and the city and alien environments are adapted from work freely available on the Unity Asset Store. Each environment is an open-world space and users are free to navigate within it and interact with pre-designated objects. These objects include trash and debris in the city environment, crystals and asteroids in the forest environment, and power cores in the alien environment. Users have a score and are awarded one-hundred

³ Unity. <https://unity3d.com/unity>

⁴ Unity Gallery. <https://unity3d.com/showcase/gallery>

⁵ Destroyed City FREE. <https://www.assetstore.unity3d.com/en/#!/content/6459>

⁶ The Courtyard. <https://www.assetstore.unity3d.com/en/#!/content/49377>

points for each successful interaction with an object, and each object can only give points once.

The forest environment is created using Unity itself along with two powerful utilities called Tom's Terrain Tools⁷ and SpeedTree⁸. Tom's Terrain Tools has the ability to convert grayscale images to terrain height maps, texturize the generated terrain based on colored images, and randomly place trees and game objects based on grayscale density maps. This is how the seemingly natural arrangement of assets in the environment is achieved. SpeedTree is used to create most of the high fidelity trees scattered throughout the terrain. Their physical features are custom designed and each type is generated with ambient occlusion and wind effects. Many of the other assets (such as rocks, crystals, and asteroids) are purchased directly from the Unity Asset Store.

The other two environments are directly adapted to fit the needs of this experiment. Tom's Terrain Tools is used to populate the city environment with interactable trash cans, stop signs, traffic cones, and soda cans. Originally, the alien environment was a complex, professional product that was directly created by developers from Unity to show off features of the game engine. As such, it had many features that were beyond the requirements of this study. These features are stripped out to better match the functionality and performance requirements of the other two environments. One such removed feature is a fully functional day/night cycle. Interactable power cores are placed by hand, as the building in this environment consists of several stories and Tom's Terrain Tools are not designed for this usage case.

A functional UML diagram for this work can be seen in Figure 1 below. Some of the game logic is done in core Unity functions like *"Awake," "Start,"* and *"Update,"* which

⁷ Tom's Terrain Tools. <https://www.assetstore.unity3d.com/en/#!/content/527>

⁸ SpeedTree. <http://www.speedtree.com/unity/>

all return void, so they have been left out of the diagram. Many small UI scripts have been ignored as well, as they simply handle transitions between dialogs that are used for instructional purposes.

Figure 1. UML diagram of the technical components of the study.

Customized scripts were created to allow participants to interact with various game objects in each scene. Each of the scripts extends a base script called “*ObjectInteraction*.” Objects that have this script attached to them can be found programmatically through the use of ray casting, which is something that Unity supports natively. A companion script called “*PlayerInteraction*” is attached to the player and performs the ray casting whenever an action command is given. These commands typically include left-clicking, or hitting the *E* key. When an object is discovered its “*Interact()*” method is called. Most of the interactable objects in this study will vanish, play a sound, and increment the player’s score when interacted with. A simple UI is included that consists of the player score in the top right hand side of the screen, and a reticle in the middle that indicates where the player is aiming when they give an action command.

The system has two built-in emotional states, fear and peace, that can be switched on and off programmatically through the use of a specially designed Unity script called the *“EmotionManager.”* The script is extensible, meaning that while it currently only supports the fear and peace emotions, adding others is as simple as inheriting the *“Emotion”* base class, overriding its *“On()”* and *“Off()”* methods, and adding it to the manager. The emotion manager is equipped with its own convenient methods such as *“On()”*, *“Off()”*, and *“SwitchEmotion()”*. The on method of the emotion manager will call the on method of the active emotion if it is not already active, and the off method will likewise call the emotion’s off method if it is not already off. The switch emotion method takes as a parameter the new emotion that is to be active and performs the necessary operations to change the state of the game. If the old emotion is currently active then the switch method will turn it off before turning on the new emotion, and if the old emotion is inactive then the manager will simply hold onto it and be ready to activate it when the on method is called.

A *“GameManager”* script is created specifically for this study. This script manages the randomization of emotional states, as well as basic logistical issues. For example, how much time is spent in a given environment and at what time the round began. Recording essential information such as player score, which emotions have been experienced, which environments have been explored, and the encoding of such information is done through the built in *“PlayerPrefs”* functionality in Unity. Randomizing the environment is done with a simple script called *“RandomLevel”* and is only necessary because the game manager doesn’t get initialized until the environment is loaded. That script will reference player preference values to ensure that no level is loaded twice, and the game manager does the same thing for emotional states.

3.2 System

Screenshots of the three environments can be seen in Figure 2 below in each of the two emotional states as well as the none state. The city, forest, and alien environments are in rows 1, 2, and 3 respectively and the fear, none, and peace emotional states are in columns 1, 2, and 3 respectively. UI elements are removed for clarity. Extra screenshots may be found in Appendix A. Top down views may be seen in Figure 3. The city environment is on the top, the forest environment is on the left, and the alien environment is on the right. Image scales are not consistent with in-game size. The city environment is the largest, followed by the forest, and the alien environment is the smallest. A simple narrative is provided in each environment to give users a gathering task, but there is no win condition. All that is required in the study is that users enter a state of immersion wherein the desired emotional can be affected.

Figure 2. Screenshots of each environment in each emotional state.

Figure 3. Top down views of each environment.

Fifty-eight participants play out three, five minute experiences. There is one experience for each environment and emotional state, but they occur in random, non-repeating pairs over three rounds. Thus, each participant is guaranteed to play each environment and emotional state, but the order in which they do so and the pairings between environments and emotional states are not statically defined across the study. An illustration of the study can be seen in Figure 4. After each experience participants complete a small survey prompting them for information. This information includes their emotional responses, age, average hours of video games played per week, game score, and a game code. This game code relays information about which of the random experience pairings they received and in what order. Overall, the entire process takes approximately thirty minutes. Surveys are used for response comparisons across emotional states, environments, and rounds.

Figure 4. An illustration of the experimental design with columns indicating rounds. Emotional states and environments can occur in independent, random, and non-repeating orders for each participant.

3.3 Fear and Peace

The fear and peace states present in this experiment are designed to induce opposing emotional responses, although the study reveals that these two emotions may not be directly oppositional. Both emotional states add a combination of simple after-the-fact audio-visual effects to the base state of the scene. These effects are summarized in Table 1 below.

Peace mode amplifies lighting in the scene, and adds a bloom effect. It also changes the environment's background wildlife noises to simulate daytime wildlife, and adds a soothing mystical melody to the background.

The fear state makes changes opposite to those of the peace state. It darkens the scene and instead of adding bloom, it creates a layer of thick fog and amplifies contrast. It also causes ambient wildlife noises to be more indicative of the night. It does this by lowering the frequency of the noises and changing the kinds of noises to those of insects, owls, etc. Instead of having a mystical melody wrapping up the ambiance, the fear state has eerie background music. It also introduces a motion-blur effect. The effect

was added in conjunction with the eerie music to convey to the user a sense of danger, with the intention of stimulating the fight or flight response.

The visual effects are all implemented using Unity Standard Assets⁹, whereas the ambient audio effects are implemented using an asset called Interactive Audio: Enchanted Forest¹⁰, which is purchasable on the Unity Asset Store.

Table 1. A summary of the fear and peace state audio-visual effects.

Fear State	Peace State
Darkened Scene ⁹	Lightened Scene ⁹
Increased Contrast ⁹	Bloom Effect ⁹
Fog Effect ⁹	Daytime Animal Noises ¹⁰
Blur Effect ⁹	Soothing Background Melody ¹⁰
Night Animal Noises ¹⁰	
Eerie Background Music ¹¹	

3.4 Surveys

The player survey is designed to prompt players to identify their emotional experiences, and can be found in its entirety in Appendix B. Names are only used to connect responses across rounds and participation is not a requirement for any assignment or credit. Each survey consists of three questions that are directly tailored to emotional responses. The first is a free response question that asks: “Please describe any feelings or emotions that you felt during your experience.” An example response can be seen below:

Calm, excitement, and curiosity. Ran around the place, climbing walls, and exploring everywhere I can get to. Was fun, and pretty calming.

-Anonymous Player

⁹ Unity Standard Assets. <https://www.assetstore.unity3d.com/en/#!/content/32351>

¹⁰ Interactive Audio. <https://www.assetstore.unity3d.com/en/#!/content/18354>

¹¹ Harbinger of Doom. <http://www.purple-planet.com/horror/4583971268>

The second question asks participants to record any primary emotional experience they have and the magnitude to which they feel it on a scale of 1 (weak) to 5 (intense). Results are encoded into four categories: fear, peace, secondary, and none. The third question instructs players to select words that stand out to them based on their experience with the game. The words are arranged randomly on the survey, but for analytical purposes they are organized into five categories: fear, peace, secondary experiences, environmental, and unrelated with 2, 2, 3, 4, and 5 words in each category respectively. The available words and their corresponding categories can be seen colored and numbered by category in Table 2 below. They are not colored and numbered on the surveys.

Table 2. Question 3 selection options colored and numbered by category.

Forest (4)	Earth (4)	Time (3)	Magic (4)	1. Fear words 2. Peace words 3. Secondary Words 4. Environmental words 5. Unrelated words
Fear (1)	Atoms (5)	Awareness (3)	Calm (2)	
Lick (5)	Peace (2)	Fortune (5)	Waffle (5)	
Anxiety (1)	Sleep (3)	Wheel (5)	Valley (4)	

Fifty-eight players participated in this study. Some of them were part of a research group at California Polytechnic State University while others were random people solicited on the campus to participate. Information about their age, average time spent playing video games per week, and game score can be seen in Table 3 below. Game score is divided by environment as each environment has varying densities and amounts of score-generating objects. Participants were directed to play through each experience individually before completing the accompanying surveys. There are 172 responses when there should be 174, meaning that some people either misunderstood the instructions and did not complete all three surveys or left the study early.

Table 3. Relevant participant information.

	Min	Median	Mean	Max
Age	17	21	22.3	44
Game Hours Per Week	0	5.0	8.2	45.0
City Score	0	650	688	1400
Forest Score	0	2100	1875	3400
Alien Score	0	2200	2181	3500

4. Results and Analysis

4.1 Coding Methodology

Qualitative responses to Questions 1 and 2 are encoded into categories by three individuals. Each coder had no knowledge of the others' work, and methodologies were agreed upon before the study began. A response is successfully encoded if there is a 2-out-of-3 agreement amongst encoders, and disagreements are discarded. This was decided as a means of dampening interpretation ambiguity on the part of the coders. Percent agreement based on the decided 2-out-of-3 method, and the unanimous method can be seen in Table 4 below. Values are out of 172 responses.

Table 4. Percent agreement amongst encoders using two different methods.

	Question 1	Question 2
2-out-3	99.4%	98.3%
Unanimous	74.4%	84.3%

Responses are encoded into four categories based on each participant's emotional verbiage. If the word fear, or a close synonym such as "anxiety" or "afraid," is used then the response is placed into the fear category. If the word peace, or a close synonym such as "calm" or "relaxed," is used then the response is placed into the peace category. If some other emotionally descriptive word is used then the response is placed into the secondary category. And if no emotionally descriptive words are used then the response is placed into the none category.

4.2 Qualitative

Question 1 is free response and its results are encoded using the above methodology. Over all of the responses 108 (63.2%) were correctly aligned with the proper emotional state. I.E. having an encoded value of fear for fear states, or an

encoded value of peace for peace states, or a value of secondary or none for none states.

Question 2 has a free response component, and its results are encoded in the same fashion. In this case, 92 (54.4%) responses are properly aligned with corresponding emotional states. This question differs from Question 1 in that it also asks participants to report the magnitude to which they felt their particular emotion, and these results can be found in the next section.

The analysis of Question 3 is focused on participants selecting (or not selecting) at least one word in each of the categories, and does not require encoding. Over the entire study 112 (65.1%) responses selected an appropriate word based on emotional state. This entails selecting “fear” or “anxiety” if playing out the fear state, “peace” or “calm” if playing out the peace state, or selecting none of the aforementioned words if playing out the none state.

In the context of this study, proper responses are defined as responses that indicate some concept of fear when responding to the fear state, some concept of peace when responding to the peace state, and the absence of fear and peace concepts when responding to the none state. There are 63.2%, 54.4%, and 65.1% proper responses for Questions 1, 2, and 3 respectively. Similar analysis in the pilot study (Reimer and Khosmood, 2016) resulted in better percentages, but this can be accounted to the addition of two extra environments and the inclusion of the none state into the experiment. While this analysis does not disprove the hypothesis, it shows that more should be done to improve the effectiveness of the emotional states if they are to be used in a production capacity. It is no surprise that Question 3 yields the most success, as it is the only question where participants are explicitly presented with concepts related to fear and peace.

4.3 Fisher's Exact Test of Proportions

P-values are calculated to show significant differences in the proportions of responses by category (fear, peace, secondary, and none for Q2, and fear, peace, secondary, environmental, and unrelated for Q3) between two emotional states, environments, or rounds. These values are obtained using Fisher's exact test, which is a well-known statistical significance test used in the analysis of contingency tables. For the purposes of this study values of less than 0.05 are considered significant, and will be bolded in any of the following tables.

An example is given below for the fear response category in Question 2 between the fear state and the none state. While only 2 people reported experiencing fear in the none state, 26 reported it after the introduction of the fear effects. These values can be seen in Figure 5 as well as Table 5.

Figure 5. Question 2 fear and non-fear responses for the fear state and the none state.

Table 5. Question 2 tabulated fear and non-fear responses for the fear state and none state with corresponding row and column totals.

	Fear State	None State	Row Total
Fear Response	26	2	$26 + 2 = 28$
Non-Fear Response	31	53	$31 + 53 = 84$
Column Total	$26 + 31 = 57$	$2 + 53 = 55$	$26 + 2 + 31 + 53 = 112$

An approximate calculation for the P-value can be seen in Figure 6 using the statistical computing language R's¹² implementation of Fisher's test. Parentheses represent binomial coefficient calculations, and all values within them are taken directly from Table 5. Subsequent values ($p_1, p_2, \dots, p_k$), represent any possible table with the same row and column totals that have equal or more extreme P-values. Those values take the same form as the first term; however, they are based on different tables, and the quantity varies by calculation. This is a reasonable thing to do as a P-value is meant to represent the probability of generating a result equal to or more extreme than the result that was observed.

$$p = 1.27 * 10^{-07} = \frac{\binom{26+2}{26} \binom{31+53}{31}}{\binom{26+2+21+53}{26+31}} + p_1 + p_2 + \dots + p_k$$

Figure 6. An example P-value calculation for Question 2 from Fisher's exact test of two population proportions for the fear response category between the fear state and none state.

4.4 Question 2

When observing the below figures and tables it should be noted they do not represent three different sets of data; rather, they represent the same set of data being parsed in three different ways. Results are summed first by emotional state where values are added over each of the three environments and all of the three rounds; second, by environment where results are being summed over each of the three emotional states and all three rounds; and third, by round where results are being summed over each of the three emotional states and environments. Summarized data of the number of participants that played each emotional state, environment, and round for Question 2 can be seen in Table 6.

¹² R. <https://www.r-project.org/>

Table 6. Question 2 emotional state, environment, and round values with corresponding totals.

Variables and (Totals)			
Emotional State	Fear (57)	None (55)	Peace (57)
Environment	City (57)	Forest (56)	Alien (56)
Round	Round 1 (57)	Round 2 (56)	Round 3 (56)

The results from Question 2 can be seen below. Responses are parsed by emotional state, environment, and round and can be seen in Figures 7, 8, and 9 respectively. Corresponding levels of significance from Fisher's test of two population proportions can be seen in Tables 7, 9, and 12 and average magnitudes can be found in Tables 8, 10, and 13.

Figure 7. The number of Question 2 responses that state a dominant emotion that belongs to each category for each emotional state across all environments and rounds.

Table 7. Question 2 P-values from Fisher's exact test for two population proportions for each category between emotional states across all environments and rounds.

Category	Fear vs. Peace	Fear vs. None	Peace vs. None
Fear	1.28e-08	1.27e-07	6.15e-01
Peace	2.99e-07	1.92e-03	2.89e-02
Secondary	1.00	2.60e-01	1.89e-01
None	2.43e-01	1.21e-02	3.17e-01

Table 8. Question 2 average magnitudes of responses for each emotional state across all environments and rounds. Values are given on a scale of 1 (weak) to 5 (intense).

Category	Fear	None	Peace
Fear	3.38	2.50	3.00
Peace	2.00	3.62	3.84
Secondary	3.45	3.35	3.71
None	N/A	4.00	4.33

There are statistically significant differences in the proportion of responses encoded into the fear category for all emotional state comparisons except for the fear category under the peace state vs. the none state comparison. This is important as it indicates that the emotional states are having a measurable effect on the extents to which participants are experiencing the emotions of fear and peace. The singular lack of significance in the fear category does not cast doubt upon the effectiveness of the peace state; rather, it suggests that the peace state may not be directly oppositional to the fear state in its current design. It must be somewhat oppositional; however, as there is significance within the peace category for all emotional state comparisons: including the fear state vs. the none state.

The average intensity of fear responses in Question 2 is higher in the fear state, and the average intensity of peace responses is higher in the peace state. Comparing intensities in the none state reveals that participants felt generally more peaceful than they did fearful. This is possibly due to flaws in the experimental design such as a consistently peaceful task and or a peaceful atmosphere in the real-world study environment. It also explains why there is a relatively small difference in the intensity of fear responses across the fear state and peace state, as the effect of the fear state is being dampened, and/or the effect of the peace state is being amplified. As expected, there are fairly consistent intensities across secondary experiences.

Number of Dominant Emotional Responses by Category and Environment

Figure 8. The number of Question 2 responses that state a dominant emotion that belongs to each category for each environment across all emotional states and rounds.

Table 9. Question 2 P-values from Fisher's exact test for two population proportions for each category between environments across all emotional states and rounds.

Category	City vs. Forest	City vs. Alien	Forest vs. Alien
Fear	6.30e-01	1.00	8.06e-01
Peace	6.88e-02	6.88e-02	1.00
Secondary	1.33e-02	7.78e-03	1.00
None	1.18e-01	1.29e-02	4.89e-01

Table 10. Question 2 average magnitudes of responses for each environment across all emotional states and rounds. Values are given on a scale of 1 (weak) to 5 (intense)

Category	City	Forest	Alien
Fear	2.89	3.91	3.00
Peace	4.00	3.69	3.50
Secondary	3.43	3.50	3.60
None	N/A	4.00	4.17

Reviewing the responses to Question 2 by environment reveals no significant differences between the proportions of responses that reported fear or peace experiences. This reveals that there are no measurable effects on the emotional

responses of fear and peace between the three game environments. There are significant differences between secondary experience proportions for the city vs. forest and city vs. alien comparisons but this can be explained by the large number of secondary experiences that were reported in the city environment. Many participants felt frustrated or bored at the relatively low density of interactable game objects in that environment. Moving on to the averages, participants felt the most intense fear on the forest environment, and the most intense peace on the city environment. Secondary experience intensity is fairly even across all of the environments.

Figure 9. The number of Question 2 responses that state a dominant emotion that belongs to each category for each round across all emotional states and environments.

Table 11. Question 2 P-values from Fisher's exact test for two population proportions for each category between rounds across all emotional experiences and environments.

Category	Round 1 vs. Round 2	Round 1 vs. Round 3	Round 2 vs. Round 3
Fear	0.315	0.315	1.000
Peace	0.264	0.832	0.490
Secondary	0.451	1.000	0.569
None	0.438	0.438	1.00

Table 12. Question 2 average magnitudes of responses for each round across all emotional experiences and environments. Values are given on a scale of 1 (weak) to 5 (intense).

Category	Round 1	Round 2	Round 3
Fear	3.29	2.73	3.91
Peace	3.75	3.40	3.79
Secondary	3.28	3.55	3.66
None	4.00	4.00	4.50

Parsing the responses to Question 2 by round results in no significant differences in proportions for any of the categories under any of the comparisons. This means that changing round has no measurable effect on response data under any of the response categories. The average intensities for various responses are also fairly consistent across all categories with the one exception of fear. Participants feel less fearful in round 2, which could be attributed to having gained familiarity with the system if it weren't for the fact that round 3 has higher fear intensity than both rounds 1 and 2.

4.5 Question 3

Question 3 is again parsed by emotional state, environment, and round. Totals can be seen in Table 13, and results can be found in Figures 10, 11, and 12. Respective levels of significance from Fisher's exact test of two population proportions and can be seen in Tables 14, 15, and 16.

Table 13. Question 3 emotional state, environment, and round values with corresponding totals.

(a)	Variables and (Totals)		
Emotional State	Fear (58)	None (56)	Peace (58)
Environment	City (58)	Forest (57)	Alien (57)
Round	Round 1 (58)	Round 2 (57)	Round 3 (57)

Number of Responses Selected by Category and Emotional State

Figure 10. The number of Question 3 responses that selected at least one word from each category for each emotional state across all environments and rounds.

Table 14. Question 3 P-values from Fisher's exact test for two population proportions for each category between emotional states across all environments and rounds.

Category	Fear vs. Peace	Fear vs. None	Peace vs. None
Fear	1.79e-15	2.46e-09	3.18e-02
Peace	3.18e-02	9.26e-04	1.87e-04
Secondary	7.01e-01	2.40e-01	5.49e-01
Environ.	8.29e-01	3.11e-01	1.49e-01
Unrelated	2.69e-02	7.97e-01	5.03e-02

There are significantly different proportions of selected words in Question 3 from the fear and peace categories selected across all emotional state comparisons. Here again changing emotional states is having a measurable effect on the emotional experiences of fear and peace across all emotional state comparisons. The only other significance lies in the unrelated category for the fear state vs. peace state comparison, and this is explained by the relatively large number of unrelated selections in the peace state. It would appear that peoples' minds are freer to wander when they are feeling

peaceful. There are no significantly different proportions of secondary emotional experiences across any of the emotional state comparisons.

Number of Responses Selected by Category and Environment

Figure 11. The number of Question 3 responses that selected at least one word from each category for each environment across all emotional states and rounds.

Table 15. Question 3 P-values from Fisher's exact test for two population proportions for each category between environments across all emotional states and rounds.

Category	City vs. Forest	City vs. Alien	Forest vs. Alien
Fear	1.30e-01	1.16e-02	4.09e-01
Peace	1.92e-01	3.53e-01	8.50e-01
Secondary	1.27e-01	6.81e-01	5.03e-02
Environ.	4.20e-01	1.70e-05	3.06e-07
Unrelated	5.13e-04	2.34e-05	5.39e-01

Examining Question 3 by environment results in only one significant difference for the emotional categories, and that is for fear in the city vs. alien comparison. When compared with the results for emotional states above, it is clear that game environment is having a much weaker effect on emotional experience. As with the emotional state comparisons, there are no significantly different proportions of secondary emotional experiences for any of the environment comparisons.

As expected, there are significant differences in the proportions of environmental and unrelated selections for most of the environment comparisons. This makes sense as these two categories are more related to game content than the other three categories. The only exceptions are the cases of environmental words for the city vs. forest comparison, and unrelated words for the forest vs. alien comparison. The former of these cases can be explained by the thick density of trees present in both the city and forest environments.

Figure 12. The number of Question 3 responses that selected at least one word from each category for each round across all environments and emotional states.

Table 16. Question 3 P-values from Fisher's exact test for two population proportions for each category between rounds across all emotional states and environments.

Category	Round 1 vs. Round 2	Round 1 vs. Round 3	Round 2 vs Round 3
Fear	1.76e-01	5.53e-01	5.64e-01
Peace	9.25e-02	1.89e-01	8.51e-01
Secondary	1.84e-01	1.07e-02	2.97e-01
Environ.	2.15e-02	1.28e-01	5.51e-01
Unrelated	2.19e-01	2.27e-02	3.90e-01

As expected, looking at Question 3 by round results in no significant differences in proportions of emotional categories. Again round is having no measurable effect on fear and peace emotional experiences. There are differences between round 1 and round 3 for secondary and unrelated words, but this likely due to participants growing bored with the study and beginning to think about other things. There is a final difference for environmental words in the first and second round, which seems to indicate that participants paid less attention to the environment after their second experience.

4.6 Emotional State vs. Environment

This section performs cross analysis between emotional states and environments. The intention here is to show that the percentage of proper responses by emotional state is even across environments, which would mean that the effectiveness of the emotional states is independent of game content. The total number of participants by emotional state and environment for Questions 2 and 3 can be seen in Tables 17 and 20 respectively. The percentages of responses by response category can be seen in Tables 18 and 21, for each environment and across all rounds in the fear state (a), none state (b), and peace state (c). Proper values are bolded. These tables include an “other” category which represents both the secondary and none categories in Question 2, and the absence of selecting fear and peace words in Question 3. Resulting P-values from Fisher’s exact test for two population proportions comparing proper responses for each emotional state can be seen in Tables 19 and 22.

Table 17. Question 2 participant totals by emotional state and environment.

Emotional State	City	Forest	Alien
Fear	25	21	11
None	22	12	21
Peace	10	23	24

Table 18. Question 2 response percentages by category for each environment and across all rounds in the fear state (a), none state (b), and peace state (c).

(a) Category	City	Forest	Alien
Fear	32.0%	52.4%	63.6%
Other	64.0%	42.9%	36.4%
Peace	4.0%	4.8%	0.0%
(b)			
Fear	4.5%	0.0%	4.8%
Other	77.3%	66.7%	71.4%
Peace	18.2%	33.3%	23.8%
(c)			
Fear	0.0%	0.0%	4.2%
Other	70%	52.2%	50.0%
Peace	30.0%	47.8%	45.8%

Table 19. Question 2 P-values from Fisher's exact test for two population proportions for proper responses by emotional state and environment.

Emotional State	City vs. Forest	City vs. Alien	Forest vs. Alien
Fear	0.231	0.141	0.712
None	0.687	0.736	1.000
Peace	0.455	0.467	1.000

The percentage of responses to Question 2 in the fear state show majorities encoded as fear in the forest and alien environments. The missing majority in the city environment is likely due to the repeated frustration that participants felt at the sparsity of interactable game objects. For the none state there are majorities of other responses in each environment. The peace state has no majorities of responses encoded as peace; however, it is competing with the other category and not the fear category. There are relatively even percentages of proper responses across environment for each emotional state. In fact, there are no statistically significant differences in the proportions of proper responses for any of the emotional states between any of the environments. This shows

that the environments are not interfering with how effective the emotion states are at affecting their corresponding emotions in Question 2.

Table 20. Question 3 participant totals by emotional state and environment.

Emotional State	City	Forest	Alien
Fear	25	21	12
None	23	12	21
Peace	10	24	24

Table 21. Question 3 response percentages by category for each environment and across all rounds in the fear state (a), none state (b), and peace state (c).

(a) Category	City	Forest	Alien
Fear	84.0%	71.4%	75.0%
Other	8.0%	9.5%	8.3%
Peace	16.0%	28.6%	25.0%
(b)			
Fear	26.1%	16.7%	19.0%
Other	17.4%	25.0%	47.6%
Peace	60.9%	58.3%	42.9%
(c)			
Fear	10.0%	8.3%	4.2%
Other	10.0%	8.3%	12.5%
Peace	90.0%	87.5%	83.3%

Table 22. Question 3 P-values from Fisher's exact test for two population proportions for proper responses by emotional state and environment.

Emotional State	City vs. Forest	City vs. Alien	Forest vs. Alien
Fear	0.475	0.659	1.000
None	0.670	0.052	0.278
Peace	1.000	1.000	1.000

The majority of all responses to Question 3 have selected the fear category in each environment. This is also true of the peace state and the peace category for each environment, but it does not hold true for the none state and other categories. Many participants selected a word from the peace category when playing out the none state. The percentage of proper responses again reveal that the proportions of responses across environments are relatively even with the partial exception of the none state. Fisher's exact test of two population proportions confirms that there are no statistically significant differences between proportions of proper responses by emotional state between any of the environments, although the none state is very close under the city vs. alien comparison. This shows that game environment is not measurably interfering with emotional state effectiveness in Question 3.

4.7 Super Scores and Lesser Scores

As a result of the pilot study, concerns were raised about whether or not serious gamers would be truthful about the extent to which they feel fear. Namely, it is expected that individuals who are quite apt at playing video games are unlikely to express their true level of fear. To understand this phenomenon the results from Questions 2 and 3 for emotional state are disaggregated by responses above (super scores) and less than or equal to (lesser scores) the median game scores for each environment. Super score participants are expected to be more serious gamers and lesser score participants are likely more casual gamers.

Totals by emotional state for super scores and lesser scores can be found in Table 23. Summarized results of Question 2 can be seen in Figures 13 and 15 with corresponding significance levels in Tables 24 and 27 and average intensities in Tables 25 and 28. Summarized results of Question 3 can be seen in Figures 14 and 16 with corresponding significance levels in Tables 26 and 29.

Table 23. Emotion state totals summed across all other variables for participants that scored above and below the median game scores. Question 2 values (Q2) account for discarded responses.

	Fear	None	Peace
Super Scores	27	33	24
Super Scores (Q2)	27	33	24
Lesser Scores	31	23	34
Lesser Scores (Q2)	30	22	33

Number of Dominant Emotional Responses by Category and Emotional State for Super Scores

Figure 13. The number of Question 2 responses with game scores greater than the median that state a dominant emotion that belongs to each category for each emotional state across all environments and rounds.

Table 24. Question 2 P-values from Fisher's exact test of two population proportions for responses with game scores above the median between emotional states across all environments and rounds.

Category	Fear vs. Peace	Fear vs. None	Peace vs. None
Fear	1.08e-03	2.26e-04	1.00
Peace	1.70e-05	6.29e-03	5.44e-02
Secondary	4.04e-01	7.94e-01	1.87e-01
None	4.71e-01	1.20e-01	3.85e-01

Table 25. Question 2 average magnitudes of responses for participants with game scores above the median for each round across all emotional experiences and environments. Values are given on a scale of 1 (weak) to 5 (intense).

Category	Fear	None	Peace
Fear	3.58	2.00	3.00
Peace	N/A	3.63	4.00
Secondary	3.67	3.60	4.00
None	N/A	3.75	3.00

Number of Responses Selected by Category and Emotional State for Super Scores

Figure 14. The number of Question 3 responses with game scores greater than the median that selected at least one word from each category for each emotional state across all environments and rounds.

Table 26. Question 3 P-values from Fisher's exact test for two population proportions for responses with game scores above the median between emotional states across all environments and rounds.

Category	Fear vs. Peace	Fear vs. None	Peace vs. None
Fear	3.57e-09	4.48e-07	1.66e-01
Peace	2.81e-08	1.05e-03	5.07e-03
Secondary	7.67e-01	5.96e-01	1.00
Environ.	4.50e-01	6.53e-02	3.78e-01
Unrelated	1.87e-01	1.00	2.24e-01

Super scores for Question 2 yield significant differences for both emotional categories for the fear state vs. peace state and fear state vs. none state comparisons. Both emotional states lack significance under the peace state vs. none state comparison. This is not alarming, as it has already been established that there is some sort of calming effect in the system that is clearly dampening the results of the fear and none states for the super scores. There are no differences for secondary or none responses for any of the comparisons. As expected, super score participants generally felt higher intensities of fear in fear state experiences, and high intensities of peace in peace state experiences.

Looking at Question 3 by super scores there is again significance for both the fear and peace categories for the fear state vs. peace state and fear state vs. none state comparisons. The peace state vs. none state comparison lacks significance for both emotional categories. This again hints there may be an inherently peaceful element in the system that is minimizing differentiation between the peace state and the none state for the super scores. There are no differences for the secondary, environmental, and unrelated categories.

Figure 15. The number of Question 2 responses with game scores less than or equal to the median that state a dominant emotion that belongs to each category for each emotional state across all environments and rounds.

Table 27. Question 2 P-values from Fisher's exact test of two population proportions for responses with game scores less than or equal to the median between emotional states across all environments and rounds.

Category	Fear vs. Peace	Fear vs. None	Peace vs. None
Fear	3.89e-06	1.38e-03	4.00e-01
Peace	2.81e-03	1.19e-01	2.49e-01
Secondary	6.17e-01	2.67e-01	5.83e-01
None	4.93e-01	1.74e-01	1.00

Table 28. Question 2 average magnitudes for responses with game scores less than or equal to the median for each round across all emotional experiences and environments. Values are given on a scale of 1 (weak) to 5 (intense).

Category	Fear	None	Peace
Fear	3.21	3.00	N/A
Peace	2.00	3.60	3.69
Secondary	3.21	3.00	3.56
None	N/A	4.50	5.00

Number of Responses Selected by Category and Emotional State for Lesser Scores

Figure 16. The number of Question 3 responses with game scores less than or equal to the median that selected at least one word from each category for each emotional state across all environments and rounds.

Table 29. Question 3 P-values from Fisher's exact test for two population proportions for responses with game scores less than or equal to the median between emotional states across all environments and rounds.

Category	Fear vs. Peace	Fear vs. None	Peace vs. None
Fear	1.89e-07	3.12e-04	2.08e-01
Peace	1.46e-05	9.85e-02	2.99e-02
Secondary	8.04e-01	2.63e-01	4.01e-01
Environ.	2.82e-01	1.00	2.47e-01
Unrelated	8.12e-02	1.00	1.24e-01

Analyzing Question 2 by lesser scores paints a similar picture. There are significance differences in both the fear and peace categories for the fear state vs. peace state, and for fear words in the fear state vs. none state. The lack of difference for peace words in the fear state vs. none state again suggests that fear and peace may not be strongly oppositional. Reasoning about the lack of difference for the fear category in the peace state vs. none state comparison is exactly the same. The missing significance for peace words in the peace state vs. none state comparison indicates that a peaceful effect is present in the system. Again there are no significant differences for the secondary or none categories. Lesser score average intensities for fear are higher in the fear state, but the averages for peace are high in the peace state and the none state. This is surprising, and the effect again indicates the inherently peaceful properties of the system. An important thing to note is that the fear and peace intensities in the fear and peace states for the lesser scores are actually less than those of the super scores.

Filtering Question 3 by lesser scores shows differences for the peace word category in all comparisons except for fear state vs. none state, and the fear category is missing significance for the peace state vs. none state comparison. This is a strong indication that the fear state and the peace state are not inducing completely oppositional responses. There are no significant differences for the secondary, environmental, and unrelated categories under any of the comparisons.

4.8 Secondary Responses

The secondary experiences of wonder, curiosity, lost, frustration, and boredom were mentioned several times in the qualitative responses to Questions 1 and 2. That begs the question of whether or not these experiences might be tied to certain aspects of the system. Percentages of responses using the aforementioned experiences over emotional states, environments, and rounds can be seen in Table 30 (a), (b), and (c) respectively and values of interest are bolded. These percentages were obtained with word scanning, as opposed to the encoding used in much of the preceding analysis.

Table 30. Percentage use of secondary experiences in qualitative responses by emotional state (a), environment (b), and round (c). Values of interest are bolded.

(a) Category	Fear	None	Peace
Wonder	5.17%	1.79%	8.62%
Curiosity	17.24%	14.29%	19.0%
Lost	17.24%	5.35%	8.62%
Frustration	8.62%	5.36%	6.90%
Boredom	3.45%	25.0%	8.62%
(b) Category	City	Forest	Alien
Wonder	5.17%	5.26%	5.26%
Curiosity	17.24%	14.04%	19.30%
Lost	13.79%	12.28%	5.26%
Frustration	6.90%	8.77%	5.26%
Boredom	13.80%	12.28%	10.53%
(c) Category	Round 1	Round 2	Round 3
Wonder	5.17%	3.51%	7.02%
Curiosity	18.97%	19.30%	12.28%
Lost	8.62%	17.54%	5.26%
Frustration	6.90%	5.26%	8.77%
Boredom	8.62%	14.04%	14.04%

There are clear correlations between the secondary experiences of lost and boredom and the emotional states of fear and none respectively. It is reasonable that participants are more likely to report a feeling of being lost when they are placed in an environment designed to affect a feeling of fear. Similarly, it is not surprising that participants feel the most bored during the none state as it is much less stimulating than both the fear state and the peace state.

The only correlation between secondary experiences and environment lies between the feeling of being lost and the alien environment. Participants feel generally less lost on this environment, and that is almost certainly due to the fact that it is the only one with a localized building structure. It is also the smallest of the three environments.

In reference to rounds, there is a strange peak in the percentage of players that felt lost during round 2. This is hard to explain as players felt least lost during round 3 so it cannot be attributed to a sudden lack of familiarity in the transition between rounds 1 and 2. Fewer participants report feelings of boredom in round 1, in comparison to rounds 2 and 3, which is not surprising.

5. Conclusion

5.1 Discussion

There are several conclusions that arise from this study, but the first and foremost is that the hypothesis, *it is possible to affect emotional responses by making after-the-fact audio-video adjustments to video game content*, has not been rejected and has in fact been supported. In the analysis of Questions 2 and 3 there are clear, statistically significant differences about the proportion of fear and peace responses between experiences in the fear and the peace state. Also, there are always measurable differences for fear responses between the fear state and the none state. This is not true of peace responses for the peace state and none state, but there are several indications of a peaceful effect in the system that is dampening this result. Qualitative analysis of all three questions results in responses that are properly aligned with emotional state (or lack thereof) more than half of the time. In order for this work to be useful in a production capacity, it would be better for responses to be properly aligned almost all of the time; however, as the results indicate, the technique is valid in the context of open world gathering games using only simple audio-visual effects. This is true across a large variety of game content while also being independent of repetition and time spent playing.

It is not the intention behind this study to show that audio-visual effects are the only means capable of affecting emotional response, rather, that they are capable of augmenting arbitrary game content. There are no statistically significant differences between the proportions of proper responses by emotional state crossed with environment, indicating that game content does not interfere with the effectiveness of the carefully designed emotional states. Analysis of aggregate data by environment reveals very few significant differences in the proportions of fear and peace responses between

environments. This suggests that environment has less of an effect on emotional response than the emotional states.

Analysis of Questions 2 and 3 by round reveal no significant differences in the proportions of emotional categories. This means that the length of time spent participating in the study does not diminish the effect of the emotional states. It also shows that having the same participant involved in multiple experiences in sequence has no effect on overall results.

As concerned in the pilot study, this study is not affected by the tendency for serious gamers to not be truthful about the level of fear that they are experiencing. When looking at Questions 2 and 3, analyzed by emotional responses above and below the median game scores, there were significant differences in the proportions of fear and peace categories across all comparisons between the fear state and the peace state. Also, the average intensities for fear and peace tended to be higher for the super scores than for the lesser scores. This combined with the above information is enough to conclude that the concern about the honesty of serious gamers is invalidated in the context of this study.

There are some discrepancies with comparisons to the none state in a few sectors of the analysis, but as indicated, there are two explanations for this. The first is that something in the system is inherently peaceful: either the task of searching for interactable objects, the length of time spent in each experience, or the actual atmosphere of the study environment. The second is that fear and peace may not be directly oppositional emotional responses. While comparisons between the two always generated results, comparisons between them individually with the none state tended to not generate results for the opposite emotional experience.

The secondary experience of being lost appears to be correlated to the emotional state of fear. There is a clear distinction between the percentage of responses that

expressed some sentiment of being lost when in the fear state, than with those feeling lost in the peace and none states. Likewise, participants tended to experience more boredom in the none state.

Overall, this study builds on the pilot study and conclusively finds that audio-visual effects are capable of affecting emotional responses in diverse video game content for first-person, open-world 3D environments with gathering tasks. These results are not clouded by whether game content or consecutive experiences are contaminating results. In addition, the affirmative values supporting the effectiveness of the emotional states were all calculated using conservative statistics. It is now up for the community at large to expand the scope of which audio-visual effects are used to induce which emotions, to what extent, and for which kinds of game.

5.2 Future Work

This work opens new possibilities for dynamic emotional experience, the revitalization of old projects, and individually tailored player experiences. More work needs to be completed to improve the fear and peace emotional states before they can be confidently used in a commercial product, but this is not daunting as the result is shown to be useful. There are also other emotional archetypes than fear and peace and for each one, a unique set of audio-visual effects will have to be carefully discovered. Furthermore, responses could be encoded for each archetype and then testing new emotional states becomes straight forward. Each emotional state's effect on each archetypal emotion would be clear and distinct, instead of being lumped into the secondary category as they are now. With this information at hand, better claims could be made as to the magnitude of each state's effectiveness as well as the presence or absence of emotional overlap. There are other opportunities for studies about the detailed interaction between the primary emotional archetypes, and the large variety of secondary emotional responses like lost, wonder, excitement, and boredom.

A published version of the emotion manager used in this experiment for programmatically switching between emotional states will be available on the Unity Asset Store. This can be used as a starting point for developing more diverse and better emotional experiences, and is easily importable into any existing Unity project. The only downside is that the Interactive Audio: Enchanted Forest asset that generates ambient noises is not free and therefore must be left out.

To add credence to the technique, further studies can be performed as to the effect of the given game task on emotional response. Are players more likely to feel one way if the given task is slow and monotonous and another way if the given task is fast paced and dynamic? The intuitive answer is yes, but it is not entirely clear which emotions are affected and to what magnitude. This work does not require an answer to this question to be compelling, but for some applications it would certainly be useful.

In this age of graphically intense video games, and multi-million dollar budgets the emphasis on emotional response seems to be lost. These things are expected by today's market, but it is my sincere hope that this work will free developers to pivot their focus back to Jesse Schell's primary goal of invoking genuine, intentional emotional responses. The concept is demonstrated, the groundwork has been completed, and it is not expensive to implement into existing or ongoing work. Now it is time to see how it can be used to drive innovation and fuel a new wave of emotion-centric, passion driven game design.

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APPENDICES

APPENDIX A ADDITIONAL SCREENSHOTS

Figure 17. Extra screenshots of the city environment in each emotional state.

Figure 18. Extra screenshots of the forest environment in each emotional state.

Figure 19. Extra screenshots of the alien environment in each emotional state.

APPENDIX B PLAYER SURVEY

INFORMED CONSENT TO PARTICIPATE IN THIS RESEARCH PROJECT

A research project on game playing experience is being conducted by graduate student Keenan Reimer (Industrial and Manufacturing Engineering) and Dr. Foaad Khosmood (Computer Science) at Cal Poly, San Luis Obispo. The purpose of the study is to gauge player emotions while experiencing an interactive scene.

You are being asked to take part in this study by playing three short interactive game scenes, and completing the following questionnaire. Your participation will take approximately 20 minutes. Please be aware that you are not required to participate in this research, you may omit any items that you prefer not to answer, and you may discontinue your participation at any time. There are no risks anticipated with participating in this study.

Your responses will be provided confidentially to protect your privacy. Your name is used only to match different surveys with each other and will never be used or publicized in any form. As an incentive, you will be offered a free pizza lunch for the day of the study. Potential benefits from this research include greater understanding of the interaction between electronic gaming and human emotions.

If you have questions regarding this study or would like to be informed of the results when the study is completed, please feel free to contact Dr. Foaad Khosmood at foaad@calpoly.edu. If you have concerns regarding the manner in which the study is conducted, you may contact Dr. Michael Black, Chair of the Cal Poly Human Subjects Committee, at (805) 756-2894, mblack@calpoly.edu, or Dr. Dean Wendt, Dean of Research, at (805) 756-1508, dwendt@calpoly.edu.

If you agree to voluntarily participate in this research project as described, please indicate your agreement by playing the game scenes, and completing and submitting the following questionnaire. Please print a copy of this consent form now for your reference, and thank you for your participation in this research.

- ☐ Yes I volunteer, and read the above disclaimer before participating.
- ☐ No, I do not volunteer.

BASIC INFORMATION

What is your age?

How many hours a week do you spend playing video games?

What is your game code? (Displayed on-screen)

What is your score? (Displayed on-screen)

Have you participated in this study before today?

- ☐ Yes
- ☐ No

EMOTIONS

Please describe any feelings or emotions that you felt during your experience:

What dominant feeling did you experience?

What was the magnitude of the dominant feeling?

	1	2	3	4	5	
Weak						Strong
	☐	☐	☐	☐	☐	

Please check any of the below words that pop out to you based on your experience:

- ☐ Forest
- ☐ Earth
- ☐ Time
- ☐ Magic
- ☐ Fear
- ☐ Atoms
- ☐ Awareness
- ☐ Calm
- ☐ Lick
- ☐ Peace
- ☐ Fortune
- ☐ Waffle
- ☐ Anxiety
- ☐ Sleep
- ☐ Wheel
- ☐ Valley