Towards the Design of Affective Survival Horror Games: An Investigation on Player Affect

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***Abstract*—An upcoming trend of affective gaming is where a player's emotional state is used to manipulate gameplay. This is an interesting field to explore especially for the survival horror genre that is excellent at producing player's intense emotions. In this research, we analyzed different player affective states prior to (i.e., Neutral, Anxiety, Suspense) and after (i.e., Low-Fear, Mid-Fear, High-Fear) a scary event using an affect annotation tool to collect player self-reports of their affective states during the game. Brainwave signals, heart rate and keyboard-mouse activity were also collected for analyzing the potential of automatically detecting horror-related affect. Results indicated that players were more likely to experience fear from a scary event when they were in a suspense state compared to when they were in a neutral state. In this state, players only experienced fear after experiencing surprise. Heart rate data gave the best result in classifying player affect, which achieved up to 90% overall accuracy. This highlights the potential of using player affect in survival horror games to adapt a scary event to evoke more fear from players.**

Keywords—affective gaming; survival horror; emotion; physiological; anxiety; suspense; fear

I. INTRODUCTION

Over the past 15 years, the Survival Horror game genre has brought the conventions of horror films to interactive media thereby creating a new realm of horror that go beyond films, by giving audiences a power to control the fate of protagonist themselves. Because of many possible actions that a player can take, game designers need to cover all possibilities and try to deliver horrific experience to any path players might take. This difficulty is the reason why most survival horror games tend to have limited choices and rely on sudden/surprising scary events rather than aiming for long psychological horror experience even though this aim has shown better success in delivering horror experience such as *Silent Hill* series and *Amnesia: The Dark Descent* (2010). While the fear manipulation approach normally comes from the creative instinct of game developers [1], better understanding of how player's affective state works during survival horror games would help the developers to design and create more believable fear scenarios.

The form of gameplay where the player's current emotional state is used to manipulate or adapt a game scenario, is commonly referred to as affective gaming [2]. There is a growing attention in the role of affect in videogames [3], which seem to focus on detecting player's emotion as well as tailoring the game responses to reduce player's frustration or induce proper challenges [4,5]. However, survival horror is unique compared to other game genres since it has an additional set of horror-related emotions (e.g., anxiety, suspense, fear) that need to be more carefully crafted than other common game emotions. Studying how player affective states change while playing a survival horror game can help improve the design quality. This will consequently improve the contribution of survival horror games as a good fear eliciting tool for studying general affective design in horror media.

There has not been any work that looks deeply into player affect when playing survival horror games or into how player affect translates between scary events in the game. In this work, we captured those affective states by letting players label their emotions after playing the game and as they watched a recorded video of their gameplay and facial expressions. Brainwaves and heart rate signals were also collected to test potentials in automatically detecting player emotions.

We start by reviewing existing research in horror media emotions, horror games and utilization of physiological measures. We then briefly introduce tools and experiment procedures used for collecting and processing data in this work. Finally, we discuss our results and conclusions.

II. RELATED WORK

Common emotions that have been mentioned across horror fiction, movies and games are anxiety, suspense and fear [6]–[8]. Although some research considers anxiety and suspense as part of a fear experience [1], these three emotions can be distinguished by the concreteness of how a threat is perceived. Fear is an emotional response to a specific threat or an attempt to cope with threatening events that have already been seen [9]. On the other hand, anxiety and suspense occur due to the uncertainty of an upcoming dangerous situation. Anxiety is usually caused by the uncertainty towards an enigmatic or unspecific threat [7,9] while suspense is usually caused by the uncertainty of an outcome from a threat [6]. Fear and anxiety are considered to be different emotions while suspense overlaps across the other emotions [10].

Most research on survival horror games tried to find a way to elicit more fear intensity from the player using various approaches. Dekker and Champion [11] tried to increase augmented horror by using the player's biofeedback to dynamically modify the game. Although results from their survey indi-

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cated heightened horror experience, analysis on biofeedback data was not discussed in detail. Garner et al. [12] tried to relate different sound properties (e.g., pitch, loudness and 3D positioning) to a player's fear intensity response, using the players' in-game action and real-time vocal response for evaluation. However, no conclusive evidence was found to support sound properties' effects on players' fear. This work attempted to collect multiple subjective data during the game but was only limited to instances when scary sounds were played. Toprac and Meguid [10] also tried to determine how to promote fear, suspense and anxiety in players by using different sound properties (e.g., volume, timing, source). Self-report surveys and interviews were gathered and suggestions on sound design were discussed. The potential of using player emotional states to manipulate the game and increase the response intensity is something that has not yet been investigated in the scope of a survival horror genre.

The benefit of using physiological measure is that it provides more objective and precise information of the player's emotion and cognitive processes than subjective methods. It can also be recorded automatically and continuously during the game without interrupting the player [13]. Researchers have used physiological measure to study different aspects of the game, such as the effect of game events to player emotions or the correlation between physiological signals and player gameplay experience [14,15]. Rajava et al. [16] tested the reliability of physiological responses in predicting different emotions elicited by game events and examining whether a given game event elicits the targeted emotional response. Weber et al. [17] used heart rate (HR) and skin conductance (SC) as indicators of player arousal levels and for further analyzing the effect of game events on different players. Their results showed that violent game actions committed by players on the same game could be more valid predictors of violence than comparing two groups of players who play violent and non-violent games. Martinez et al. [3] also made use of HR and SC to predict player affective states (i.e., frustration, fun, challenge). The results show a strong dependency between the subsets of physiological features to an affective model even in different datasets from different games. An attempt to evaluate a player's emotional state continuously during gameplay has been done by Mandryk and Atkins [18] using a fuzzy logic model to transform physiological data to the arousal-valence space and then to game-related emotions. These works show the potential of using physiological measures for analyzing the effect of in-game events and player affect transitions during such events. This analysis could be very beneficial for survival horror games since game events were mainly utilized for affecting player emotions in this type of games.

III. DATA COLLECTION

In this section, we briefly introduce the game environment that we used to elicit emotional responses from the player and the data we collected that includes electroencephalography, electrocardiography and keyboard-mouse activity. Then, we show how the participants' subjective ratings were collected using an affect annotation tool developed for this particular purpose. Lastly, the experiment procedure and the participants' information are discussed.

A. Game

The survival horror game we used for the experiment is called *Slender: The Eight Pages* (STEP), a free downloadable indie-developed game that is based on the internet mythos of the Slender Man, a faceless creature who passively stalks his targets until they mentally break down and vanish with him. STEP's first released in June 2012 and the updated version (v0.9.7) was used in this experiment. STEP was praised for its simple yet effective horror approach. Gaming website IGN even called this game "pure horror". STEP uses a first-person shooter (FPS) control style and the player is situated in the middle of a forest with the objective of collecting eight pages of paper scattered randomly around 10 areas while avoiding being captured by the Slender Man. Without using any violent visual effects, STEP makes used of sound to create an atmosphere of being followed by the Slender Man. Since the game ends with either the Slender Man is being too close or the player looks at the Slender Man for too long, the player's awareness of the Slender Man's presence becomes heightened. The game takes about 5-20 minutes regardless of whether the player collected all eight pages or got captured by the Slender Man. The random placement of the pages to be collected by the player, some random behavior of the Slender Man and changes in the player's decision make each game different resulting in varied scary situations even for the same player.

B. Electroencephalography

Electroencephalography (EEG) is the recording of electrical activity of the brain and has been used in several literatures on emotion recognition [1,2]. For our research, we used the Emotiv EPOC (www.emotiv.com), which is a high resolution, multi-channel, wireless portable EEG system for recording EEG data. Based on the international 10-20 system, 14 electrodes are placed on the scalp at the AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8 and AF4 positions and electrical activity is recorded with a 128 Hz sampling rate. Additionally, 2-axis MEMS-based gyroscope data are provided along with the 14 EEG channels.

C. Electrocardiography

Electrocardiography (EKG) is the measurement of electrical activity that is generated by the heart over a period of time, and heart rate (HR), inter-beat interval (IBI) and heart rate variability (HRV) can be computed using EKG. In different studies, the heart rate has been used as an indicator of both valence and arousal [11,19,20]. In this work, EKG signals were recorded at 2048 Hz by ProComp5 Infiniti and EKG-Flex/Pro sensor (www.thoughttechnology.com) by attaching three electrodes on the subject's chest and abdomen. HR, IBI and HRV were then computed from the EKG signals.

D. Keyboard and mouse activity

Players might display different behaviors when pressing keyboard buttons or moving the mouse while experiencing fear. Hence, we developed a Keyboard-Mouse Activity (KMA) capturing tool that collected activity from key assigned to the gameplay controls, as well as mouse clicks and cursor position changes. All data were recorded at 1 Hz sampling rate.

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E. Affect annotation tool

In order to capture player affect during the game, Affect Annotation Tool (AAT) was developed and used to display gameplay and player's facial videos simultaneously while the player watched and annotated his affect continuously throughout the video. MSI Afterburner (v2.3.1) and Window Live Movie Maker (2011) were used for recording gameplay and player's facial videos respectively. Fig. 1 shows a screenshot of the AAT wherein the gameplay video is playing at the left side and player's facial expression is at the right. Below the videos is the timeline showing the current game time and the annotation bar showing the self-reported affective state. In this work, we focused on player emotional responses prior to and after the appearance of the Slender Man since it is the main scary event of the game and can occur multiple times during the game. An affective state is labeled as 1) "Neutral" if there is no certainty on the presence of Slender Man or if the player is feeling bored, 2) "Anxiety" if the player thinks that the Slender Man is near or is going to appear soon but does not know or cannot imagine how the Slender Man is going to show up and 3) "Suspense" if the player has a strong feeling of how the Slender Man is going to appear. We call these three emotions *pre-fear* affect. After the Slender Man is seen, the player experiences *post-fear* affect and needs to annotate the amount of fear experienced when the Slender Man appeared namely, 1) "Low-Fear" if fear was not experienced or a very low level of fear was experienced, 2) "Mid-Fear" if a normal level of fear was experienced, and 3) "High-Fear" if it was really scary. The player stays on post-fear affect until a new scary event is anticipated and goes back to annotating the situation as pre-fear affect. AAT recorded player affect with 1 Hz sampling rate.

Fig. 1. Screenshot of Affect Annotation Tool (AAT)

F. Experiment procedure

All players were first asked to fill out a pre-questionnaire to provide information such as their age, gender, horror preference, experience in FPS game style control and their experience in STEP. Players were then asked to relax for 30 seconds and then watch the STEP trailer for another 90 seconds while EEG and EKG signals were recorded. The purpose of the relaxation phase was to capture the minimum baseline values. Showing the trailer became necessary since the game itself has no prologue or introduction to acquaint the player of what to be careful and fearful of. In other words, the trailer was presented to elicit some feeling that the Slender Man is the threat and the player needs to be scared of getting captured by him. Without it, the player might lose the first game knowing nothing. After recording the baseline values, players played STEP while EEG, EKG and KMA data were collected. Immediately after the game is played, the players annotated their affect. The players were also asked to rate how much fear and fun they experienced in that game using a 5-point likert scale. Playing and annotating sessions were then repeated for two more times thereby resulting to three sets of data for each player. Finally, the players were asked to answer a post-questionnaire.

G. Participants

Eleven participants (6 Male, 5 Female) aged between 21 and 32 years old (Mean=26.45, SD=3.11) took part in this experiment. There were 3 participants who considered themselves as gamers, 2 participants were not and the other 6 participants considered themselves as casual gamers. For horror preference, 4 participants did not like horror movies or games, 4 participants felt neutral and 3 participants liked to watch or play horror movies or games. There were 3 participants who do not know the FPS type controls and 5 participants who know the controls but were not familiar with it. There were 2 participants who have played STEP before and other 2 participants who knew STEP but have not played it before.

IV. DATA PRE-PROCESSING

To apply machine learning algorithms to the data, which came from different tools with different sampling rates and scales, all data were first resampled to 1 Hz by averaging their values, so that they have the same sampling rate as the annotated affect data. After which, EEG and KMA statistical features were extracted by computing the average and standard deviation of the past 2, 5 and 10 seconds of data. For the EKG signals, we used additional features computed by the ProComp5 Infiniti tool which extracted HR, IBI and their statistics from EKG signal. All features were then normalized to a [0, 1] scale using data from the three gameplay sessions and the baseline data of each player using the formula shown in equation (1). This resulted for each instance a feature vector consisting of 159 normalized values from the EEG, EKG, KMA signals, and labeled with a subjective affect class.

$$A_{\text{normalized}} = \frac{A - \min(A)}{\max(A) - \min(A)} \tag{1}$$

V. RESULTS

To analyze the results, we first looked at the potential of using physiological signals for automatically predicting player affective states. Then, we analyzed player affect transitions to find out how to improve the scariness of survival horror games using player affect. Finally, information from the questionnaire was analyzed.

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A. Classification result

We decided to combine altogether the feature sets from each game and each player during classification in order to build a generalized predictive model. Data from three players were not used for classification due to some missing EEG data that occurred during the experiment. Hence, for building our predictive models, we used data from eight players consisting of 15,699 instances. The number of instances belonging the Neutral (N), Anxiety (A), Suspense (S), Low-Fear (LF), Mid-Fear (MF) and High-Fear (HF) are 47.8%, 25.6%, 16.4%, 4.0%, 3.8% and 2.4%, respectively. The C4.5 and Multilayer Perceptron (MLP) algorithms were used to create predictive models, which were evaluated using 10-fold cross validation. Table I shows the percentage of instances correctly classified by C4.5 and MLP when all features were used and when EEG, EKG and KMA features were used separately.

TABLE I. CLASSIFICATION RESULT

Classifiers	All	EEG	EKG	KMA
C4.5	***86.1%***	***72.8%***	***90.8%***	***61.2%***
MLP	***78.4%***	***65.4%***	***65.4%***	***52.8%***

The results showed considerably high prediction accuracy by the models considering that we used these algorithms without any specific modifications for the prediction. Specifically, using C4.5 on EKG features alone achieved the highest accuracy which was even higher than when all features were used together. Using MLP on EKG features did not achieve results as high as C4.5. While the result from EEG and KMA were considerably low and might not be usable yet, it does not mean that these features are not capable of detecting emotion. Better EEG and KMA related features might be needed to improve the prediction accuracy.

Using C4.5 and EKG features, F-measure achieved 0.96, 0.88, 0.88, 0.82, 0.8 and 0.75 for predicting N, A, S, LF, MF and HF, respectively. Post-fear affect got considerably lower accuracy compared to the first three pre-fear states which could have been caused by the data being skewed towards the pre-fear affect. To increase the accuracy over the skewed data, we divided and did the classification separately for pre-fear affect and post-fear affect classes. F-measure for LF, MF and HF increased to 0.92, 0.86 and 0.82, respectively, and 0.96, 0.88 and 0.91 for N, A, and S. The predictive models for pre- and post-fear affect can be utilized separately depending on the game context (e.g. pre- and post-scary event).

Knowing the players' pre-fear affect can help support game designers to find the best timing for showing a scary event to a player in order to maximize the scariness of the event. For post-fear affect, it can be used to evaluate the effectiveness of the scary event that the player saw and to use that result to adapt the upcoming event in a way that will be scarier to the player. Nevertheless, our result showed the promising potential of using EKG signals in automatically predicting player horror-related affect while playing survival horror games.

B. Affect transitions

With the subjective affect that players reported using with AAT, we can investigate how player affect transitioned between pre- and post-fear affect with the appearance of the Slender Man. To measure the likelihood of transitioning from pre-fear affect to post-fear affect, we used the transition likelihood function introduced by D'Mello et al. [21] which was used in measuring the likelihood of transitioning between students' affective states while using an intelligent tutoring system presented in equation (2). The likelihood function served as a better measurement of transition likelihood than using probabilities because it measured the transition likelihood relative to the base rate of each emotion. All pairs of affect transitions from pre-fear affect (F_{pre}={N,A,S}) to post-fear affect (F_{post}={LF,MF,HF}) were counted and used to compute transition likelihood.

$$\mathrm{L}(F_{pre} \rightarrow F_{post}) = \frac{\Pr(F_{post}|F_{pre}) - \Pr(F_{post})}{1 - \Pr(F_{post})} \tag{2}$$

$\Pr(F_{post})$ function returned the probability of player emotion transitioning from any pre-fear affect to F_{post} affect, and the $\Pr(F_{post}|F_{pre})$ function returned the probability of players transitioning to the F_{post} affect given that they were previously experiencing an F_{pre} affect. Transition likelihood L returns value ranging from $-\infty$ to 1 where $L>0$ indicates a likely transition with increasing likelihood as it approaches to 1, $L=0$ indicates that the transition probability is equal to chance and $L<0$ means that the transition is less likely to occur compared to the base rate of players transitioning into the F_{post} affect. Table II shows the resulting matrix of transition likelihood values for each pair between F_{pre} and F_{post} with the positive transition likelihood values highlighted.

TABLE II. TRANSITION LIKELIHOOD FROM PRE-FEAR TO POST-FEAR

From\To	Low-Fear	Mid-Fear	High-Fear
Neutral	***0.06***	***0.22***	***-0.26***
Anxiety	***0.09***	***0.10***	***-0.16***
Suspense	***-0.05***	***-0.12***	***0.14***

This result indicates that players were likely to transition into a high-fear state if they faced the Slender Man while experiencing the suspense emotion. Neutral and anxiety had positive transition likelihood values to both low- and mid-fear with neutral had higher likelihood towards mid-fear than anxiety. When we looked at individual transitions from neutral state, players would rate with higher fear when the Slender Man got them surprised while there were not as many big surprises when they were in the anxiety state. Also, players were normally surprised only in the 1st or 2nd game because they became more accustomed to the Slender Man each time.

This result suggests that stimulating player affect to a suspense state is the best way to maximize the effectiveness of producing a scary event. This result also supports the study of Perron [11] that showed many successful examples of forewarning techniques used in horror movies and horror games,

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suggesting that long anticipation of a harmful confrontation (suspense) is more disturbing than short anticipation (surprise). In the case of affective survival horror games, we can use player affect as an input so that the game can detect if the previous forewarning technique was enough to cause the player to experience suspense. If not, the game can delay the scary event and make use of other game elements, such as sound or some distorted vision to try to elicit suspense before actually showing the scary event to the player.

We also investigated the transition likelihood between F_{pre} to see how STEP built up player emotion during the time when the Slender man has not yet appeared (see Table III).

TABLE III. TRANSITION LIKELIHOOD BETWEEN PRE-FEAR AFFECT

From\To	Neutral	Anxiety	Suspense
Neutral		*0.71*	*-0.13*
Anxiety	*0.40*		*0.25*
Suspense	*-0.25*	*0.81*	

When players were in a neutral state, they were likely to transition to anxiety but not likely to transition directly to suspense. While they were in an anxious state, they were likely to transition to both neutral and suspense, and when in a suspense state, they were likely to move into an anxious state. Unlike the transitions from pre- to post-fear affect, which is the result of the Slender Man's appearance, transitions between pre-fear affective states were not caused by any specific event. Sometimes players transitioned from neutral to anxious when they collected a page and music started playing. However, there were times when the player affect changed without any changes in the game. To investigate how each game element affects player, it is necessary to know how and when each game element is used so that we can find the relation between game elements and affect transition, however, it is difficult without an access to that information in STEP. These results show that STEP built up players' emotions by moving them from a neutral state to an anxious state, an anxious state to a suspense state, and then back to an anxious state and then a neutral state. However, there were not many transitions between neutral and suspense states in the game.

After seeing the Slender Man, players moved to F_{post} and stayed there until they started to anticipate a new scary event. In this state, there were also transitions between F_{post} which was caused by the scary event. Transition likelihood between F_{post} was computed and shown in Table IV.

TABLE IV. TRANSITION LIKELIHOOD BETWEEN POST-FEAR AFFECT

From\To	Low-Fear	Mid-Fear	High-Fear
Low-Fear		*0.84*	*-0.19*
Mid-Fear	*0.40*		*0.31*
High-Fear	*-0.30*	*1*	

Similar to the transitions between F_{pre}, players were likely to transition from low- to mid-fear and high- to mid-fear. From mid-fear state, they were likely to transition to either low- and high-fear, with a little more possibility to low-fear. There was not any transition from high-fear to low-fear from the entire data and there were only few transitions from low to high-fear. Although there is a possibility that players might get higher fear as a scary event goes on, these results suggest that eliciting the high-level fear from a player at the start of a scary event is better if the objective is to keep the player in the high fear state along the course of a scary event.

C. Questionnaire result

Players were asked to rate how much fear and fun they experienced after each game and also asked to rate the overall fear and fun of all games they played using a 5-point likert scale. The average of overall fear ratings was 3.82 (SD=0.75) and the average of overall fun ratings was 3.46 (SD=0.82). When looking at after-play ratings, the average of after-play fear was 3.6 (SD=0.98), while the average of after-play fun was 3.44 (SD=0.84). Similar results for overall and after-play ratings where fear ratings were higher than fun ratings. It can be observed that almost all the players who rated overall fear higher than overall fun were those who do not like horror media, hence, they also do not enjoy being scared by the game.

The average fear ratings after the 1st, 2nd and 3rd play from all players, were 3.5, 3.55 and 3.73, respectively, while the average fun ratings were 2.7, 3.64 and 3.91, respectively. ANOVA test clearly indicated statistical difference between the average fun ratings in each play ($p<0.001$), but without any statistical significance for the average fear ($p>0.05$). The reason why players had considerably higher fun later in the gameplay is probably because they were likely to know STEP better in latter games, like knowing how to escape when the Slender Man is near. This allowed them to be more immersed in the game and experienced more fun, especially for those who had not seen or played STEP before. Although fear ratings remained consistent across three gameplays, many players reported that they felt less fear in the latter games. One player mentioned that it took less time to feel relief after seeing the Slender Man in the 2nd and 3rd games.

We also asked players to rate the scariness of game elements with using a 5-point likert scale. Table III shows the description and average scariness rating for each game element asked in the post-questionnaire.

TABLE V. SCARINESS RATING OF GAME ELEMENTS

Game elements	Description	Avg. rating
Slender Man	Main threat of STEP, appear randomly	***3.27***
Shock sound	Played when the Slender Man has been sighted	***4.91***
Music	Mute at first, more intense as the game progress	***4.09***
Static screen	Shows when the Slender Man is close to player	***3.73***

Shock sound was considered by most players to be the scariest game element in STEP, with music coming in at second. Although the music that imitates sound of footsteps caused players to be aware of the Slender Man at first, it became static over time when the players did not make progress through the game or the Slender Man did not really appear. Shock sound, on the other hand, made players know that the Slender

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Man was already in front of them and the feeling of having to do something to get away from the Slender Man made the sound very scary to players even if they have already heard it for many times or even if they haven't really seen the Slender Man yet. Other than sound, the static screen was a visual element that scared players with a similar effect as the shock sound. The difference, however, is that instead of telling the players that the Slender Man was in front of them, it just alerted them that the Slender Man is near. The probable reason why the Slender Man got a slightly low rating was that the Slender Man did not make any explicit actions to attack the players. Most of the time, the players were just scared of losing rather than being scared of seeing the Slender Man.

There are no conclusive answers that players gave when they were asked about what caused them to feel anxiety or suspense. Many players said that the music was the cause of anxiety because they knew that as soon as the music started, the Slender Man also started following them. However, some players answered that the music made them experience suspense. This indicates that each player may have their own way of differentiating anxiety and suspense. It is also possible that the same game element might have had different effects on players. We also think that it was difficult for players to recall exactly how they reacted to certain game elements which suggests the benefit of using real-time affect detection tools for mapping changes in player affect to game elements.

VI. CONCLUSION

In this work, we investigated emotions in horror-related entertainment and the possibility of bringing an affective gaming concept to the survival horror game genre. We conducted an experiment by collecting EEG, EKG and keyboard-mouse activity from players while they were playing the survival horror game called "Slender: The Eight Pages". Continuous subjective affect, which included pre-fear affect (i.e., neutral, anxiety, suspense) and post-fear affect (i.e., low-, mid-, high-fear), was also annotated by players after each play using our own Affect Annotation Tools. Results showed the potential of EKG signals in predicting player horror-related affect and found that the suspense state has the most effect in maximizing the scariness of a game event. Players also identified that sound elicited anxiety and suspense during the game. We only used simple approaches for our analysis due to the lack of similar research related to the study of player affect in survival horror games.

For future work, we want to investigate further the relationship between player affect and game elements. We want to identify which game element is best suited for causing anxiety or suspense. We will, however, need to either create our own game or use an existing one that allows modification so we can adapt and retrieve the information we need.

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