芸術科学会論文誌 Vol. 11, No. 3, pp. 59-68

From Brain Waves to Game Design: A Study on Analyzing and Manipulating Player Interest Levels

Kenneth Chan Koji Mikami Kunio Kondo

Tokyo University of Technology

chan.kenneth.k@gmail.com, {mikami, kondo} ＠ media.teu.ac.jp

Abstract

Traditional single player first person shooter (FPS) games adopt a generally linear level design. Players are not given much choice as to where to go next, and thus it is paramount that the designer is able to keep the player interested throughout the whole level. It is widely accepted that in order to keep the player's interest, it is important to offer the player a varied gaming experience by presenting high interest and low interest encounters in an alternating fashion. However, while there are general theories and rules of thumb as to how this can be done, there is little formal knowledge about how exactly high or low interest levels can be achieved. Our goal is to create a better understanding on how to design encounters that affect interest levels in linear FPS games. Specifically, how exactly a player's interest levels can be raised intentionally.

To accomplish this, we developed a method for measuring and comparing player interest levels based on electroencephalogram (EEG) data measured using a "Neurosky Mindset" unit, which is a commercially available EEG device. We measured player EEG data for the first 4 levels of the FPS game "Call of Duty: Modern Warfare 2" and calculated player interest levels for the entire length of gameplay. By referring to recorded gameplay videos, we were able to associate each increase in interest levels for each player to a specific point in game. From this data, we found and isolated points in each level where most players showed a rise in interest levels, and discovered that certain patterns existed between these situations.

These findings led to another study where we further analyzed these situations and found out what factors caused most players to show a rise in interest levels. We were able to divide these factors into 6 different categories called Triggers: "Anticipation", "Concentration", "Surprise", "Frustration", "Overwhelm" and "Fear". As these triggers represent mutually exclusive elements that affect a player's interest levels, we found that in most situations where many test subjects showed a rise in interest levels, more than one trigger is present, a phenomenon we call Stacking.

While our study is still ongoing, we believe that by using these triggers as guidelines, game designers will be able to intentionally plan and control the player's interest level for FPS games with a certain level of guarantee.

1. Introduction

The traditional game design process is a “mechanics-centered” design process. This begins with the designers devising game mechanics assumed to be “fun” , before proceeding on to developing the game world and assets to facilitate those mechanics. However, in recent years, a reversed, “player-centric” design process, which focuses on designing the player experience first and mechanics after, has become a popular trend within the industry. Consequently, the science of understanding player experience has also begun to draw great attention [1][2][3].

Professional game designers rely on their years of experience and expertise to understand and design player experience. But, there is currently neither a structured methodology that allows them to pass on or share their know-how with other designers, nor any kind of formal knowledge readily available for less experienced designers to learn from, much less how to incorporate it into game design [4][5][10].

With the concept of “player-centric” design become more and more popular, there is an increasing need to develop a framework that encompasses both game design and player experience.

2. Player Experience in FPS Games

This paper presents a method of understanding and manipulating player interest levels within single player first person shooter (FPS) games. FPS games are a sub-genre of action games, where the player looks through the eyes of the player character and navigates through a 3D world, fighting other characters using a selection of projectile or melee weapons.

Most single player FPS games to date adopt a generally linear level structure, where the player is presented a series of challenges in a fixed order. As players are not given much choice as to where to go next, it is entirely up to the designer to create a level that can keep the player interested all throughout. The general consensus of industry experts is that in order to keep the player’s interest throughout the game, it is important to offer the player a varied gaming experience by presenting high interest and low interest encounters in an alternating fashion.

Our goal is to create a better understanding on how to design encounters that affect interest levels in linear FPS games. Through the analysis of interest levels in existing games, we aim to discover what factors affect interest levels, and to create formalize a taxonomy of elements that raise or lower interest levels. Our study involves a two step research approach that allows us to evaluate player interest – which is normally highly subjective – in an objective manner.

In the first step, we monitored player interest levels by measuring the player’s electroencephalogram (EEG), or brainwave data during gameplay and extracting attention level data. We chose to use attention as a measure for interest, as it has been shown that high attention levels correlate to high interest levels [6]. In the second step, we analyzed the data collected and investigated where and why player interest levels rose.

3. Related Works

Two separate fields of research are related to this study. Firstly, studies that concern the development of frameworks for game design, and secondly, work focused on gathering biometric data to understand player experience. Examples of these are described below.

3.1 Previous Efforts in Formalizing Game Design

Many books and articles have been written on game design by industry experts, which tend to provide general rules of thumb and common practices when designing games based on the author’s experience. These texts provide broad, overarching concepts relevant to game design, but do not provide any deep insight as to how levels are structured, and how they affect the player.

For example, in their book Feil et. al [7] discuss the importance of tension in games, and how well paced games employ a reoccurring structure of tension followed by relaxation to create good gaming experiences. A lengthy section of the book is dedicated to describing how aspects of the terrain, such as height and access advantages, can affect tension, but never defines clearly as to what exactly “tension” and “relaxation” refer to and how they are affected by the game.

Schell [8] proposes a similar idea called interest curves, where the designer intentionally manipulates the player’s interest level by alternating high interest and low interest encounters to create a wave-like gaming experience (Fig.1) While he goes into detail regarding the significance of alternating high and low interest encounters, he does not explain clearly how interest levels can actually be controlled.

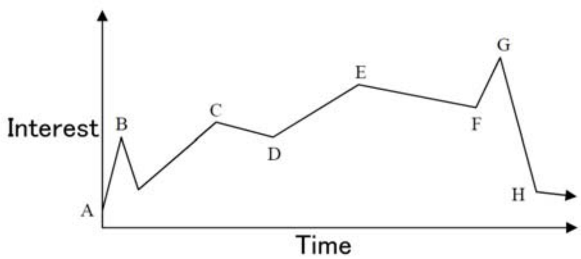

Fig. 1: Schell’s example of a good interest curve.

Several academic efforts have been made with the goal of creaing a structural framework for games, with the goal of developing a formalized method with which scholars and game industry professionals alike can study and share their knowledge of game design.

Milam et. al [9] conducted an experiment where several experienced game designers were asked to play a selection of FPS games. The authors interviewed the designers and discussed the elements used in each game to "push" and "pull" a player through a video game. From the interviews, they were able to identify five different patterns of push and pull. Similarly, Hullet et. al [10] evaluated a number of modern FPS games and proposed a taxonomy of different patterns of level design present within FPS game levels.

Smith et. al [11] proposed the concept of rhythm groups, which is a method of analyzing level structure in 2D platform games. A single section of a game level that requires the player to perform a continuous set of actions is defined as one rhythm group. Rhythm groups are separated from each others by breaks, which are safe places the player can rest without penalty before continuing the level. The authors also identify several different types of actions which rhythm groups and categorized them based on their purpose in the level.

Another approach to creating a formal methodology of understanding and designing games was proposed by Bjork et. al [12] in the form of game design patterns. The authors devised a method of summarizing games into "patterns", which can then be archived and referred to when needed. The drawback to this method is that the guidelines for identifying each game's pattern are loose and subject to personal opinion, and that the sheer number of available patterns (over 200) make this method difficult to apply in a practical situaion.

Konzack [4] explored the different aspects of the game *Soul Calibur* and was able to divide the game into seven different elements. One of these categories, Gameplay, is further broken down into 8 sub-categories; Positions, resources, space, time, goals, obstacles, knowledge and rewards/penalties. A similar study by Consalvo et. al [5] looked at a simulation game and proposed 4 areas that should be considered when studying games. Object inventory, interface study, interaction map and gameplay log. Both these studies focused on the need of having a method for analyzing games, and provide different solutions for this. However, the categories defined are vague, and their application to practical game design is left fairly untouched. Furthermore, being qualitative studies, the authors provided no real empirical evidence to support their claims, and it is unclear as to how they were able to reach their conclusions.

3.2 Using Biometrics for Game Research

Biometric data is now a popular method of understanding player experience, and a number of related talks have been held at industry level events [1][2]. These talks share knowledge on how biometric data is used in game evaluation at game development studios,

The objective nature of biometric data makes this category of research a suitable approach for empirical studies in player experience. Van den Hoogen et. al [13] measured changes in pressure exerted on a gamepad during racing games, as well as physical controller movement. They discovered that players would press the controller buttons harder when mentally aroused, and had a tendency to tilt the controllers in conjunction with turns and corners on the racetrack.

Kallinen et. al [14] used eye tracking, facial electromyography (EMG) and self reports to study whether sense of presence in games changed with the ingame camera view. 50 participants were asked to play the same 3D game in both third and first person mode. They discovered that although players felt a greater sense of presence in first player mode, it also caused them to generate less pleasant responses. They were also able to deduce that there is no correlation between the camera mode and eye movement.

Neither Van de Hoogen et. al nor Kallinen showed any intent on developing a unified theory of game design, but their studies show the effectiveness of biometric data in understanding player experience.

4. Test Subjects and Environment

We measured the attention levels of 7 healthy adults, all of whom with previous experience playing FPS games. They were asked to play through the first 4 levels of the campaign mode of *Call of Duty: Modern Warfare 2 (CoD:MW2)*, a recent and popular FPS game.

Tests were conducted inside an isolated cubicle (Fig. 2) to minimize unwanted external stimuli. Attention levels were measured using a "Neurosky Mindset" unit, a commercially available electroencephalogram (EEG) measuring device. The game was played on a 24inch widescreen LCD monitor placed at approximately 75cm from the player's seat, resulting in a viewing angle of 38 degrees, which is close to the "THX" standard recommended viewing angle of 36 degrees. Sound was played through the internal speakers of the Neurosky Mindset, with all volumes at a fixed level. Gameplay videos were also recorded for later analysis.

Fig 2: Photograph of the test environment.

5. Methodology

The raw EEG data was converted to attention levels through Neurosky's algorithm, which has been shown to be effective in measuring attention levels [15]. The Mindset samples data at a rate of 512 Hz, and averages the values recorded within each 1 second interval to an "attention" value between 0-100 on an arbitrary scale. A value between 0-20 is considered "strongly lowered", 20-40 is "reduced", 40-60 is "neutral", 60-80 is "slightly elevated" and 80-100 is "elevated". The algorithm adapts to different users, and all values are relative to each individual user [16].

Players took different amounts of time to clear the same levels. In some cases the slowest player spent more than double the time of the quickest player. Thus, comparing interest levels based on a time scale would be meaningless. Instead, we compared player data based on player progression within the map.

Here, we used the concept of "rhythm groups" proposed by Smith et. al [11] as guideline to break each level down into distinct sections. The data for every player was also divided in the same way by referring to the gameplay videos and observing when the player moved to the next area, thus creating a basis upon which player progression could be compared. Fig. 3 shows the timeline of a portion of the map *Cliffhanger* broken down into 11 rhythm groups.

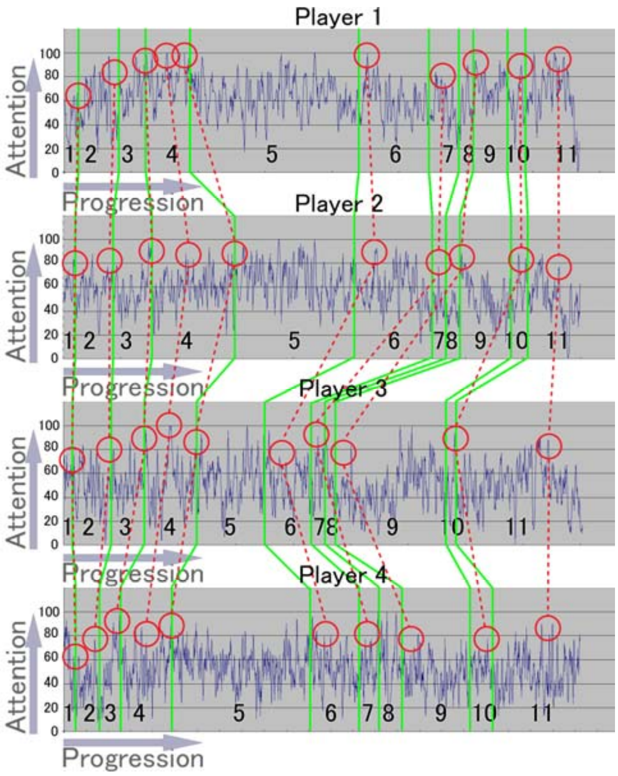

Fig. 3: Example comparing attention levels between all players for a portion of the mission *Cliffhanger*. The map was divided into 11 areas, separated by the green lines. Circles connected by red lines indicate points of common high interest (PCHI)

We identified points where each player's interest levels suddenly rose to "slightly elevated" and "elevated" for each rhythm group, and associated these points with specific moments in-game by referring to the respective gameplay videos. Points in the game where all players showed a rise in interest levels were identified and further extracted for analysis. The linked red circles in Fig. 3 represent such points. We chose not to compare cases where players took radically different actions, for example where some players chose to eliminate a 30 person enemy squadron, while the others avoided it. An example of this is rhythm group 5 in Fig. 3.

6. Analysis

By comparing data between different players, we were able to reveal several places within each level where all the players showed heightened attention levels. An example of this is an encounter at the end of area 3 in the level "Cliffhanger". Here, players are required to infiltrate an enemy base without alerting enemy guards. Early on in the level, players encounter two enemy guards next to an important location. If the player had previously alerted other enemy guards, only one guard is present. In either case, the player approaches the guard(s) from behind and can easily sneak past them, but all the tested players choose to kill the unwary guards.

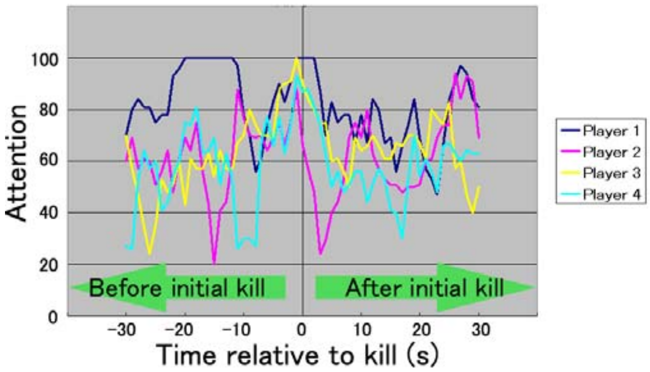

Fig. 4: Graph comparing attention levels for an encounter in the level *Cliffhanger*, with the moment of kill in the center. Players approach and attack a single enemy guard from behind, unnoticed.

A sudden spike in interest levels was observed in all players as they aimed carefully at the motionless guards, in order to kill them as quickly as possible to prevent them calling for help. Fig. 4 shows the attention levels of all 4 players during this encounter, from 30 seconds before until 30 seconds after the first guard is killed. A spike in attention levels is clearly seen in the center of the graph, which corresponds to the moment that the first guard is taken down. The same phenomenon was not observed for most of the other, countless kills during this level, suggesting that there is something specific here which is causing a rise in attention levels.

As previously mentioned, attention and interest have been shown to be strongly correlated, and thus in our study we considered the attention levels measured by the neurosky mindset to be directly translatable to player interest levels.

Since all players reacted in the same way during these points of common high interest (PCHI), we can deduce that further analysis of these points will likely reveal how certain specific encounters and game elements are able to cause high attention, and thus interest levels. We were able to identify multiple PCHI per level for analysis. Table 1 shows the number of rhythm groups and PCHI fore each of the levels analyzed.

Table 1. Number of points of common interest (PCHI) identified

Level Number	Level name	Rhythm Groups	Number of PCHI
1	SSSD	8	8
2	Team Player	13	11
3	Cliffhanger	11	13
4	No Russian	8	9

7. Six Triggers of Player Interest

Through analyzing PCHI, we were able to identify six different elements, or "Triggers" that appear to cause player interest levels to rise. These triggers were divided into groups based on the cause-effect relationship between the game environment and the player's actions. In particular, the risk and reward involved in overcoming a situation that the game imposes upon the player.

The different triggers are explained in detail below.

7.1 Anticipation:

Description:

The player waits for a both predicted and favorable event to occur. Interest levels rise during the time lag between when the player engages the situation and the moment of resolution.

Examples:

When thrown, grenades in *CoD:MW2* explode after a few seconds and damage all enemies within a certain radius. In the mission *SSSD*, players are required at one point to throw a grenade at a dummy target as part of the gameplay tutorial. All test subjects showed a rise in interest levels when they waited for the thrown grenade to explode(Fig.5).

Another example is in the mission *Cliffhanger*, when players are required to detonate explosives using a detonator. The player is given an audio countdown to the detonation, during which all test subjects showed a rise in interest levels.

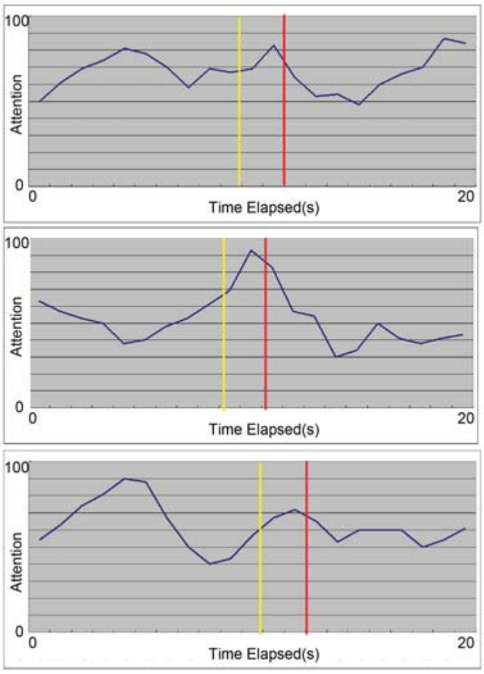

Fig. 5: Comparison of interest levels of a sample of 3 players at above mentioned event for All players showed a rise in interest levels from between throwing the grenade (yellow line) and detonation (red line).

Other characteristics:

Our observations showed that interest levels are elevated only until the moment of the anticipated event. Once the event has passed, interest levels drop almost immediately. We also noticed that the magnitude of the effect of the player's actions possibly has a correlation to the player's interest levels. For example, throwing a grenade at a single target dummy caused a rise in the test subjects' interest levels, while throwing a grenade at one enemy while being surrounded by several did not.

7.2 Surprise

Description:

The player's situation changes suddenly and dramatically, and the player is forced to adapt in a short time.

Examples:

In the mission *No Russian*, players begin the level by walking out of an elevator with several friendly NPCs into an airport lobby populated with neutral NPCs The player is able to move but unable to shoot. Several seconds after exiting the elevator, all friendly NPCs suddenly begin shooting at neutral NPCs, who begin running in all directions. Alarms sound and screaming is heard and test subjects displayed a rise in attention levels.(Fig. 6)

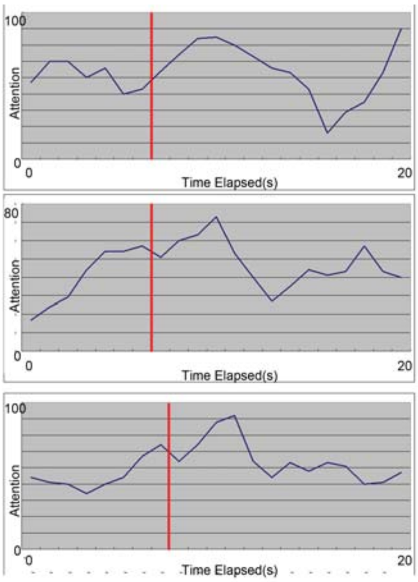

Fig. 6: Comparison of interest levels of a sample of 3 players at above mentioned event. All players show a rise in interest levels after friendly NPCs begin attacking neutral NPCs.

The mission *Team Player* begins suddenly with the player on lying on the ground, unable to move. Enemies are shooting at the player from across a river. A friendly NPC comes and helps the player get up, after which the player is then given control of the player character. All test subjects showed a rise in interest levels from the start of the mission until several seconds after control is regained.

Other characteristics:
In all recorded instances of surprise, the test subjects' interest levels rose very fast (within 1 second) of the trigger initiating, and then slowly dropped over the course of several seconds. We noticed a possible inverse correlation between the duration of heightened interest level and the player's skill or experience with FPS games (which we confirmed verbally). However, at the time of the experiment we were unable to objectively measure the player's skill level, and thus unable to confirm this hypothesis. The significance of the duration of heightened interest is also unknown.

7.3 Concentration

Description:
The player focuses on completing a certain task at hand. The task cannot be immediately overcome, but has a clear goal and an apparent method of achieving it.

Examples:
CoD:MW2 offers an alternative shooting mode which allows players to aim down the sights of their gun, zooming in on the target and increasing accuracy at the cost of mobility. In almost all cases where it was necessary to use this mode, players did so and showed a rise in interest levels.

For example, players are presented with a situation where they are required to defeat several enemies hidden behind a short barricade in the mission *Team Player*. While the barricade blocks the player's bullets, it is only knee-high and so the enemies are partially exposed, but the player needs to aim carefully to hit the enemies. When players did so, a rise in interest levels was recorded.

A different kind of example is towards the end of the mission *Cliffhanger*. Here, players ride a high speed snowmobile down a snow mountain. One part of the course takes the players through an area scattered with obstacles (trees). The snowmobile moves very fast, and players have to concentrate and react quickly to avoid bumping into the trees. Test subjects showed raised interest levels during this portion of the course.

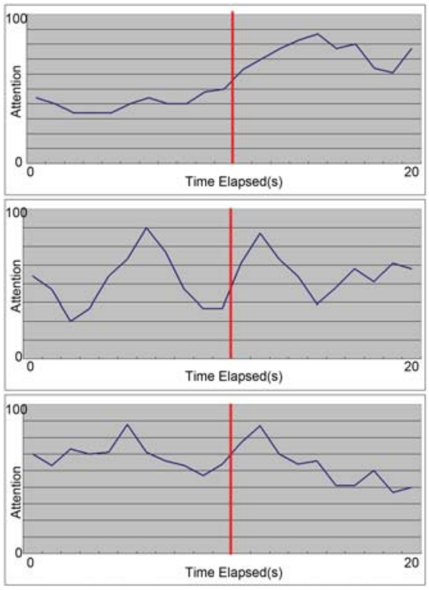

Fig. 7: Comparison of interest levels of a sample of 3 players at above mentioned event. All players showed a rise in interest levels when they engage the enemies (red line).

Other characteristics:
Concentration was the most commonly observed trigger, appearing in an average of 65% of all PCHI recorded. The duration of heightened interest levels in players during cases of concentration were also generally longer than other triggers. This can be associated with the fact that the concentration trigger by definition requires the player to engage in some kind of continuous task, as opposed with other triggers such as anticipation and surprise where players are reacting to a momentary event.

7.4 Frustration

Description: When the outcome of the player's actions is different from what the player expects.

Examples: The mission *SSSD* includes a trial run phase where players have to move through a training course and shoot dummies that appear as quickly as they can. Some of the dummies are “civilian” dummies, which players are penalized for shooting, but the player is not notified of their presence until one is shot. All test subjects showed a rise in interest levels when this happened.

Partway through the mission *No Russian*, players are presented with a type of enemy that is protected by an impenetrable handheld shield. The shield is large enough to cover the enemy’s whole body, and the player must attack from the side or from behind in order to kill the enemy. However, when this enemy first appears, all test subjects attempted to kill it from the front by shooting the shield. Naturally, the enemies could not be defeated, and the test subjects soon changed strategies. Until then, however, test subjects all showed heightened levels of interest.

One common example occurs when players are required to reload in the midst of a firefight with enemies, such as in Fig. 8.

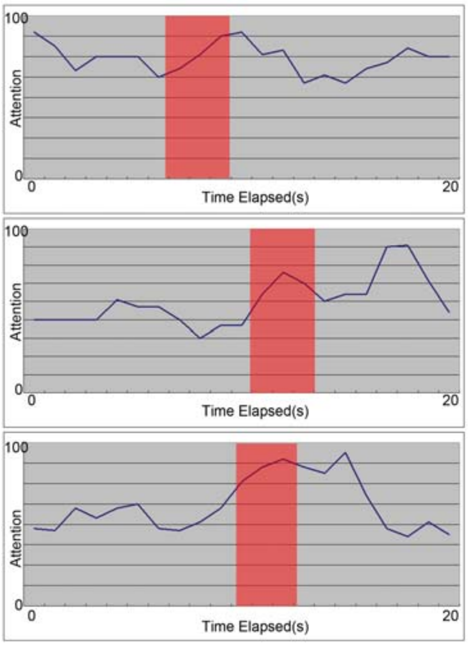

Fig. 8: Comparison of interest levels of a sample of 3 players required to reload during the same firefight. All players showed a rise in interest levels for the duration of the reloading animation (red area).

Other characteristics:

Like concentration, heightened interest levels due to frustration last longer than for surprise and anticipation. Cases of frustration tend to occur when the player is given a task with special requirements, such as the examples listed above. Naturally, this causes the player to take a longer time to complete the task, hence leading to a longer duration of heightened interest.

7.5 Fear

Description:

The player is given indication of impending failure, or when failure becomes inevitable.

Examples:

In all cases where the player character receives a large amount of damage and is close to dying, test subjects showed an instant rise in interest levels, such as in Fig. 10. Most of these situations occurred as a result of emergence in game rather than a predesigned event.

However, intentional cases of the fear trigger also exist, such as in the level *Cliffhanger*. One part of the starting area requires the player to jump across a chasm high up on a cliff, which triggers a scripted (predesigned) real time event where the player character slips and almost falls off, before being rescued by an NPC character. All test subjects showed a rise in attention levels from when the slip occurs until the NPC is able to rescue the player character.

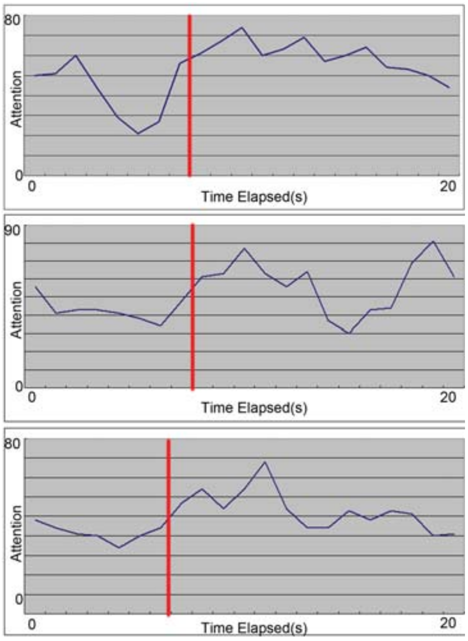

Fig. 9: Comparison of interest levels of a sample of 3 players receiving a large (near fatal) amount of damage during the same event. All players showed a rise in interest levels upon receiving the damage (red line)

Other characteristics:

Similar to concentration and frustration, fear often triggers a somewhat lengthy period of heightened interest levels. This is because most situations of fear are caused by the player character being low on health. The player health system in *CoD:MW2* is designed such that health regenerates over time, during which he fear trigger remains active.

7.6 Overwhelm

Description: When the player is given a challenge greater than expected or able to handle.

Examples:
In the mission *No Russian*, shortly after the first set of shielded enemies appears, a second set of the same type of enemy emerges. This type of enemy takes longer to kill than the usual, unshielded enemies, and as a result by the time the second set of shielded enemies arrives, all test subjects were still engaged with the first set. Here, all test subjects showed a rise in interest levels and retreated to a sheltered area.

Another example is when the players enter an area where enemies endlessly reappear immediately after being killed. Here, the player eventually understands the situation and is forced to escape. During the escape period, players showed heightened interest levels(Fig. 10)

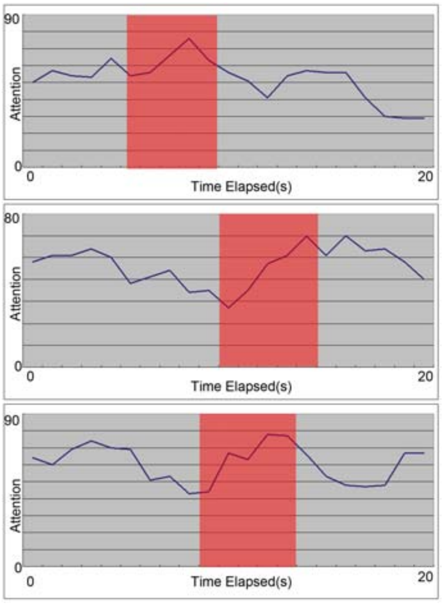

Fig. 10: Comparison of interest levels of a sample of 3 players escaping from endlessly respawning enemies. All players showed a rise in interest levels while escaping (red area).

Other characteristics:
While overwhelm may seem similar to a previous trigger, fear, they differ in that overwhelm has only a possibility of failure if the player stays in the same state or position. In such situations players react cautiously, and may, for example, fear death and choose to find cover before they are damaged. Fear, on the other hand, represents cases where the player is faced with an immediate threat, with failure being imminent unless immediate action is taken.

8. Trigger Stacking

As these triggers are mutually exclusive to each other in concept, it is possible to have several triggers occur in the same situation. We called this phenomenon "stacking". 29 out of the 40 total PCHI we studied were composed of more than one trigger. This can be seen in Table 2, where the combined values exceed the total number of PCHI observed. Stacking occurs in two different ways; simultaneous stacking and consecutive stacking.

Table 2. Number of times each trigger was observed in each level

Level	Antici-Pation	Surprise	Concen-tration	Frustr-ation	Fear	Over-whelm
1	5	3	5	2	0	0
2	4	4	8	3	5	1
3	8	2	6	1	2	1
4	2	1	7	2	1	2

8.1 Simultaneous Stacking:

Simultaneous stacking is when two or more triggers are presented to the player at the same time. As a result, the rise in player interest levels in this case can be attributed to more than one trigger. For example, the scenario described above in the level *No Russian* where players are confronted with shielded enemies contains both frustration and concentration. The player is frustrated as the enemies are not killable by simply shooting them from the front, and at the same time concentrates on trying to move to a position from where they can damage the enemies.

The scenario in *Cliffhanger* where players approach an enemy guard from behind presents the player with both anticipation and concentration. Players anticipate the enemy's death as they sneak up quietly behind it knowing it cannot fight back, but at the same time concentrate on aiming carefully to ensure a quick and instant kill.

The most common combinations of simultaneous stacking observed include anticipation with concentration, which occurred for a total of 10 times throughout the 4 missions tested.

Our data showed that simultaneous stacking did not have a significant effect on the magnitude of the test subjects' rise in interest levels. Player interest levels for situations where more 3 or 4 different triggers were stacking simultaneously did not differ from situations where only 1 trigger was present.

8.2 Consecutive Stacking:

Consecutive stacking is when multiple triggers are presented to the player one after another, each before the player's interest levels have recovered from the previous trigger.

For example, in the mission *Team Player*, the player is rides a jeep through a suburban area. At one point, an explosion occurs and the player is thrown off the jeep and onto the ground. For the next few seconds, the player is able to look around using the mouse but unable to move. During this time, a number of enemies surround and shoot the player to low health, after which the player regains full control of the player character. Surprise, frustration, fear and overwhelm are stacked here, in this order. Surprise occurs when the player is thrown off the jeep, frustration when the player realizes that control over the player character has been lost, fear when the player receives damage, and overwhelm when the player regains control but does not have enough health to engage all the enemies present.

Consecutive stacking is was less common than simultaneous stacking in our experiment, with a total of only 6 attributed PCHI as opposed to 24 for simultaneous stacking.

9. Conclusion

In this study, we measured and recorded player EEG data while they played FPS games, from which we were able to extract the player's interest level data. We identified points in-game where all test subjects showed a rise in interest levels (PCHI), which we further analyzed. We were able to categorize all the PCHI into six categories, or "triggers" which appear to be the cause of the test subjects' rise in interest levels.

While our study is still ongoing, we believe that by using these triggers as guidelines, designers will be able to intentionally plan and control the player's interest level for FPS games with a certain level of guarantee. Furthermore, triggers can be used as a standardized format of analyzing and discussing games, providing a first step in the development of a formalized framework for understanding game design.

To test the validity of our triggers, we are in the process of designing a map using these six triggers, and plan to conduct play tests to see whether player interest levels respond as expected. Furthermore, we plan to investigate the effect triggers have on player opinion and evaluation of FPS games through self reports and surveys.

Naturally, as our study focused only on single player linear FPS games, it is likely that different triggers exist for multiplayer games as well as games of different genres. We hope that our study can act as a base which future studies can develop on, perhaps eventually leading to a unified theory of user experience and game design.

References

[1] M. Ambinder, Biofeedback in Gameplay: How Valve Measures Physiology to Enhance Gaming Experience, presentation at GDC2011

[2] V. Zammitto, The Science of Play Testing: EA's Methods for User Research, presentation at GDC2011

[3] M. Leblanc, R. Hunicke, R. Zubeck, MDA: A Formal Approach to Game Design and Research, Proceedings of the AAAI Workshop on Challenges in Game AI, pp. 1-5, 2004.

[4] L. Konzack, Computer Game Criticism_A Method for Computer Game Analysis, Proceedings of the Computer Games and Digital Culture Conference, 2003.

[5] M. Consalvo, N. Dutton, Game analysis: Developing a Methodological Toolkit for the Qualitative Study of Games, Game Studies, Vol. 6 (1), 2006.

[6] J. Koran, J. Foster, M.L. Koran. The Relationship Among Interest, Attention and Learning in a Natural History Museum. Visitor studies: Theory, research and practice, Vol.2, 239-244, 1988.

[7] J. Feil, M. Scattergood, "Beginning Game Level Design." Thomson Course Technology. 2005.

[8] J. Schell, The Art of Game Design: A Book of Lenses, Morgan Kauffman Publishers, 2008.

[9] D. Milam, M.S. El Nasr, Design Patterns to Guide Player Movement in 3D Games, Sandbox '10: Proceedings of the 5th ACM SIGGRAPH Symposium on Video Games, 2010.

[10] K. Hullet, J. Whitehead, Design Patterns in FPS Levels, FDG '10: Proceedings of the Fifth International Conference on the Foundations of Digital Games, pp. 78–85, 2010

[11] G. Smith, M. Cha, J. Whitehead. A framework for analysis of 2D platformer levels, In Proceedings of the 2008 ACM SIGGRAPH Symposium on Video Games, pp. 75-80, 2008.

[12] S. Bjork, J. Holopainen, S. Lundgren, Game Design Patterns, Proceedings of Level Up: Digital Games Research Conference, pp .180-193, 2003.

[13] W.M. van den Hoogen, W.A. IJsselsteijn, A.W. de Kort Yvonne, Effects of Sensory Immersion on Behavioral Indicators of Player Experience: Movement Synchrony and Controller Pressure, Proccedings of DiGRA, 2009.

[14] K. Kallinen, M. Salminen,, N. Ravaja, R. Kedzior, M. Sääksjärvi, Presence and Emotion in Computer Game Players During 1st Person vs. 3rd Person Playing View: Evidence From Self-report, Eye-tracking, and Facial Muscle Activity Data, Proceedings of the PRESENCE pp.187-190. 2007.

[15] G. Rebolledo-mendez , I. Dunwell , E.A. Martínez-mirón , D. Vargas-cerdán , S. De Freitas , F. Liarokapis , A. R. García-gaona, Assessing NeuroSky's Usability to Detect Attention Levels in an Assessment Exercise, Proceedings of the 13th International Conference on Human-Computer Interaction. Part I: New Trends, pp. 149-158, 2009.

[16] NEUROSKY INC, 2009, eSense(tm) Meters, retrieved Web. 27 August 2010, from http://developer.neurosky.com/docs/doku.php?id=esenses_tm

Games Cited:

Call of Duty: Modern Warfare 2. Infinity Ward Inc. (PC), 2010.

Kenneth Chan, M.S

Graduated in 2008 from The University of Notre Dame with a BA in industrial design, and completed his master's degree in 2011 at Tokyo University of Technology.

His research interests include interactive media and technology, with a focus on games and game design. He has given multiple presentations at academic session such as SIGGRAPH ASIA and Nicograph on game design, as well as industry events such as CEDEC. He is also an active member of DiGRA Japan. He has also been selected as jury member for CEDEC game design contests.

Kenneth currently works at Q Entertainment Inc. as a game designer/producer.

Koji Mikami, Ph.D.(Keio University, 2008)

Graduated in 1995 from Faculty of Environmental Information, Keio University. He worked at Nissho Iwai Corporation and MK Company as a producer. In 1998, together with Mitsuru Kaneko, he established "Creative Lab" at the Katayanagi Advanced Research Lab of Tokyo University of Technology (TUT), where research on next generation visual content production and the digitization of the animation production process is conducted. Currently, he is an associate professor at the School of Media Science, TUT.

His research interests are computer graphics, animation, games. He received the IPSJ Education Award in 2012.

He is Director of The Society for Art and Science, Advisory board of CEDEC.

Kunio KONDO, Dr.Eng.

Kunio KONDO is a professor and the Vice Dean of the School of Media Science, Tokyo University of Technology. He received his Dr.Eng from the University of Tokyo in 1988 and Bachelor from Nagoya Institute of Technology in 1978.

He was Associate professor of Department of Information and Computer Sciences, Saitama University from 1989 to 2007, Lecturer of Tokyo Polytechnic University from 1988 to 1989 and Technical staff of Nagoya University from 1973 to 1988, a part-time lecturer of Tokyo University from 1991 to 2007, Aichi prefectural university of fine arts and music from 1989 to 1999, Kyushu Institute of Design from 2002 to 2010.

His research interests are computer graphics, animation, game, and interactive modeling. He received the IPSJ the Anniversary Best Paper Award in 1985, JSGS Research Award in 1985, and JSGS Best Paper Award in 2011.

He is President Elect-2012 of The Institute of Image Electronics engineers of Japan, and He was former President of The Society for Art and Science, former Vice President of Japan Society of Graphic Science, and Chair of SIG on Computer Graphics and CAD of Information Processing Society of Japan, Board member of Asia Digital Art and Design Association.