Games and Affect

Beste Filiz Yuksel

Affect detection in the form of bio/physiological sensing and/or facial expression recognition has been emerging into the gaming world.

Valve Software (creator of *Portal* and *Half-Life*) have been experimenting with player's emotions - biometric enhanced gameplay.

Mike Ambinder is Valve's resident experimental psychologist - a job position that they advertise for - presented a talk at the 2011 NeuroGaming Conference and Expo in San Francisco on Valve's work with biometric enhanced gameplay.

Here is the video and slides. E.g. a countdown speeds up the more you panic!

Here is a job description for Software Engineer at Valve for VR or Hardware with experience in User Interfaces and Human Computer Interaction

Another company that has been a pioneer is in affect and gaming is Flying Mollusk.

Founder, President, and Creative Director, Erin Reynolds, will give a guest lecture on March 5 about their game Nevermind which you can play on Steam here.

Nevermind uses biofeedback technology to detect feelings of stress while playing, when you become scared or anxious, the game will dynamically respond to your feelings of stress.

Flying Mollusk is currently working on a new project but they can’t talk about it right now!

Nevermind

Nacke et al. 2011 Direct and indirect physiological sensor input to **augment** traditional game control.

Nacke, L.E., Kalyn, M., Lough, C. and Mandryk, R.L., 2011, May. Biofeedback game design: using direct and indirect physiological control to enhance game interaction. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 103-112). ACM.

Game Mechanics

Manipulated the enemy target size through physiological control.

Rather than increasing the size of the entire sprite, they displayed a shadow of the enemy that grew (See Figure 1). But it resulted in enemy targets looking more threatening.

Figure 1. Target enemies increase in size.

Flamethrower weapon flame length was increased under variable control.

Figure 2. Flamethrower weapon: flame length was increased

Rate of snowfall under variable control which makes it harder to see the enemy and affects their accurary.

Also affects their ability to move and become more of a target

Figure 3. Behavior of the final boss (a yeti) and the snow effect were controlled together in a variable.

Gaze control for 20 seconds to temporarily freeze enemies and moving platforms.

Beware of Midas Touch problem!

Figure 4. The Medusa's Gaze feature in the game.

Methodology - conditions

Two conditions plus control condition.
Two conditions mapped two direct and two indirect sensors to the four game mechanics.
Third condition used no physiological input.
‘Although it would have been useful to include only direct physiological input in one condition and indirect in the other, this was not possible as the indirect sensors are difficult to control independently.’

Mechanic	Cond. 1	Cond. 2
Target size	RESP	GSR
Speed/jump	EKG	EMG
Weather/boss	TEMP	EKG
Flamethrower	GSR	RESP
Avatar control	Gamepad	Gamepad
Medusa’s Gaze	Gaze	Gaze

Table 2. Game conditions. Direct sensors are shaded in dark blue, and indirect in light blue. Gaze tracking is a special case of direct sensor control; the gamepad was used in all cases.

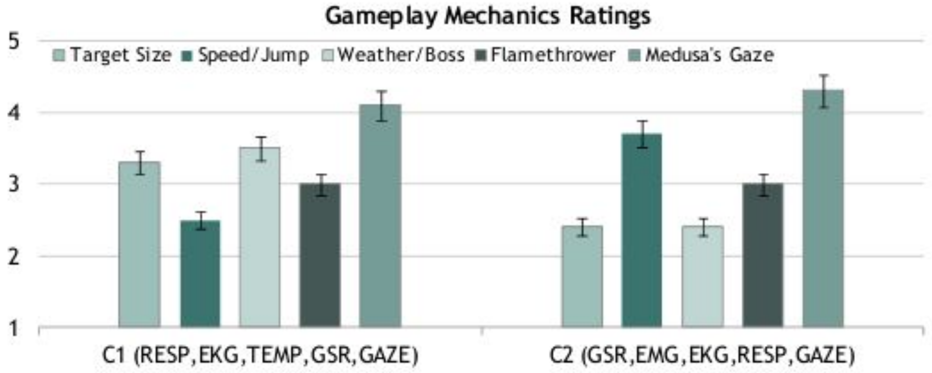


Figure 8. Game mechanic ratings (CI:95%) for each condition.

Figure 8 shows how participants rated the direct controls higher than the indirect controls for target size increases, speed/jumps, and weather/boss speed, but not for the flamethrower. In the post-game questionnaire, we asked participants about their preferred sensors (see Figure 9).

Figure 9. Player choices for physiological control by game mechanic. Dark wedges are direct sensors, light are indirect.

Results

They asked players which they would choose if they could only use one combination of RESP/EMG/TEMP (direct) or EKG/GSR (indirect).

Eight of the ten participants chose the direct sensors combination.

Findings

Results show participants have a preference for direct physiological con-
trol in games.
Two major design implications for
physiologically controlled games:
(1) Direct physiological sensors should be mapped intuitively to reflect an action in the virtual world;
(2) Indirect physiological input is best used as a dramatic device in games to influence features altering the game world.

Discussion Topic

What Other Game Mechanics could you use that respond to physiological sensing and/or facial expression recognition?

Discussion Topic - What Other Game Mechanics could you use?

-Let’s look at another paper Kuikkaniemi et al. 2010. First Person Shooter Game.

‘Finding the right balance between game play and biofeedback for the experiment was problematic because robust experimental conditions required relatively simple game design.’

Kuikkaniemi, K., Laitinen, T., Turpeinen, M., Saari, T., Kosunen, I. and Ravaja, N., 2010, April. The influence of implicit and explicit biofeedback in first-person shooter games. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 859-868). ACM.

Sniper rifle mode - game’s goal is to shoot far-away enemies

Machine gun mode - game’s goal is to shoot circulating enemy and avoid being shot

Adaptations/Game Mechanics

Moving, aiming, and shooting were modulated by biofeedback interaction.

Movement - walking speed, turning speed.

Aiming and shooting - aiming direction, amount of recoil, and firing rate.

Magnitude of shaking of player character at all times was modulated.

All had to be modulated enough to be noticed but not too much so that the game could not be played.

Their goal was to increase player identification through modulations

‘Rather than just proceeding to test modulations of some obvious features of background music or enhancing some visualizations of the game, for example, we propose a novel biofeedback game design pattern (or technique), character identification, that tries to address the common problem of player character identification in games.’

Findings

‘From quantitative data, we can recommend the use of explicit biofeedback in first-person shooter games to increase the quality of the gaming experience.

Implicit biofeedback appears non-responsive in terms of experience, and complicated to design. Explicit biofeedback is responsive, players are able to manipulate the biosignals, and explicit biofeedback game interaction appears to increase immersion and challenge. Also, it is much easier to design explicit biofeedback manipulations than implicit biofeedback.’

Would you agree with this? Is it possible to create exciting games with implicit physiological sensing?

Nevermind

Lobel, A., Gotsis, M., Reynolds, E., Annetta, M., Engels, R.C. and Granic, I., 2016, May. Designing and utilizing biofeedback games for emotion regulation: The case of nevermind. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 1945-1951). ACM.

To concretely demonstrate these design principles, we draw on examples from the Client #251 level. In this level, players inhabit the subconscious of a middle-aged woman whose father passed away when she was very young – there was a fatal car accident, her mother told her. With the recent passing of her mother, however, the Client reports sudden feelings of guilt and anger. Related to this, she also reports anxiety coming from the belief that people stare at her, seemingly in judgment. In the Client's nightmarish subconscious, the idyllic suburban home from her childhood becomes a dark, dilapidated house of horrors. There are signs of financial insecurity and marital unrest. Over the course of the level, the player discovers that the story about Client #251's father dying in a car accident was a lie. [SPOILER ALERT / MATURE CONTENT WARNING:] In actuality, when Client #251 was a little girl, she mistakenly entered her parent's bedroom just as her father was committing suicide, and witnessed him firing a gun into his head.

Some examples: The idea that Client #251's family unit corroded is depicted by a literally broken home (Figure 3). Also, Client #251 spoke about an intense guilt she feels when she is being looked at; so not only do family portraits in the home have blank faces, but in the nightmare version of the home, these faces are blotched out aggressively (Figure 3, bottom panel). These images recur throughout the game, and in some cases, blank faces follow the player, staring in judgment (see Figure 4 in Sidebar).

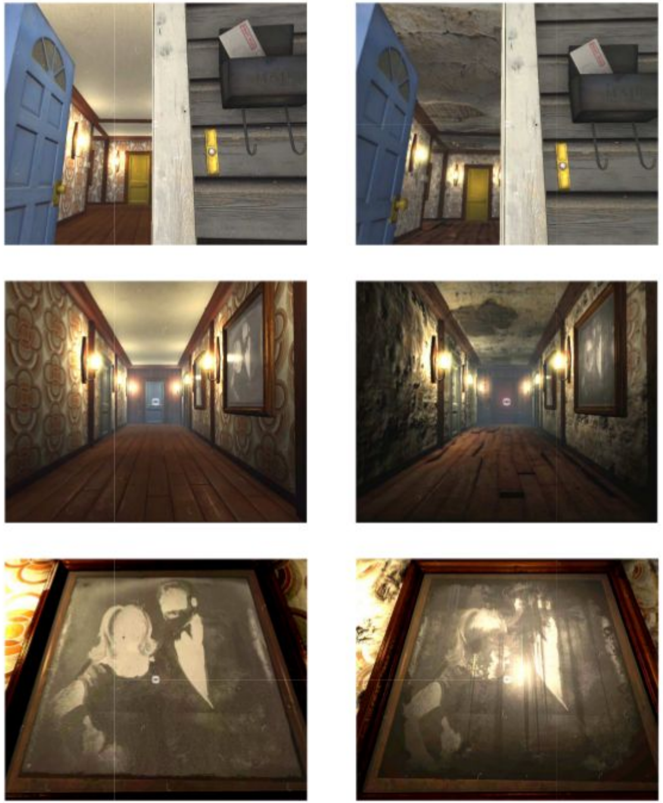


Figure 3: Client #251's childhood home. Players first experience a non-threatening version (left), before solving puzzles in the dilapidated nightmare version (right).

Thematic congruence: Blank and blotched out faces

Figure 4: Blank or blotched out faces are a recurring visual motif in the Client #251 level. This motif reflects the Client's anxiety experienced when seeing people look at her.

Heart rate variability as a proxy for stress

Heart rate variability refers to the extent to which the time between one's heartbeats vary. When calm, heart rate variability tends to fluctuate, demonstrating that the heart is in an easily adaptable state, ready to speed up or slow down depending on one's needs [1]. When under duress, however, heart rate variability narrows as the body focuses on self-control, performance, and on maintaining a fixed, high level of arousal. Figure 1, below, gives an illustration of heart rate variability.

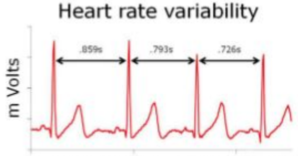


Figure 1: Heart rate variability demonstrated using hypothetical heart rate data.

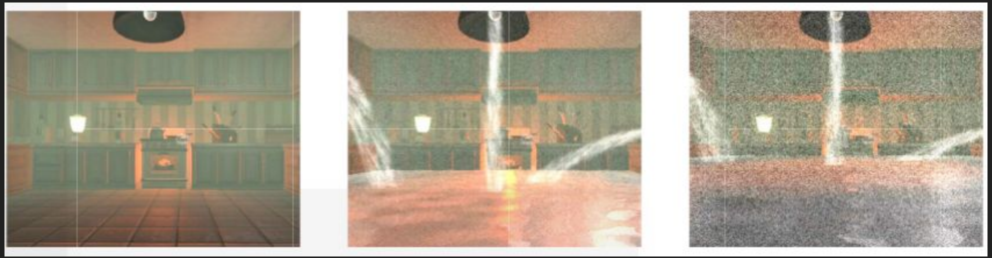


Figure 2: An example of Nevermind's biofeedback system. As the player's stress increases, the higher the milk rises. In this scenario, the player's character can drown, forcing him/her to restart the challenge. However, returning to a relaxed state causes the milk to subside.

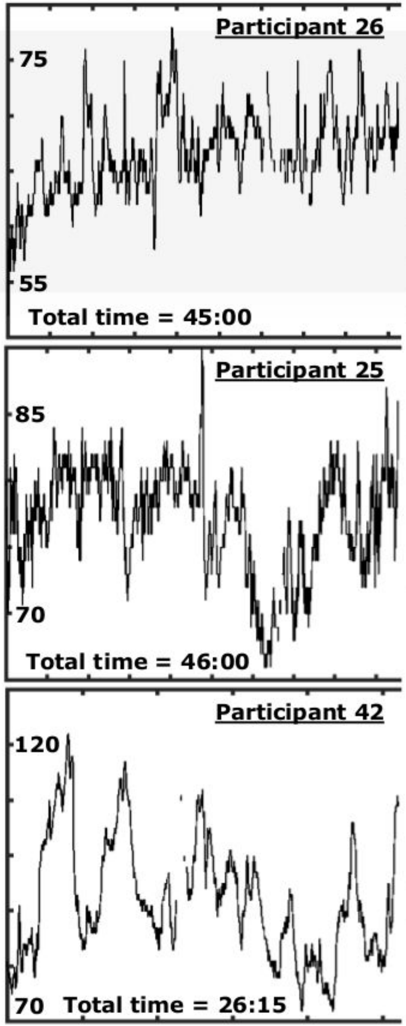


Figure 5: Heart rate data from three participants with heart rate in beats per minute on the y-axis, and time in minutes on the x-axis. Each graph plots a single play session from a single participant. While Nevermind utilizes heart rate variability for its biofeedback mechanic, heart rate is plotted here for ease of discussion and readability. Gaps in lines represent missing data. Participant 26 did not complete the level, Participant 25 did, and Participant 42 requested to end the session early due to duress. (This was the only participant in our sample to do so.)

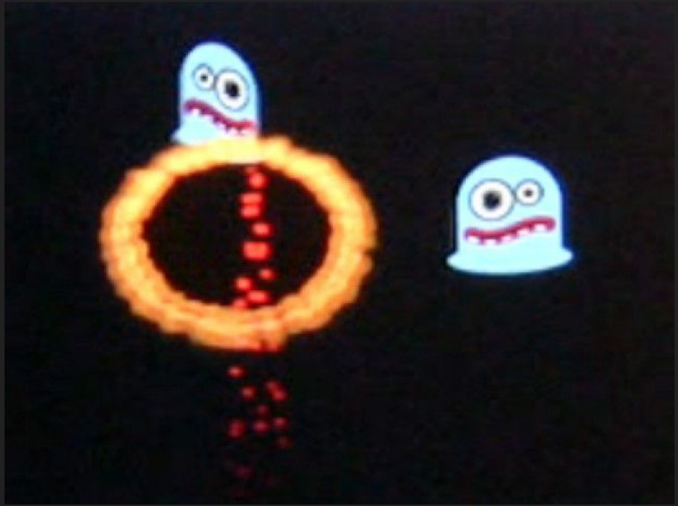
- Frequency of spikes in negative physiological arousal – Comparing Participant 26 (P26) to P25, it seems that there is variability in the number of times which Nevermind caused players' heart rates to spike. This may be an indication of (over-)sensitivity to negative emotional stimuli.
- Speed of recovery – Perhaps more important than the number of times Nevermind evoked negative arousal, is the speed with which participants are able to recover from spikes in arousal. Thus, the slopes of the lines coming off of a spike may be important. This could be a metric of an ability to healthily down-regulate negative arousal after highly stressful experiences.

- Frequency of dramatic drops in negative physiological arousal – Again comparing P26 and P25, P25 seems to more frequently have dramatic drops in heart rate. These may be indicative of freeze responses, or perhaps to an ability to quickly regulate physiology when the situation requires it.
- Intensity of negative physiological arousal – Finally, negative arousal may vary in intensity across participants. For example, P42 seems to show a resting heart rate of about 80 beats per minute, while her heart rate exceeded 110 beats per minute on a number of occasions. This too may be an indication of (over-)sensitivity to negative emotional stimuli.

RAGE Control video game

RAGE Control (Regulate and Gain Emotional Control) video game - modified version of Space Invaders - can't shoot too many alien ships if too excited (measured by finger heart monitor).

Used in therapy of children with high levels of anger and hostility in Children's Hospital Boston




Heart Rate
71
Score
500
Nice shot!
Children's Hospital Boston

Applications - Szwoch 2015

1. Increase the difficulty level of game challenges for advanced players in order to prevent them from being bored by too easy gameplay.

2. The second is the opposite action to prevent inexperienced players from becoming disenchanted with the game, which can be especially important for educational video games used in e-learning for young children.

Szwoch, M., 2015, June. Design elements of affect aware video games. In *Proceedings of the Mulitimedia, Interaction, Design and Innnovation* (p. 18). ACM.

Measurements

Two possible ways of getting information about the current emotional state of a player:

1) External sensors, such as video and RGB-D cameras, microphone, keyboard, mouse, as well as physiological ones.

2) Current behavior in the game.

Aside on keyboard and mouse detection of stress

Hernandez, J., Paredes, P., Roseway, A. and Czerwinski, M., 2014, April. Under pressure: sensing stress of computer users. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 51-60). ACM.

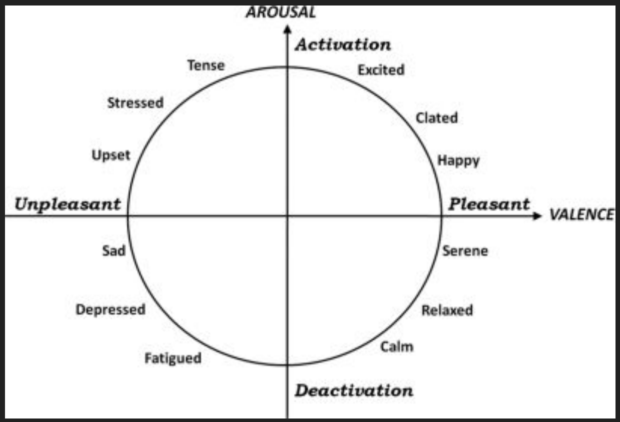
During stressful conditions, the large majority of the participants showed significantly increased typing pressure (>79% of the participants) and more contact with the surface of the mouse (75% of the participants).

Figure 1. Pressure-sensitive keyboard (left), and capacitive mouse (right).

Which Emotions to detect?

Although it would be very impressive to take many emotions into consideration during gameplay, it is not needed in many cases, and leads to low recognition efficiency.

Very often a simple set of two opposed emotions is enough to create an interesting affect-aware character of the game. Such pairs of emotions usually lie along the valence-arousal axes.



Influencing gameplay difficulty

Table 1. Sample parameters influencing game difficulty

Parameter class	**Sample parameters**
Avatar attributes	Number of lives, health, speed, resistance
Avatar equipment	Weapons, ammunition, spells, potions, money
Enemies	Enemies number, kind, equipment
Obstacles	Obstacle number, difficulty
Time, pace and safety	Time limits, gameplay pace and rhythm, number of safe points
Bonuses	Number and kind of bonuses
Balance	Gameplay symmetry and balance, handicaps
Interface	Reaction time, scene brightness
AI	AI level and its aggressiveness

Discussion

Why do you think the industry hasn’t adopted affect in games?

And what would we need to do to achieve this?

Hardware

Ethics/privacy of data

Difficulty of interpretation of data

Account for individuality and differences in data

Synkin: A Game for Intentionally Synchronizing Biosignals

Wikström, V., Makkonen, T. and Saarikivi, K., 2017, May. SynKin: A Game for Intentionally Synchronizing Biosignals. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 3005-3011). ACM.

Discussion Topics - Multi-Player

How could this affect multi-player games?

Show representations of other player’s emotional state?

Is it engaging to view vital signs of teammates/opponents?

Is it a useful game mechanic?

Detect distress?

Most enjoyable thing we’ve done so far.

High sense of satisfaction when opponents spike

Entertaining to view teammates response - Not useful (yet)