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An analysis of affective state transitions in survival horror game with the aid of player self-reports and physiological signals

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The current trend of indie survival horror games reveals some level of success in using randomly generated events or the randomness of AI behavior as main scaring technique and to extend game replayability. With more insight on how player's affective states transitioned while playing survival horror games, the effectiveness of scary events could be increased. This paper analyzes the impact of different player affective states prior to (Neutral, Anxiety, Suspense) and after (Low-, Medium-, High-Fear) a scary event. Affect annotation tool was used to collect player's pre and post scary event affect while playing a survival horror game. The player's brainwave signals, heart rate and in-game actions were also collected for testing the potential of automatic measurement of horror game-related affect. Initial results indicated that players are more likely to get more fearful of a scary event when they are in suspense state, and the heart rate showed a good potential on differentiating players' neutral, anxiety and suspense states. Game designers could utilize player's affective state for maximizing player's fear level by slowly building tension until the player got into the target pre-scary event emotion, and then play the scary event.

1. Introduction

The term "survival horror" was first introduced by Resident Evil (Capcom, 1996) and the survival horror genre had become a famous game genre as many game developers tried to follow the successful direction of the game. However, the nature of survival horror is the limited way of fighting hostiles and the slow speed tension building, eventually, more and more players turned their interest towards exciting action games instead. The golden age of survival horror ended with the release of Resident Evil 4 (Capcom, 2005) that turned away from the genre it had established by adding many action elements to the game which consequently reduced horror aspect of the game. While the popularity of survival horror began to fade away from the game market, an indie game called Amnesia: The Dark Descent (Frictional Games, 2010) had successfully brought the genre back to life and was praised by many critics for its decent atmosphere and horror elements. The game had showed that they are still many players out there who still hunger for more survival horror games.

There are two interesting free downloadable indie-developed survival horror games that were released recently, Slender: The Eight Pages (Parsec Productions, 2012) and SCP: Containment Breach (Regalis, 2012). The first game was praised for its simplicity using very few horror approaches, some critic even went as far as calling this game a "pure horror". Player has an objective of finding eight pages of paper scattered around the forest while being pursuit by Slender Man who randomly teleported around the map to find and create random surprise encounter and pressure player to be aware of Slender Man all the time. SCP: Containment Breach, on the other hand, has more complex environment and different variety of enemy. The key element of the game is the randomly generated map, making it possible to play the game multiple times and still has different experience. These two games have showed that, by including some randomness into the main horror approach of the games, it can extend the replayability of the game and can create an endless amount of memorable horror scene to any players. From our knowledge, there is not any work that tries to find the way to improve this kind of horror approach by investigating into players affect while they are playing survival horror games.

In this work, we captured players' affective states during the play experience by letting players label their emotions continuously while watching their gameplay video along with their facial expressions. Brainwaves, heart rate and keyboard-mouse activity were collected during the course of the game for further analyzing their potentials in automatically detecting player emotions.

Next section, we start by reviewing works that related to horror media emotions, horror games and utilization of physiological measure. We then briefly introduce tools and experiment procedures that we used for collecting physiological signals and players affect. Finally, we discuss our results and conclusion.

2. Related works

Common emotions that have been mentioned across horror fiction, movies and games are anxiety, suspense and fear [Falsafi 11, Perron 04, Prieto-Pablos 98]. Although some research considers anxiety and suspense as part of a fear experience [Garner 11], 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 [Öhman 07]. On the other hand, anxiety and suspense occur due to the uncertainty of an upcoming dangerous situation. Anxiety is usually caused

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by the uncertainty towards an enigmatic or unspecific threat [Falsafi 11, Öhman 07], while suspense is usually caused by the uncertainty of an expected outcome from a threat confrontation [Prieto-Pablos 98]. Fear and anxiety are considered to be different emotions while suspense overlaps between the other emotions [Toprac 11].

Most research on survival horror games tried to find a way to elicit more fear intensity to player using different ways. Dekker and Champion [Dekker 07] tried to increase augmented horror by using player's biofeedback to dynamically modify the game. Result from their survey indicated the improvement of horror however analysis on biofeedback data was not discussed in detail. Garner et al. [Garner 10] tried to relate different sound properties (pitch, loudness, 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' effect 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 [Toprac 11] also tried to determine how to promote fear, suspense and anxiety in players by using different sound properties (volume, timing, source). Self-report surveys and interviews were gathered and suggestions on sound design were discussed. The potential of using player's emotional state 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 process than subjective methods. It can also be recorded automatically and continuously during the game without interrupting the player [Kivikangas 10]. Researchers have used physiological measure to study different aspects of the game such as the effect of game events, to predict player experience or to model emotion. Rajava et al. [Rajava 05] 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. [Weber 09] used heart rate (HR) and skin conductance (SC) as an indicator of player's 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. [Martinez 11] also made use of HR and SC to predict player's 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 player's emotional state continuously during gameplay has been done by Mandryk and Atkins [Mandryk 07] using a fuzzy logic model to transform physiological data to the arousal-valence space and then to game-related emotions. These works showed the potential of using physiological measure for analyzing an effect of in-game scary events and player affect transition during such events, which could be further used for adapting the events to suit player even better in the later course of the game. This will benefit games that utilize some randomness into their scary events such as Slender: The Eight Pages very much because the scary events are always adaptable.

3. Data collection

In this section, we briefly introduce the game environment that we used to elicit players' emotions, the data we collected including electroencephalography, electrocardiography and keyboard-mouse activity. Then, we show how we collected players' subject affect using Affect Annotation Tool. Lastly, the experiment procedure and the participants' information are explained.

3.1 Games

The survival horror game we used for the experiment is Slender: The Eight Pages (STEP). 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 when the player looks at the Slender Man for too long or the Slender Man comes too close to player, the player's awareness of the Slender Man's presence is also heightened. The game takes between 5-20 minutes regardless if 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, the random behavior of the Slender Man and changes in the player's decision and behavior make each game different resulting in varied scary situations even for the same player.

3.2 Electroencephalography

Electroencephalography (EEG) is the recording of electrical activity of the brain and has been used in several literatures on emotion recognition. For our research we used the Emotiv EPOC Headset (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 at the AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8 and AF4 positions on the scalp and retrieves electrical activity with a 128 Hz sampling rate. Additionally, 2-axis MEMS-based gyroscope data are also provided along the 14 EEG channels.

3.3 Electrocardiography

Electrocardiography (EKG) is the measurement of electrical activity that is generated by heart over a period of time, and heart rate (HR), interbeat interval (IBI) and heart rate variability (HRV) can be computed from EKG. In different studies, heart rate has been used as an indicator of both valence and arousal. In this work, EKG signals were recorded at 2048 Hz by ProComp5 Infiniti and EKG-Flex/Pro sensor (www.thoughttechnology.com) by attaching 3 electrodes on the subject's chest and abdomen. HR, IBI and HRV were then computed from the EKG signals.

3.4 Keyboard and mouse activity

Players might display different behavior in pressing keyboard buttons or moving the mouse while experiencing fear, so we developed a Keyboard-Mouse Activity (KMA) capturing tool that collected data when the keys for movement and running were pressed as well as mouse clicks and mouse movement distance. All data were recorded at 1 Hz sampling rate.

3.5 Affect Annotation Tool

In order to capture the player affect during the game, we developed the Affect Annotation Tool (AAT). After each game, gameplay video and player's facial expressions, which were recorded while they played the game, were shown through the AAT interface. While watching, the player can annotate affect continuously throughout the video. Fig. 1 shows a screenshot of the AAT wherein the gameplay video is playing at the left side and player's facial expression at the right. Below the videos is the timeline showing current game time and the annotation bar shows the affect that player had annotated. A different color is used for each affective state. In this work, we focused on player emotional responses prior to and after the appearance of the Slender Man which is the main scary event of the game and can occur multiple times during the game. As the player walks around the world, affect is annotated 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 Slender Man going to appear. We called these three emotions pre-fear affect. After the Slender Man is seen, the player experiences post-fear affect and needs to annotate how much fear was experienced from the appearance of the Slender Man as 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)

3.6 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 games 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 as baseline values. A trailer of the game was shown to elicit fear towards the Slender Man especially for players who do not know STEP or are not familiar with horror games. Then, players played STEP, and annotated their affect for 3 repetitions. This resulted in 3 sets of temporal EEG, EKG, KMA and affect annotation data for each player. After each game, the players were also asked to rate how much fear and fun they experienced in that game using a 5 point likert scale. Finally, the players were asked to answer a post-questionnaire.

3.7 Data pre-processing

To apply machine learning algorithms to the data that came from different tools with different sampling rates and scales, all data were first resampled to 1 Hz so that they have the same sampling rate with annotated affect data. Then, EEG and KMA statistic features were extracted by computing average and standard deviation of the past 2, 5 and 10 seconds of data. For EKG, we used additional features computed by ProComp5 Infiniti tool which extracted HR, IBI and their statistics from EKG signal. All features were then normalized into [0, 1] scale using data from the 3 gameplay sessions and the baseline data of each player using the formula shown in equation (1).

$$A_{\mathrm{normalized}} = \frac{\mathrm{A}-\min(\mathrm{A})}{\max(A)-\min(A)} \qquad (1)$$

This resulted in a feature vector consisting of 159 normalized values from EEG, EKG, KMA and 1 subjective affect class for each instance.

3.8 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 them-selves 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 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.

4. Results

In this section, we first analyze the information we got from questionnaire, and then we move to analyze subjective affect data labeled by players using AAT. Finally, the potential of physiological signals in automatically predicting player affect is shown.

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 and standard deviation of overall fear were 3.82 and 0.75 respectively, and the average and standard deviation of overall fun were 3.46 and 0.82 respectively. When looking at after play rating, the average and standard deviation of after play fear were 3.6 and 0.98, while the average and standard deviation of after play fun were 3.44 and 0.84 respectively. Similar results for overall and after play rating where fear ratings were higher than fun rating. This can be observed that almost all players who rated overall fun higher than overall fear were the players who do not like horror media. The average fear values after the 1st, 2nd and 3rd play from all players, were 3.5, 3.55 and 3.73 respectively, while the average fun values were 2.7, 3.64 and 3.91 respectively. The reason why players had considerably higher fun in later games is probably because they were likely to know STEP better in later games, like knowing how to escape when the Slender Man is near. This allowed them to be more immersed in the game and experience more fun especially for players who had not seen or played STEP before. When asking players if they felt any difference playing the game on 2nd and 3rd times compared to the 1st game, players who had not played STEP before answered that the 1st game was the scariest game and they felt less fear but had more fun in the later game. 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 1-5 point scale. Table I shows the description and average scariness rating for each game element asked in post-questionnaire

TABLE I. SCARINESS RATING OF GAME ELEMENTS

Game elements	Description	Avg. rating
Visual	Overall game visual	***3***
Darkness	Vision becomes darker as the game progress	***3.36***
Slender Man	Main threat of STEP	***3.27***
Environment sound	Walking, wind sound	***3.72***
Shock sound	Played when the Slender Man has been sighted	***4.91***
Music	Mute at first, more intense as the game progress	***4.09***
Pages of paper	Objective items of the game, trigger of music	***2.09***
Static screen	Appear 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 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 have not really seen the Slender Man yet. Other than sound, the static screen was a visual element that scared players with a similar effect to the shock sound, but 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 players. Most of the time, players were just scared of being killed and losing rather than being scared of actually seeing the Slender Man.

There are no conclusive answers when players were asked about what caused them to feel anxious or suspense. Many players said that 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 music made them experience suspense. This indicates that each player may have their own way of differentiating anxiety and suspense, or 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 suggest the benefit of using real-time affect detection tools for mapping changes in player affect to game elements.

After each play, players watched and labeled their affect with AAT. Fig. 2 shows the relative time players spent in each affect and the relative frequency of players transitioned into each affect. Overall, players spent most of their time in pre-fear affect and only little time in post-fear affect. This reflects the nature of STEP that there are only short amount of time of the actual contact with the Slender Man, the main scary event of the game, while the game spent most of its time creating an uncertainty or anxious feeling to players. The huge different between time spent in neutral state and frequency that players translated into this state indicated that when players translated into neutral state, they are likely to be in this state for long time. On the other hand, players only spent time short amount of time when they translated into post-fear affect and immediately went back to pre-fear affect.

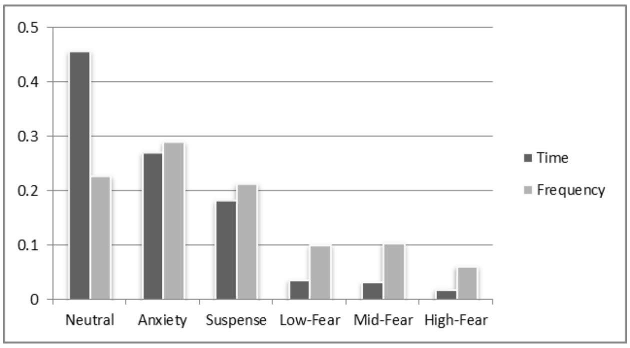

Fig. 2 Relative time players spent in each affect and frequency of translating into each affect.

To further investigate how player affect translated between pre and post-fear affect from 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. [D'Mello 07] 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.

$$L(F_{pre}, F_{post}) = \frac{\Pr(F_{post}|F_{pre}) - \Pr(F_{post})}{1 - \Pr(F_{post})} \qquad (2)$$

$\Pr(F_{post})$ function returned the probability of players transitioning from any pre-fear affect to F_{post} affect, and $\Pr(F_{post}|F_{pre})$ 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\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 indicated that players were likely to transition into a high-fear state if they faced the Slender Man while having suspense feeling. Neutral and anxiety had positive transition likelihood values to both low and mid-fear with neutral had higher likelihood to mid-fear than anxiety. When we looked at individual transitions from neutral state, players would rate higher fear when the Slender Man got them surprised while there were not as many big surprises when they were in 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 suggested that changing 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 [Perron 04] that showed many successful examples of forewarning techniques used in horror movies and horror games, 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 decided to combine all of the feature sets from each game and each player together for classification in order to build a generalized predictive model. Data from 3 players was not used for classification due to technical problems. So for building our predictive models, we used data from 8 players consisting of 15,699 instances. The amount of instances belonging the Neutral (N), Anxiety (A), Suspense (S), Low-Fear (LF), Mid-Fear (MF) and High-Fear (HF) classes are 47.8%, 25.6%, 16.4%, 4.0%, 3.8% and 2.4% respectively. C4.5 [Quinlan 93] and Multilayer Perceptron (MLP) were used to create predictive model which were evaluated by 10-fold cross validation using machine learning tool Weka [Hall 09]. Table III shows the percentage of correctly classified instances of C4.5 and MLP algorithm when all of feature were used and when only EEG, EKG and KMA features were used.

TABLE III. CORRECTLY CLASSIFIED 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 correctness of predictive models considering that we used these algorithms without any specific modifications for the prediction. Specifically, using C4.5 on EKG features 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 or some additional information might be needed to improve prediction accuracy. To look deeper into the accuracy of the model created using C4.5 and EKG features, accuracy and f-measure of predicting each affect class is shown in Fig. 3. The neutral class had highest accuracy followed by anxiety and suspense. Post-fear affect however, got considerably lower accuracy compared to the first three pre-fear affect which could have been caused by the data being skewed toward pre-fear affect.

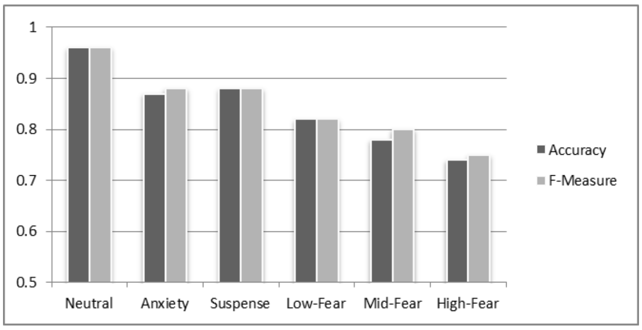

Fig. 3 Accuracy by class using C4.5 and EKG features

Knowing players' pre-fear affect could 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, this result showed promising potential of EKG in automatically predicting player horror-related affect while playing survival horror games.

Combined all of the findings in this work, game designers can create affect predicting model using some physiological tools, such as EKG, in the alpha or beta state of the game with certain amount of test players, as we can see that the model have a good level in generalization to other player. After getting player affect as an additional input, game designers can create a scary event that based on current player affect, for example, when the player is in neutral state, tension can be built with some glimpse of the threat in the game, using an unusual sound or visual effect to cause uncertain feeling to the presence of the threat to player while waiting to the time where player translates into suspense state and then shows the scary event to player. This additional information will benefit survival horror games very much especially for the game that contains some randomness or could be able to adapt its scary event during the game depends on the player performance or current affective state. With the current trend of indie survival horror games where everyone want to explore a new technique, affective survival horror is surely an amazing field waiting to be explored.

5. Conclusion

With the upcoming trend of affective gaming, it could open up a new possibility in the survival horror genre using player's affective states to manipulate in-game scary event in a way that will be scarier to any kind of player, especially for survival horror games that utilizes randomness in their horror approach. In this work, we investigated players affect namely neutral, anxiety, suspense, low-, mid- and high-fear annotated continuously by the players using Affect Annotation Tool. Players' brainwave and heart rate signals were collected along with keyboard and mouse activity while they were playing a survival horror game called Slender: The Eight Pages. Many aspects of data were analyzed. Post-questionnaires showed that players were having more fun playing the game as they were getting used to the system but getting less fear after repeated the game for a few times. Players also identified that sound elicited anxiety and suspense during the game. By computing the transition likelihood between pre and post-fear affect, it revealed that players were likely to get more fear by a scary event when they were in suspense state. Classification results showed the potential of heart rate signals in predicting player horror-related affect.

For future work, we want to investigate more on relation between player affect and game elements, which game element is the better for causing anxiety or which game element is better for causing suspense to players. With the limited information we can access or modify on the existing survival horror games, open-source game might be needed for further investigation of individual game element.

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