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Exploring Affective Representations in Multiplayer FPS Games and their Impact on Social Presence

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Exploring Affective Representations in Multiplayer FPS Games and their Impact on Social Presence

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requirements for the degree Master of Science

in

Computer Science

by

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Professor Nadir Weibel, Chair
Professor Jurgen Schulze
Professor Geoffrey Voelker

2023

The Thesis of Rohan Yogesh Bhide is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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2023

DEDICATION

To Aaji, Dada, Aai, Baba, and the entire family, for their love and support throughout this journey.

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ABSTRACT OF THE THESIS

Exploring Affective Representations in Multiplayer FPS Games and their Impact on Social Presence

by

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Master of Science in Computer Science

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Professor Nadir Weibel, Chair

Affective state visualizations can influence social interaction in digital games, and analyzing such visualizations could help game designers to identify avenues for enhancement, leading to more engaging gameplay. Facial expressions can be used to detect affective state in real-time which can then be projected to the player in-game. Previous work has shown that representations of facial expressions in the form of emojis in a two-player car racing game improves player experience. However, its use in multiplayer first-person shooters, where the full attention of the player is needed at every moment of gameplay, remains largely unexplored. Improving on past work, we explore emoji as an affect representation in multiplayer FPS games.

In addition, we introduce a novel diegetic representation of affect, and compare it with the emoji. Our user study with 18 participants shows that while emojis can be distracting, they are also enjoyable and easy to interpret. Our diegetic representation shows promise as a strategic game mechanic, but a more in-depth analysis is necessary to fully understand its potential. We further analyze their impact on social presence and find significant improvements in empathy and behavioral engagement for emojis. Our findings highlight the potential use of physiological representations as a non-verbal form of communication in virtual spaces, such as multiplayer games.

Introduction

Digital games are interactive entertainment experiences that have garnered immense popularity due to their capability to challenge cognitive abilities, immerse players in narratives, and foster social connections. Concurrently, the emergence of self-tracking physiological technology has revolutionized the gaming landscape by enhancing player experiences and pushing the boundaries between virtual and physical reality [12].

Incorporating physiological signals in gaming typically includes collecting physiological data, projecting the collected data into the game, and mapping the data to in-game elements or game inputs [18]. For instance, games like AffQuake adapted the player's avatar in response to their arousal levels [16]. Valve Software's experiment with Left4Dead linked enemy spawns, weapon placements, and boss appearances to arousal levels. In a multiplayer setting, players regarded viewing emotional states of teammates and opponents as an enjoyable experience, resulting from a high sense of satisfaction when opponents displayed heightened emotions [2]. In another study on multiplayer car racing games, the use of emojis to convey emotional states resulted in increased perceived competitiveness and enjoyment, impacting player emotions and in-game behavior [22]. Despite these promising developments, widespread commercial success in affective gaming on major platforms is still a challenge.

Several gaps exist in the affective gaming research. First-Person Shooters (FPS) are a popular genre of video games that immerse players in the action from a first-person perspective. These games typically involve using various firearms to engage in combat, offering an intense and adrenaline-pumping gaming experience. We point out that despite the genre's popularity, the use of affect in FPS games is limited [2, 13] and remains largely unexplored. Multiplayer games expand on this concept by allowing multiple players to connect and play together in the same virtual world. Multiplayer games have great potential to foster social connectedness [4]. However, prior works integrating physiological signals in cooperative [19] and competitive [22] multiplayer games do not provide comprehensive analysis of its impact on social presence.

Moreover, the current techniques for conveying emotional states rely primarily on in-game overlays and Heads-Up Displays (HUDs), which have the potential to disrupt players' immersion in the game [22]. Whether such disruptions contribute to an enjoyable gaming experience and whether there exist more effective means of representation remain open questions. Further, affective states are used to explicitly control game difficulty [11]. However, current literature does not consider the prospect of implicit difficulty control with visualizations of affect. As a result, the potential to utilize these representations as a game mechanic warrants deeper exploration. To address these gaps, we propose the following research questions:

In multiplayer FPS games,

RQ1 How can we better represent emotional states to enhance player experience?

RQ2 Does representing affect, measured with facial expressions, impact perceived game difficulty?

RQ3 How does awareness of emotional expression affect social presence?

To investigate these research questions, we augment Unity's FPS template by adding emotional state representations on the player's avatar. In particular, we focus on two representations - the emoji, inspired by Sekhavat et al. [22]'s work, and the diegetic rings, inspired by Dead Space (Electronic Arts, 2008). These visualizations are tied to the player's affective state and are measured using a facial expressions analyzer [25, 27, 26]. Then, we conduct a within-subjects study with 18 participants focusing on both quantitative results and qualitative analysis. Notably, we employ questionnaires to measure distraction, perceived game difficulty, and social presence.

Our research yields valuable insights into the design of affect-based representations in FPS games and their potential to influence players' perceptions of game difficulty. More specifically, we offer explanations for the effectiveness of using emojis to convey affect in FPS games and provide considerations on their usage in competitive gaming contexts. Additionally, we demonstrate the utility of our novel representation of affect, diegetically placed rings, to reduce distractions and highlight its promising role in implicitly controlling game difficulty.

Furthermore, our study highlights the capacity of emojis to evoke empathy and impact player behavior, suggesting that emotional representation in games can serve as a powerful non-verbal tool for communication. However, we argue that it's crucial to strike a balance between minimizing distraction and enhancing social presence. Ultimately, our findings provide valuable insights that can guide game designers in creating more engaging and immersive gameplay experiences.

Chapter 1

Related Work

Our research builds upon and extends various related studies in the affective gaming domain. In this section, we outline previous research on integrating affective state in digital games, discuss the ways to measure physiological signals, and point out the existing gaps in affect-based multiplayer games.

1.1 Why First-Person Shooters?

The FPS genre's high-stress, competitive scenarios are ideal for exploring emotional responses, and team-based gameplay introduces a layer of complexity when investigating social presence. Additionally, players of this genre are known for their ability to swiftly switch between complex tasks [5], providing a unique context for investigating the effect of adding emotion visualizations on distraction and perceived challenge. By leveraging these unique characteristics, we aim to deepen our understanding of emotional representation, its effects on perceived game difficulty, and its role in enhancing social presence within FPS games.

1.2 Affective Game Loop Framework

Robinson et al. [18] developed the Affective Game Loop Framework that describes the affective gaming experience. According to the framework, affective games use a sensing system to measure physiological state and feed it into the game as input, followed by integration of that input, and finally provide feedback to the user. Physiological data is used as a game input individually [28] or alongside standard inputs such as a keyboard and a mouse [2]. Physiological inputs are integrated into the game directly by mapping them to game mechanics [13] or indirectly by mapping them to game difficulty [11]. The player receives visual, auditory, or haptic feedback from the game [9].

Often, physiological data collected by the sensing system is not integrated into the game. Instead, it is displayed back to the user in-game [22] by overlaying it over the gameplay. Current methods to represent affective state such as emojis on the HUD can be distracting [22], and Sekhavat et al. [22] argue that this effect is amplified in FPS games. Our work is grounded in theory surrounding the utilization of affect in games, and aims to explore the physiological projection branch of the Affective Game Loop Framework.

1.3 Detecting change in affective state in games

In FPS games, players are constantly on the lookout for enemies, and their attention is fully absorbed by the action on the screen. Players of this genre describe the gaming experience as intense which is validated by an increase in average heart rate [1]. However, there is a dip in stress levels when a State Trait Anxiety Inventory (STAI) [23] is administered pre-game and post-game [1]. Therefore, physiological state can change in FPS games.

To detect physiological states, the circumplex model of affect comprising of two neurophysiological dimensions, arousal and valence, is employed [21]. Arousal can be measured directly in short intervals with electroencephalogram (EEG), in somewhat longer intervals with skin conductance and heart rate, in even longer intervals with body temperature, or indirectly with self-reports [17]. Valence is measured by observing facial expressions, using the Facial Action Coding Systems (FACS) or by muscle activity through facial electromyography [30].

Digital games can evoke a range of facial expressions indicating emotions such as boredom, anger, surprise, joy, and disappointment [29]. Facial expressions, arousal, and valence can be detected from camera data by employing deep neural networks [24] or partial least squares regression [26]. We leverage these advances to sense affect in our study.

1.4 Physiological state representations in games

Affective games use the physiological state detected by the sensing system, and project it over the gameplay. In a two-player car racing game, the opponent's physiological state is represented with emojis on the bottom-center of the player's screen. Change in the physiological state of the opponent is accompanied by a sound effect [22]. However, such a representation is inadequate for a multiplayer game with more than two players, and additional context needs to be provided to help the player distinguish between multiple emojis. In a multiplayer FPS game, Left4Dead, teammates' and opponents' vitals are displayed in the HUD [2]. Sekhavat et al. [22] argue that such representations of physiological data can be distracting in a FPS game because the genre requires the full attention of the player at every moment of gameplay. Therefore, better ways of displaying affective state need to be explored and thoroughly tested for distraction and user preference. Diegesis is a well-known approach to provide the player with cues and information without distracting them from the narration of the world [20, 7]. Our diegetic approach to represent physiological information is inspired by Dead Space (Electronic Arts, 2008). We hypothesize that it will minimize distractions from gameplay commonly found in non-diegetic representations [22, 2].

Subsequently, physiological data is mapped to in-game elements to adapt the level of difficulty in games [11]. However, the use of visual representations of physiological data to influence difficulty has not been investigated yet. The use of diegetic elements in-game increases perceived challenge in experts [10] and shows potential for use as a game mechanic. However, changing difficulty in multiplayer games whilst maintaining fairness is challenging, and warrants deeper exploration. We hypothesize that difficulty can be influenced in multiplayer games implicitly by linking visual representations to the players' emotional states. Our diegetic display of affect aims to influence difficulty by making it easier to spot players that are highly stimulated.

1.5 Team dynamics and social interaction in affective multiplayer games

We hypothesize that our novel approach to adapt difficulty will alter game dynamics and allow for new forms of social interaction in-game. Previous work on using affect in multiplayer games has been successful in influencing the dynamics of the game and in providing additional channels of social interaction [22, 9, 2]. In an experiment conducted on affective representations in a multiplayer Left4Dead game, players reported feeling satisfied when they see a spike in the opponents' arousal [2]. Similarly, in a two-player car racing game, players could not withstand opponents overtaking their cars with a happy face. Participants described the affective representations as a meta-game on top of the actual game [22]. In an asymmetric VR multiplayer game using affect, non-HMD (Head Mounted Display) players experienced high agency and immersion when their heart rate affected the game difficulty for their HMD counterpart [9]. Despite the promising results of past research, a comprehensive analysis of social presence is lacking. Motivated by the lack of a comprehensive study, this research investigates the role affective representations play in influencing social presence, in a multiplayer FPS game, through quantitative and qualitative assessments.

Chapter 2

System Design

2.1 Multiplayer FPS Game

We chose to use the FPS game template from Unity 2021 for its versatility in customization and ease of use. The default capsule-shaped model available in the template is replaced by a player model from the third-person shooter template in Unity 2021. The material on the player model was modified by setting the base color to red for enemies and blue for teammates as seen in Figure 2.1.

The shooting mechanics comprise of a crosshair at the centre of the screen and a weapon which fires when the player presses the left mouse button. A particle effect was linked to the mouse input for weapon fire to add visual feedback. A ray is cast from the crosshair into the game world and collisions with enemies are detected. A collision deals damage to the enemies and instantly eliminates them, but teammates cannot be damaged. A score is displayed at the top-left corner of the screen, and is updated when an enemy is hit.

2.2 Representation Design

To project a player's affective state into the game world, two designs were chosen. An emoji corresponding to the player's facial expression detected by the sensing system is overlaid on the avatar's face (refer Figure 2.2). This design is inspired by previous work on using affective state in a multiplayer car racing game [22]. Their game displays the other player's emotion on

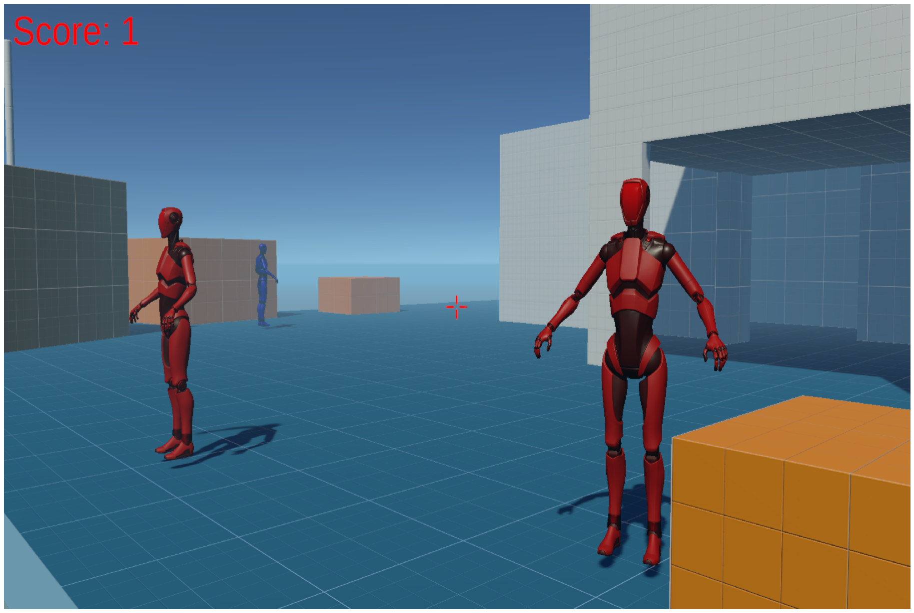

Figure 2.1. Multiplayer FPS Game (Unmodified)

the HUD at the bottom of the screen. Representing the other player's emotional state in the HUD gives the player access to affect information at all times, but we argue that the HUD can become visually cluttered when the number of players increase. Alternatively, such information can be directly displayed on the player's avatar. Sekhavat et al. [22] argues that using emojis in a FPS game can be distracting because *"such games require the full attention of the player at every moment of the gameplay."* However, players of the genre are found to have short reaction time while switching between tasks [5]. Therefore, we argue that FPS players are well-equipped to handle an additional modality of game elements and hence, affect visualizations will not be distracting for them.

Diegetic elements have been proven to reduce distractions and improve immersiveness in digital games [14]. Inspired by the design of the health bar in Dead Space (Electronic Arts, 2008) (refer Figure 2.3), we attach circular rings on the player avatar. The goal of this design is to make the rings blend in with the rest of the character model. For better visibility, we added three rings on the back, and two on each side of the chest. Rings are placed on both the front and the back of the player avatar to improve visibility. Similarly, rings are attached to the sides of the

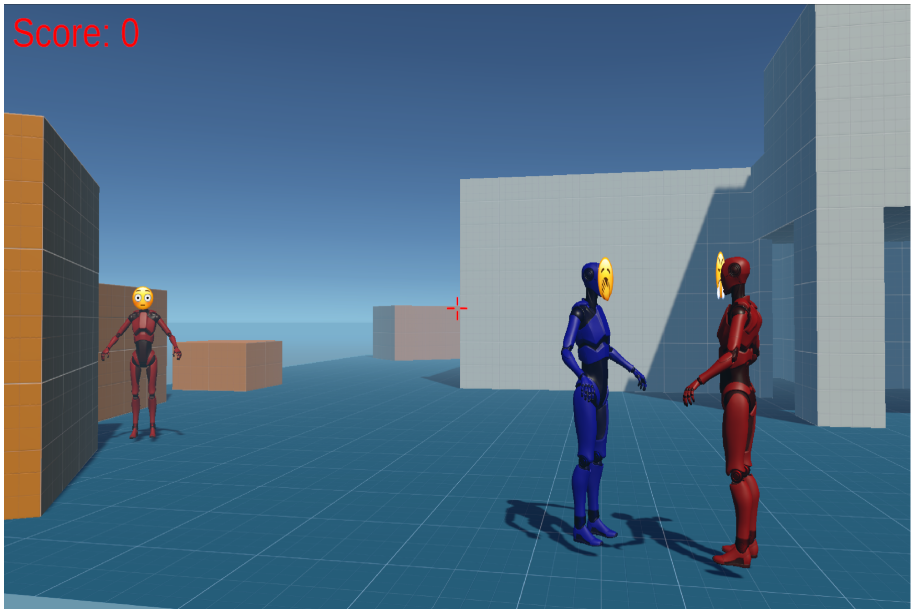

Figure 2.2. Affect Represented with Emojis

chest, instead of the center, for better visibility when peeking corners.

These rings glow bright cyan when the sensing system detects high arousal to indicate stimulation, and go dark when low arousal is sensed as seen in Figure 2.4. The glow intensity is changed by manipulating the emission color of the material. The cyan color is chosen for the glow as it is clearly visible on all backgrounds present in the Unity scene. All rings for a player are updated via a C# script simultaneously.

2.3 Agent Controller System

The rectangular map is divided into two halves across its length. The player spawns at a fixed location on one side of the map. 10 spawn locations are chosen for each half of the map, making sure that the player's spawn location is not repeated. One teammate (blue agent) spawns randomly in one of the ten locations closest to the player's spawn point. Similarly, two enemies (red agents) spawn randomly in one of the ten spawns farthest from the player's spawn location.

All spawned agents move towards a randomly chosen spawn point on the other side of the map. The agents are controlled by Unity's NavMesh system where the floor and ramps are

Figure 2.3. Diegetic Representation of Health in Dead Space [15]

walkable areas. The blue agent is destroyed when it reaches its desired position while the red agents simply wait at their randomly chosen destination until they are hit by the player. Upon destruction, all agents respawn at a random point on the side of the map they were initially spawned, and follow the same random movement patterns described above. The map displaying spawn locations and examples of agent movement patterns are shown in Figure 2.5.

Agents do not fire back at the player, nor at each other. This design decision is necessary to decouple the emotional response resulting from the game mechanics of the game and the emotional response associated with emotional awareness.

2.4 Affect Sensing System

To measure affect, we use face data captured by a Logitubo video camera. The camera records at 1080p 30fps. The video feed is recorded frame-by-frame using OpenCV in Python. At every frame, the open-source DLib library identifies faces, crops them, and detects 2D landmarks on the face. The cropped faces and the 2D landmarks are then passed to the emotion detection model [25, 27, 26]. Figure 2.6 shows a snapshot of the affect sensing system in action. It

Figure 2.4. Affect Represented with Rings

provides fine-grained emotion estimation based on Russell's circumplex model [21] with 24 distinct emotions and 4 degrees of intensity. The predicted facial expressions, arousal, and valence are passed to Unity over a local server.

As the player embodies the in-game character in a FPS game, their avatar is not visible to them. Therefore, representations of self affect can only be displayed back to the user via the HUD or in-game elements. To retain consistency with past work on multiplayer affect representations [22], the player is not shown a representation of their emotional state. However, the player is made aware that other characters in the game space can see their affective state.

2.5 Affect Simulation System

To test whether emotions made an impact on social presence, we simulated the affective state of the intelligent agents in the game. We randomly sample an affective state from the range of emotions detected by the sensing system. A random value ensures that the measured social presence is not tied to specific affective states but to the entire range of emotions expressible by humans.

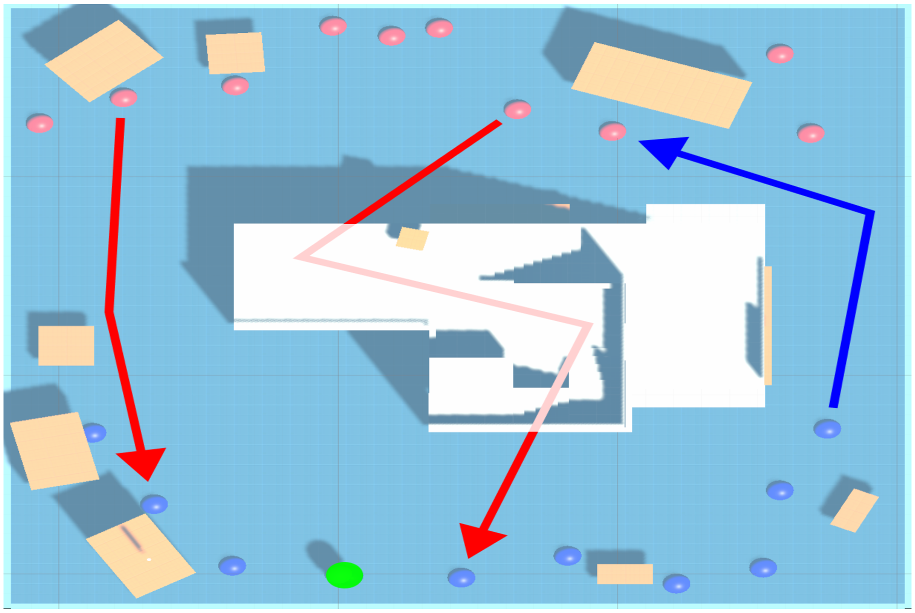

Figure 2.5. Game Map, Spawns and Movement Patterns (Red Indicates Enemies, Blue Indicates Teammates, Green Indicates Player)

For the non-diegetic emoji representation, an emoji is randomly chosen from the 24 available emojis. For the diegetic representation, a random value between 0 and 1 is chosen for the intensity of ring glow. A random intensity or a random emoji is generated every 3 seconds, a value chosen after analyzing the data collected from our pilot studies.

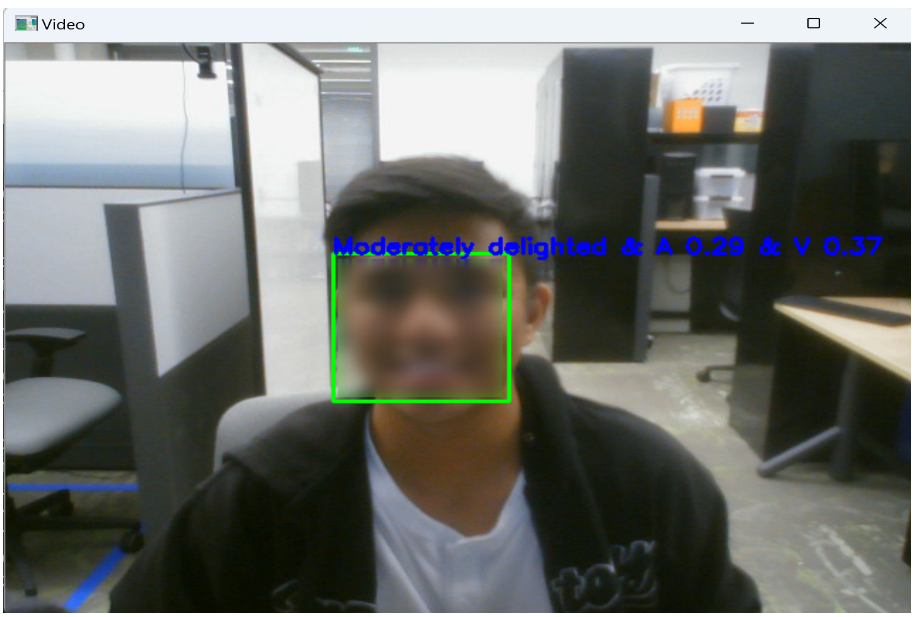

Figure 2.6. Model for Affect Recognition from Faces

Chapter 3

User Study

The goal of the study is to explore whether the diegetic representation of affect can minimize distractions in-game and if the representation would elicit a change in the perceived difficulty of the game. Further, we aim to test the influence of such a representation on social dynamics within the game. Aiming to inform the design of affect representations, we compare our diegetic representation of affect with a non-diegetic design motivated by previous work.

3.1 Participants

18 participants (12 males, 6 females), ages ranging from 19 to 29 years (M = 22.5; SD = 3.0), were recruited through the researchers' networks. Our sample contained beginners (4/18) without any experience playing FPS games as well as professional players (2/18) on the university team. More than half of the participants indicated that they had prior experience (in years) playing games of this genre (M = 3.3; SD = 3.3). Additionally, 8 participants reported that they had played a FPS game in the last two weeks. Their self-reported playtime for the last two weeks ranged from 1.5-56 hours (M = 14.9; SD = 21.0).

3.2 Tasks

A within-subjects design is used for the study, with the type of physiological representation as the independent variable. To get familiarized with the game, participants first play the unmodified version of the game. This task, also referred to as the baseline, aims to evaluate the difficulty of the core mechanics of the unmodified game.

- No representation of affect (Baseline): In this adaptation, the enemies, programmed by the research team, did not have visualizations of the affective state. To keep conditions comparable across the three tasks, the players sit in front of a camera attached to the monitor. Players are made aware that their affective state was computed by the sensing system. However, similar to other tasks, their affective state is not displayed back to them. Our pilot study confirms that participants found our game design to closely resemble popular FPS titles in terms of game mechanics.

After getting familiar with the core game mechanics, the participants play the game in two altered conditions which seek to add a layer of emotional difficulty on top of the mechanical difficulty of the unmodified game. Therefore, the two altered conditions rely on the skills gained by the player through the baseline task.

- Non-diegetic representation of affect (Emoji): In this variant, an emoji representing affect was overlaid on top of the enemies' faces and the teammate's face. The emojis are tied to the emotion calculated by the sensing system.
- Diegetic representation of affect (Rings): In this condition, 7 rings linked to the player's arousal are attached to the player models of the enemies and the teammate. The design of the rings is described in Chapter 2 and is inspired by Dead Space (Electronic Arts, 2008).

3.3 Procedures

The experiment is carried out individually for each participant with the baseline measurement and two altered conditions. To avoid carry-over effects, the two conditions that rely on the baseline are fully counter-balanced between the 18 participants. Before conducting the experiment, participants are introduced to the game, the controls of the game, and to the affect sensing system. To ensure that the affect detection algorithm works correctly, participants are asked to make a happy face, followed by a sad face. The sensing system is able to predict both emotions for all participants. Players are asked to think-out-loud during the entirety of the study. The lead researcher then follows up with relevant questions whenever necessary. Participants play each variant of the game for approximately three minutes. A hard limit was not set because of the qualitative nature of the experiment. After every task, participants filled out the Social Presence in Gaming Questionnaire (SPGQ) [6]. For the modified game versions that incorporate emojis and rings, participants were evaluated on self-reported distraction, mechanical difficulty, and emotional difficulty. After finishing both conditions, a semi-structured interview is conducted focusing on effectiveness of emotion displays as a form of communication in-game.

3.4 Measures

The widely accepted SPGQ is chosen to measure social engagement. The questionnaire has three sub-scales - Psychological Involvement (Empathy), Psychological Involvement (Negative Feelings), and Behavioral Engagement. SPGQ contains a total of 21 items, each rated from '1' (Not at all) to '5' (Extremely). In the modified versions of the game, participants are asked to rate an additional three questions about **(Q1)** distraction, **(Q2)** mechanical difficulty, and **(Q3)** emotional difficulty on a 5-point Likert scale using the same categories as the SPGQ.

Qualitative measurement include think-out-loud exercises and semi-structured interviews. For the baseline measurement, the participant is asked about their communication preferences in-game, whom they usually play with, and the genre of games they usually play. For sessions using the modified version of the game, the researcher focuses on understanding changes in gameplay, player experience, and social interaction. If needed, the participant is prompted to elaborate on their decisions and provide specific examples. Finally, the post-game semi-structured interview aimed to measure the utility of affect displays in team-based FPS and the impact of emotional awareness on social interaction.

3.5 Data Analysis

To analyze the data collected from our mixed methods study, quantitative analysis of the self-reports, and qualitative analysis of the think-out-loud exercises and semi-structured interviews are performed.

Because of the ordinal nature of the quantitative measures, non-parametric statistical tests were used for data analysis. The mean of individual items for each subscale were used for computing the SPGQ scores. To check if there was a clear favorite amongst the participants, a Friedman test ($\alpha = .05$) was used to compare reports from the SPGQ between the baseline, emoji, and ring variants. It was followed by a post-hoc pairwise Wilcoxon signed-rank test adjusted with a Bonferroni correction to account for the number of comparisons. Similarly, for the three additional measures, namely distraction, mechanical difficulty, and emotional difficulty, statistical analysis is performed with a Wilcoxon signed-rank test.

The lead researcher then performed thematic analysis [3] and adopted a mixture of emergent and priori coding approaches on the 7.24 hours of video recordings for 18 participants. First, we transcribed the recorded video clips. Then, we closely read the transcripts and watched the recorded videos iteratively, allowing codes to emerge freely from the data. During analysis, we removed filler words like ”um” and ”ah” from the transcripts.

Chapter 4

Results

In the following section, we report the analysis of quantitative data collected using questionnaires, and qualitative data recorded through semi-structured interviews and think-out-loud exercises.

4.1 RQ1: How can we better represent emotional states to enhance player experience?

4.1.1 Emojis can be more distracting than rings yet more enjoyable

Participants frequently reported experiencing distraction from emojis, with 8 out of 18 participants expressing that they were fairly or extremely distracted by them (refer Figure 4.1). For example, P6 mentioned, "*seeing the faces is a lot more distracting because I'm looking at their faces a lot more.*" Notably, some participants found this distraction to be a "*positive*" [P8, P10, P17], "*fun*" [P8, P18], and "*entertaining*" [P17] aspect of the game. However, participants expressed concerns about its use in competitive settings as it can "*interfere with the objective*" [P11, P14], be "*too distracting*" [P15, P16], and can be abused [P13].

In contrast, 12 out of 18 participants reported only slight to no distraction when affect was displayed with rings (refer Figure 4.1) hinting at the potential of diegetic elements to reduce distraction. Participants had mixed opinions about the experience ranging from "*feels like a decal*" [P11] and "*just something else to look at*" [P17] to "*it felt natural*" [P16]. A statistically significant difference in distraction between emojis and rings was observed ($p = 0.0142$).

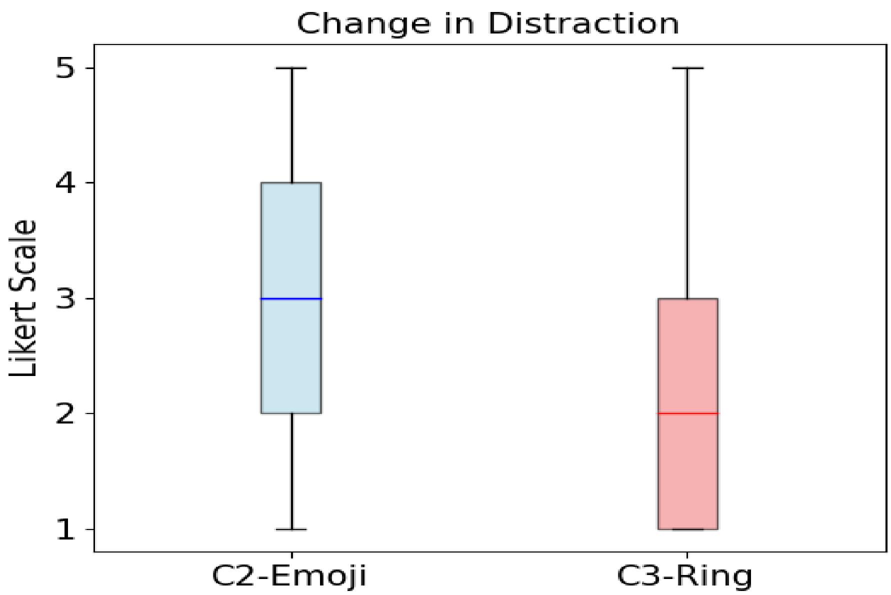

Figure 4.1. Box Plot Illustrating the Data for (Q1) Distraction

4.1.2 Emojis can be easier to interpret as humans have the capacity to read facial expressions

Participants generally found emojis to be more intuitive and "*easier to interpret*" [P2] compared to rings. Emojis were described as "*vivid*" [P1], "*better equipped to convey emotions*" [P16], and able to "*show a wide range of emotions*" [P7]. This intuition might be associated with humans being "*tuned to read faces*" [P16], and with participants using conferencing tools such as "*FaceTime and Discord*" [P12] or "*voice call*" [P8] while playing games. Notably, P1 brought to attention that "*human emotion can be complicated*" and that people "*interpret it in a different way, based on culture*."

Rings, however, were harder to interpret. Particularly, P15 said, "*it takes a little bit more time for me to think that oh, this is how somebody is feeling*". Other participants agreed and commented "*I don't think I'm processing it in any way*" [P16], "*didn't really know how to feel about it*" [P17], and "*it doesn't really mean anything*" [P7]. This view was shared by P11 who mentioned, "*If you didn't tell me what the purpose of the rings were, I wouldn't have associated* *them with my emotional state*" [P11].

4.1.3 Emojis are generally preferred over the more realistic faces

When asked about displaying realistic faces in-game, participants expressed a preference for the use of emojis to represent affect. For instance, P12 mentioned, "*emojis are so fake that it's hilarious*". Their preference could be associated with emojis being "*easier to decipher than a full human face*" [P8], human faces making the game "*too realistic*" [P13, P17], and potential privacy concerns [P17].

Contrary to these opinions, one participants expressed, "*since it's simulated...interesting experience to try*" [P4]. Another expressed that adding realistic sound effects to the avatars would make them "*pause*" and "*feel bad*" [P3].

4.2 RQ2: Does representing affect, measured with facial expressions, impact perceived game difficulty?

4.2.1 Affect visualization can impact perceived mechanical difficulty for some players

The glowing rings made it "*easier to see enemies*" [P14, P17] from far away whereas P4 was "*confused*" by them. Further, P14's "*if you're like a [camouflaged enemy]...you're [sitting] really calmly...you don't glow*" suggests its potential as a strategic game mechanic. In comparison, emojis required the players to "*get closer*" [P14, P16], "*turn towards their face*" [P2], and added "*player intrigue*" [P4].

Still, the majority of participants (13 out of 18) reported only slight or no change in the game's mechanical difficulty due to either representation of affect (refer Figure 4.2). Comparing between rings and emojis, we found that mechanical difficulty is not significantly different ($p = 0.2068$), indicating that both affect representations had a similar effect on perceived mechanical difficulty.

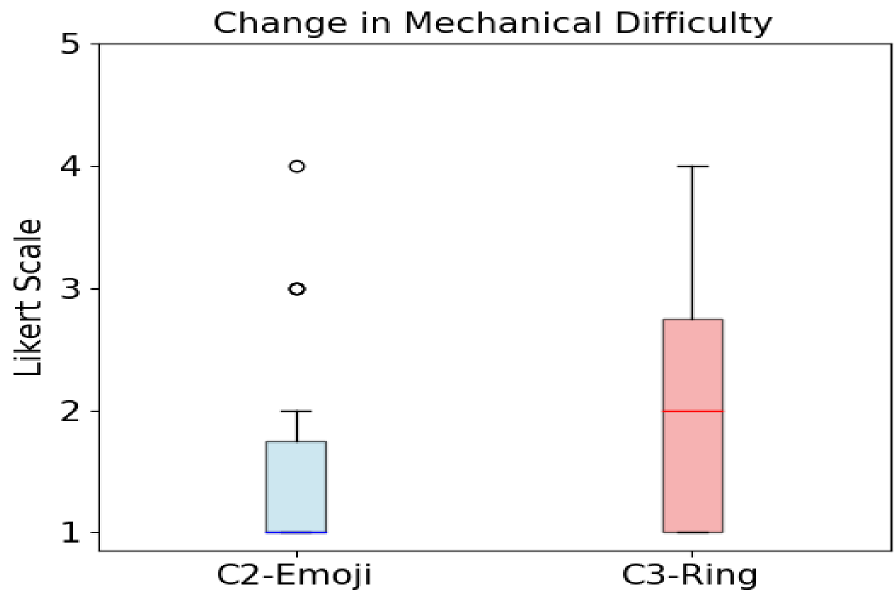

Figure 4.2. Box Plot Illustrating the Data for (Q2) Mechanical Difficulty

4.2.2 Affect visualization can impact difficulty associated with controlling emotions for some players

Participants found emotional awareness to be challenging in the game. A few participants experienced a change in their emotional states while looking at the other players' affect. On that, P1 said, "*when you see other intentions, it will make your intentions magnified*." Their opinion was shared by P8 who felt "*tense...because they're tense*" and P6 who said "*I was getting a little shy because...they're looking at me*." P18 further emphasized their point by saying, "*I don't know...if they're approaching me to comfort me*." Their view was countered by P16 reporting that "*it also eases tension...when you're just seeing emojis*" and by P2 who said, "*I did not pay much attention to my affective state*."

Our quantitative data reveals that 10 out of 18 (emojis) and 11 out of 18 (rings) reported only slight to no change in the difficulty of emotional awareness (refer Figure 4.3). Notably, the ring and emoji conditions are not statistically different ($p = 0.4333$), pointing towards identical impact on perceived emotional difficulty.

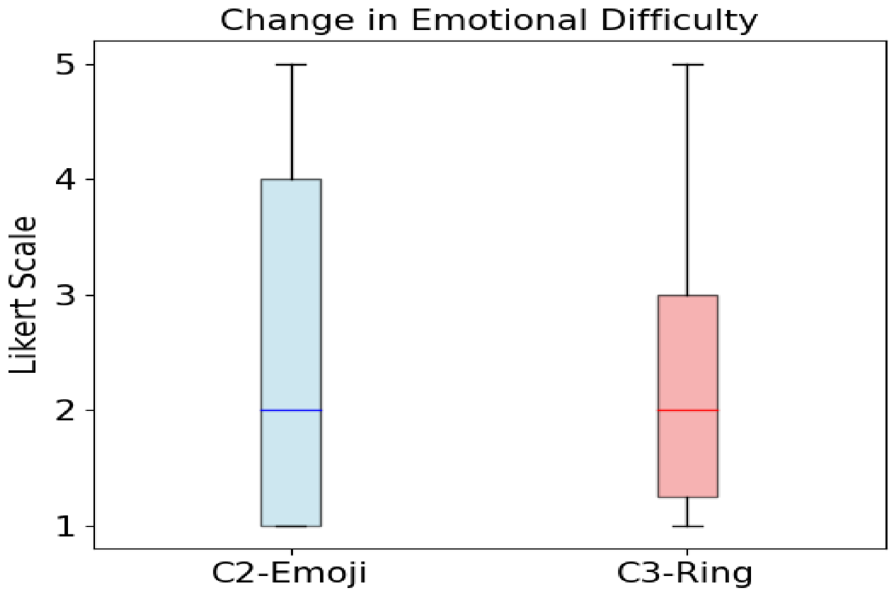

Figure 4.3. Box Plot Illustrating the Data for (Q3) Emotional Difficulty

4.3 RQ3: How does awareness of emotional expression affect social presence?

4.3.1 Emojis have the potential to evoke empathy

Emojis invoked a sense of empathy in participants, with participants reporting feelings of happiness and pity. For instance, P6 said, "*I accidentally shot my teammate...felt a little bad*" which was similar to P4's "*When you attach your emotion...feels more sad to do this*" and P17's "*looks sad...maybe he's having a miserable day*." P18 deviated from the primary game objective and said, "*Maybe I don't have to eliminate them*" and "*I'm sad that this person is angry*." On the other side of the empathy spectrum, a participant reported, "*it saw me and I was smiling and it also smiled*" [P8] referring to the computer-controlled agents. "*He was very excited looking at the view...poor guy*" [P10] and " this guy is staring into the abyss and smiling, so I let him be" [P11] were additional examples. Upon conducting a Friedman test on the Empathy sub-scale, the results displayed statistical significance ($\chi^2 = 13.7681$, $p < 0.01$) with post-hoc tests revealing a significant difference between baseline and emoji conditions ($p < 0.01$).

In contrast, difference between baseline and ring conditions has no statistical significance ($p = 1.0000$). Yet, some participants felt sympathy towards the agents. P4 described the feeling as "*I'm sorry that you lost, but I have to get to the top*" while P3 said, "*someone was having a bad day...I'll try to be nice*." Further, P15 believed that the agents were "*happy when I'm not happy and they're sad when I'm unhappy*."

Finally, the difference in emoji and ring conditions is statistically significant ($p < 0.01$). Self-reported data for SPGQ's empathy subscale is visualized in Figure 4.4.

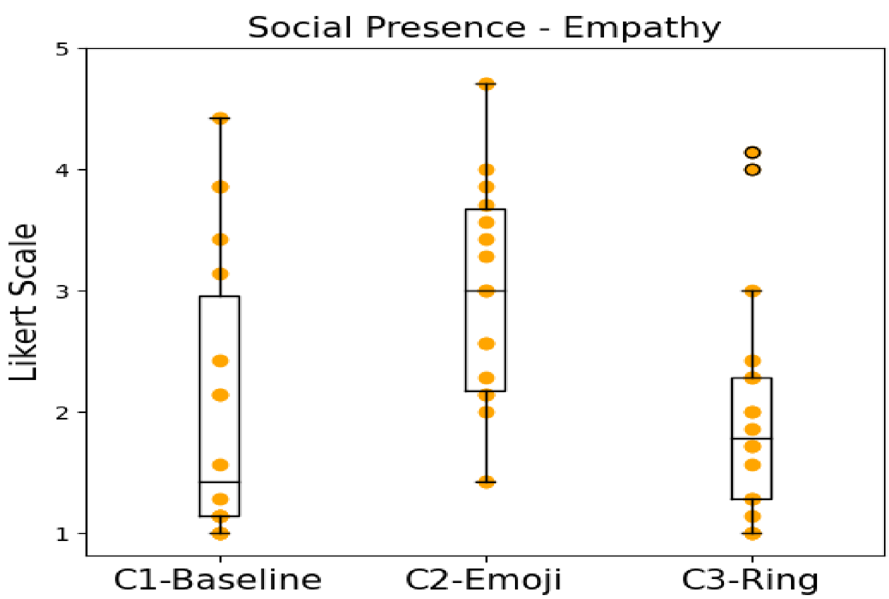

Figure 4.4. Scattered Box Plot for SPGQ's Empathy Subscale

4.3.2 Emojis have the ability to evoke negative emotions, including feelings of mischievous enjoyment and a desire for retribution

The Friedman test for the negative feelings subscale of the SPGQ yielded no significant difference ($\chi^2 = 1.8246$, $p = 0.4016$) in responses between emojis, rings, and baseline variants (refer to Figure 4.5). Nevertheless, some participants reported that they felt "*malicious glee*" [P8, P12, P15] when they defeated opponents who were "*happy*" [P8] or "*nervous*" [P12, P15]. Notably, P2 said "*my strategy has changed...I'm trying to...see how scared they get, as they see me*." Few mentioned that they felt revengeful when they were targeted by agents who were "*super happy*" [P10] or "*sleepy*" [P1, P6]. On the other hand, P18 felt "*ignored*" when they joined a group of two agents standing next to one another.

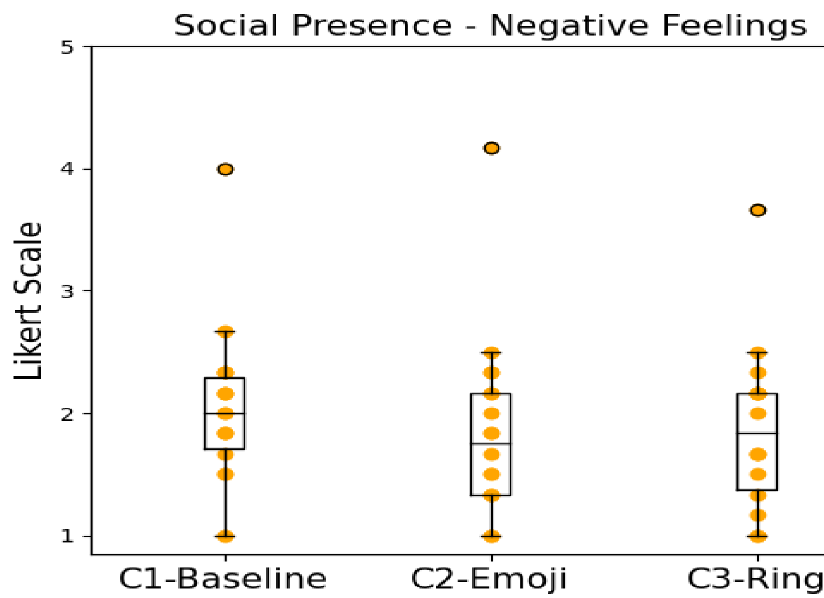

Figure 4.5. Scattered Box Plot for SPGQ's Negative Feelings Subscale

4.3.3 Player behavior can be influenced by displaying affect with emojis

Performing a Friedman test on the behavioral engagement subscale of the SPGQ indicated a preference among the three variants ($\chi^2 = 9.7391$, $p < 0.01$). Pair-wise Wilcoxon tests with Bonferroni correction pointed to statistical significance between emojis and the baseline variant ($p < 0.01$). For example, participants wanted to "*explore around*" [P1] and "*look for people and see how they're feeling*" [P6]. Some wanted the agents to interact with them. For instance, P8 said, "*I just want one to look at me*" and P18 said "*What if I am sad, somebody come to me?* " On that P10 added, "*this person came close and it seems like they're talking*."

Further, participants expressed desire to play with their friends to "*see how they're feeling*" [P8] and to "*strategize*" [P16] during the game. P7 added "*it would be cool to see other people's emotions...during a funny moment...and see other people's reactions*."

Comparison between baseline and ring ($p = 0.1711$), and emoji and ring ($p = 0.3371$)

yielded no statistical significance. A box plot of the collected data is shown in Figure 4.6.

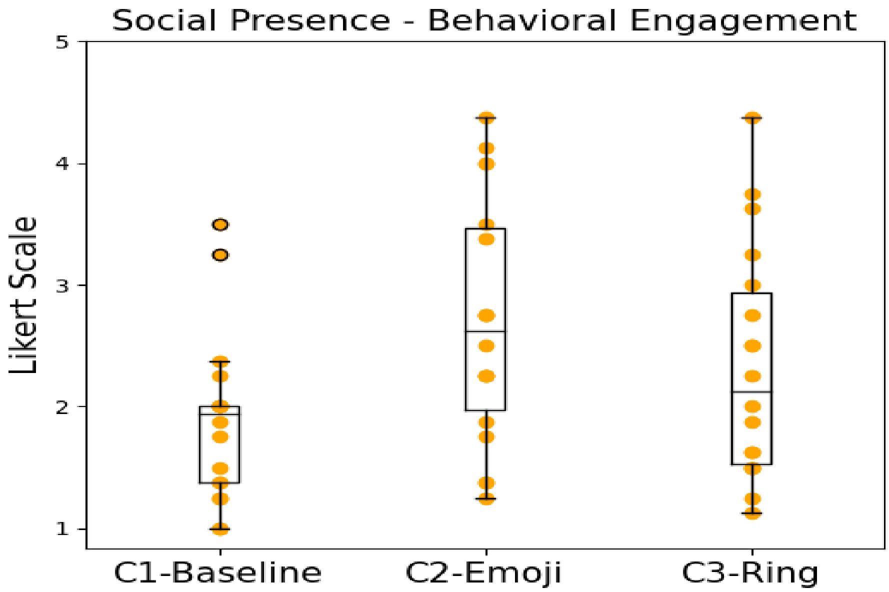

Figure 4.6. Scattered Box Plot for SPGQ's Behavioral Engagement Subscale

4.3.4 Participants typically prioritize the objectives established by the game, but eliminating these objectives can influence behavior

Exploring the notion of eliminating the core objective of accumulating points intrigued participants, although some expressed concerns about losing interest in such a game. For instance, scoring more points was "*more important than knowing how others feel*" [P9] and was the "*ultimate goal*" [P4, P11], especially in competitive games [P14, P15, P16]. However, for P10, looking at emojis was "*taking away from the purpose of the game...but [they] don't really care.*"

Subsequently, participants were asked to imagine a situation where the primary objective of scoring points was removed from the game. Participants reacted positively with some saying that "*[emojis would] add to the experience compared to hampering [their] objective*" [P11], "*[they would] just stay around...watch them react...have a conversation*" [P10], and "*[they would] play with [their] buddies...explore the map...constantly see the emotions that they're feeling*" [P16]. A few expressed concern about playing such a game by saying, "*what's the point?*" [P18] and "*[I'm more interested] when there's goals*" [P14].

Chapter 5

Discussions

5.1 Summary of Findings

Several important findings emerge from our analysis. Initially, our research reveals that emojis, despite their potential to distract, generally provide players with a more enjoyable affect visualization compared to other methods. This preference is likely because emojis are visually striking and attention-grabbing, yet less complex than interpreting human facial expressions. However, participants expressed concerns about how this distraction might interfere with the game's objectives, particularly in competitive contexts. This implies that game designers should carefully balance the use of affect visualization to enhance player engagement without overwhelming them.

In contrast, our innovative approach to representing affect, rooted in the concept of diegesis, significantly reduces distraction. This finding suggests that diegetic representations of affect can effectively minimize distractions, making them suitable for use in competitive gaming. However, players found this visualization less engaging than emojis, possibly because they were playing against pre-programmed game agents.

Emojis appear to be relatively more intuitive and straightforward to interpret in comparison to rings, likely because humans are attuned to reading faces. This observation is further supported by participants who frequently used video conferencing platforms like FaceTime and Discord during their gaming sessions, as they tended to favor emojis due to their greater ease of understanding. This suggests that player preference for such representations may be influenced by their preferred methods of social interaction in the real world. Game designers can leverage this insight to create personalized visualizations.

The results of this study suggest that physiological representations of affect can impact perceived game difficulty. However, the impact is relatively small and does not seem to be significantly different between the two representations used in this study: glowing rings and emojis. This could be attributed to the fact that participants were playing against computer-controlled agents, and further investigation involving human players is necessary for a more precise assessment. However, there are some exceptions to this finding. For instance, one participant reported that the presence of glowing rings facilitated the detection of distant enemies, while another participant suggested that these rings might inadvertently reveal the whereabouts of camouflaged enemies in a game. These exceptions point to the possibility of incorporating this aspect into game design as a strategic element. This finding highlights the potential for affect visualization to influence gameplay and strategy.

Some participants reported heightened emotional awareness, where the presence of affect representations seemed to amplify their own emotional states, particularly tension or shyness. This suggests the possibility of a positive feedback loop, similar to what was observed by Ambinder [2]. Conversely, others found affect visualization to have a soothing effect, easing tension during gameplay. However, it is important to note that the majority of participants in both the emoji and the ring conditions report only slight or no change in the difficulty associated with emotional awareness, perhaps due to the presence of non-human agents in the game. These findings highlight the nuanced nature of affect visualization's impact on emotional control, with individual differences in player responses and the need for further exploration in this domain.

Further, our study reveals that emojis had the potential to evoke empathy among players. Participants frequently reported experiencing emotions like joy and sympathy when interpreting the emotional states of their virtual counterparts. The quantitative analysis confirms the statistical significance of these findings, with a notable difference between baseline and emoji conditions in the Empathy sub-scale of the SPGQ. Interestingly, emojis also exhibit the capacity to evoke negative emotions, including feelings of mischievous enjoyment and a desire for retaliation. Some participants openly confessed to a sense of ”malicious glee” when triumphing over opponents displaying positive emotions, while others expressed a desire for revenge, aligning with Sekhavat et al. [22]'s findings. Although the quantitative analysis did not reveal significant differences in the Negative Feelings sub-scale of the SPGQ, these qualitative insights shed light on the complex emotional dynamics in gaming and underscore the potential of affect visualizations to elicit diverse emotional responses in players.

Furthermore, our study demonstrates that player behavior could be influenced by the display of affect through emojis. Participants expressed a desire to interact with and strategize with other players based on their emotional expressions. The behavioral engagement sub-scale of the SPGQ confirmed the statistical significance of these findings, with participants indicating a preference for emojis over the baseline condition in terms of behavioral engagement.

Lastly, we explore the impact of eliminating the primary game objective, which typically involves accumulating points. While participants generally prioritized the game's objectives, they expressed interest in scenarios where these objectives were removed, allowing them to focus on emotional interactions. Some participants envisioned a more social and exploratory gaming experience, emphasizing the potential for emotional expression to shape player behavior and interactions. These findings contribute to our understanding of the intricate relationship between emotions and social interactions in gaming and provide valuable insights for game designers aiming to create emotionally engaging and socially interactive gaming experiences.

5.2 Limitations and Future Work

We recognize three limitations that may hinder the applicability of our findings to a more diverse group of players. First, our affect sensing system requires a high-quality video camera plugged into the player's computer. However, some players may opt not to use a camera in order to maintain their privacy. Consequently, researchers must take into account potential privacy concerns when designing affect representations to ensure a fair and balanced gaming experience for all. Further, we assume that the player is situated in a well-lit environment where their facial expressions are clearly visible. While the algorithms employed in this study have been trained under naturalistic conditions, they are not equipped to handle cases where faces are partially obscured or out of focus. Additionally, we do not measure the latency associated with detecting the player's affect. Future research should explore strategies for addressing these edge cases and develop resource-intensive games with careful attention to latency considerations.

Second, our decision to incorporate computer-controlled players into the design may limit the potential of emotion visualizations to impact game dynamics and social interactions. Conducting a subsequent study involving human players engaging in cooperative and competitive tasks within teams is essential for a more comprehensive evaluation of our findings. Further, future researchers should consider using the Competitive and Cooperative Presence in Gaming (CCPIG) [8] tool to differentiate the specific influence of teammates from that of opponents on social presence.

Third, our game does not project the player's affect back to the user, given the inherent limitations of first-person perspectives in observing one's own emotions manifested on avatars. Therefore, it is crucial to investigate alternative presentation methods, including their placement, and assess any potential distractions they might introduce.

There are several promising avenues for future research in this area. Firstly, it's essential to validate the robustness of our findings across different game genres to understand how displaying emotions affects various gaming scenarios. Secondly, game designers should prioritize accessibility, considering the needs of players with disabilities when designing affect visualization systems. These steps are essential for creating a more inclusive and emotionally engaging gaming environment.

Additionally, while our study includes both beginners and professionals, future research in the domain of affective gaming should comprehensively examine how affect representation can cater to players with varying levels of expertise. Lastly, given the immersive nature of Virtual Reality (VR) games, exploring affect visualization within this context could yield valuable insights into enhancing player experiences.

In addition to the above, future work should explore the application of affect-based matchmaking in competitive video games, ensuring that players with similar emotional profiles are matched together for a more balanced and enjoyable gaming experience.

Conclusion

We conduct a within-subject study (N=18) to investigate the impact of different emotional representations in multiplayer FPS games on player experience, game difficulty, and social interaction. Emojis, despite their potential to distract, can be a powerful tool for enhancing player engagement and social presence in virtual worlds. Their intuitiveness and ease of interpretation makes them a preferred choice among participants, aligning with their familiarity in real-world social interactions. However, the challenge lies in striking the delicate balance between immersion and distraction, particularly in competitive gaming contexts. Game designers can leverage our findings to create personalized and inclusive visualizations that resonate with players.

Furthermore, our research highlights the immense potential of affect visualization to shape player behavior, foster empathy, and influence gaming strategies. While the impact on perceived game difficulty remains modest, the prospect of integrating affect as a strategic element within game design is promising. These findings offer valuable insights into the complex interplay of emotions, gameplay, and social interaction in multiplayer gaming contexts. In the long run, we envision that our findings will incorporate seamlessly into the broader domain of collaborative experiences within virtual spaces.

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