Using Biometrics as a Social Intervention in Gaming

Raquel Robinson
University of Saskatchewan
Saskatoon, SK Canada
raquel.robinson@usask.ca

ABSTRACT
My doctoral research examines the use of biometrics as a design intervention in games to increase social closeness. I have built an overlay for Twitch that reveals streamer biometrics to spectators (All the Feels [16]). Using this tool, along with additional design interventions, I plan to explore and expand communication possibilities between players, streamers and spectators in order to facilitate social connection. In this abstract I briefly describe the three projects I am currently working on through my doctoral work: In the Same Boat, Twitch Plays 'All the Feels', and Turnin' the Beat Around.

Author Keywords
Digital games; Haptics; Live streaming; Biometrics; Emotions.

CCS Concepts
•**Human-centered computing** → **Human computer interaction (HCI); Collaborative interaction;** *Haptic devices;*

INTRODUCTION
People who care about each other, work together, or know one another don't always live in the same geographical location. As social closeness—i.e., feeling connected to others—is vital for our well-being [17], building and evaluating tools that help connect people over a distance has been a priority for designers and researchers in human-computer interaction (HCI). For example, technology-enabled communication, such as always-on video chat [9], mobile streaming of experiences on-the-go [7], and connected tangibles [10], have helped people feel closer and more connected to one another over a distance.

Games and playful activities have been long used to support co-located social interactions: pick-up sports leagues or board game nights can help us satisfy our need to feel related to others [18] and create shared experiences that draw us together. With recent technological advances, these shared game experiences can now connect people over a distance as well. Gamers spend an average of 6 hours/week playing with others online and 5 hours/week playing with others in person [3]. More than half of frequent gamers report that video games help them connect with their friends and family [3].

From another angle, we consider the game live streaming experience, which adds another level to distributed social gaming. Since the advent of televised digital gaming in the 1990s, sharing gameplay video footage has been a fundamental part of gaming culture and activity. In the last decade, video sharing services such as YouTube have become more prominent. Additionally, esports (playing computer games in tournaments with spectators) have become an emerging phenomenon, driving interest in sharing both live and recorded gameplay. The intense popularity of the streaming phenomenon in recent years is largely due to the creation of Twitch. Twitch was founded in 2011 and has since become the leading service for gameplay streaming. The popularity of gameplay streaming continues to rise, with 100+ million unique viewers per month and 1.7+ million broadcasters per month [1]. The videogame live streaming market continues to grow with sites (such as YouTube) creating communities of their own. Spectators using Twitch do not simply view a player's stream passively; they can interact with the streamer during play. The Twitch platform allows spectators to chat using both typed text and emotes engaging in lively side conversation in real time. Twitch also provides a fertile environment for experiments in sociability due to the customizability and robust chat features it offers. For example, Twitch Plays Pokémon turned the chat room into a game controller, allowing users around the world to collaborate and directly interface with the game [2]. Both streamers and spectators regularly customize their Twitch experience in order to interact more effectively. In recent years there has been a rise in the desire to increase interactivity between the audience and online performers [19]. This is partially because websites like YouTube and Twitch make it more accessible for people around the world to become performers [21]. The role of an audience ranges from observing the performance passively to the audience becoming the performers.

I consider both social games and live streaming in my research goal to use biometrics as the main mechanic for designing emotional experiences that will support people to form or maintain intimacy and trust over a distance. I will explore this through three projects: 1. In the Same Boat: an embodied physiological mirroring game designed to explore social closeness between players over a distance; 2. Twitch Plays 'All the Feels': exploring audience interactivity in a horror game in which spectators have access to the streamers' vitals,

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looking at spectator/streamer interactions and how visualizing biometrics can change the experience; and 3. Turnin' the Beat Around: considering which contexts to use haptic communication of performers' heart rate data in live-performance experiences (type of performance e.g. sports, gaming, music events or type of emotional experience)? Although each project was designed to facilitate different experiences, all of these projects hope to increase trust, intimacy, and social closeness among spectators and players.

RELATED WORK

Biometrics and Game Live Streaming

Over the last decade, biometric sensors have been explored in the context of game design and research. Sensors have primarily been used as novel (interaction) inputs to games (e.g. [13]), and as tools to evaluate games and their effect in players [11, 12]. Visualizing sensor data is rarely used as a design tool, and instead primarily for information tracking and quantified self reports. My doctoral work takes a different direction, examining how such sensors can enhance social closeness for both players and live streaming spectators.

In this regard, research and design in the domain of interactive performances can be illuminating, for example Reeves et al.'s investigation of spectator experience of interactive installations [15], and Wang et al.'s work assessing audience engagement with a theater performance [24]. Tennent et al. [23] engaged in a similar project during a prototype TV show, displaying physiological data from actors. The goals of these authors – to allow the audience to engage in "sense-making practices when watching actors" and "potentially enhance the vicarious nature of viewing another's experience – resonate with our goal of providing a rich spectator experience. The same research team has also implemented a tool for capturing video, audio, heartrate, and acceleration data of those riding a roller coaster, streaming this live to spectators, thus transforming riders into performers [22].

In the realm of game design, biometrics to enrich the spectator experience were used during Dreamhack, a biannual European eSports event where key players around the world gather to play competitive games that are broadcasted on a large scale. In 2011, Dreamhack equipped players with heart rate monitors while streaming games, which was commented and celebrated by the audience: "I think it's a great addition and I'm really getting more into the player's minds by knowing how stressed they are in the particular moment." [14] Unfortunately, subsequent Dreamhack events discontinued the display of this biometric feature, which some fans attributed to distraction for the players [14]. This intervention shows the potential of displaying the players' biometrics for the sake of a rich spectator experience. Yet, this is an underexplored topic that needs to be further examined.

Physiological input has been used as a novel input approach, designed to enhance engagement through intimate interaction with the system. For example, Nacke et. al [13] built a system in which a game played using a traditional controller is augmented using both direct (e.g., facial expressions) and indirect (e.g., galvanic skin response) physiological sensor input.

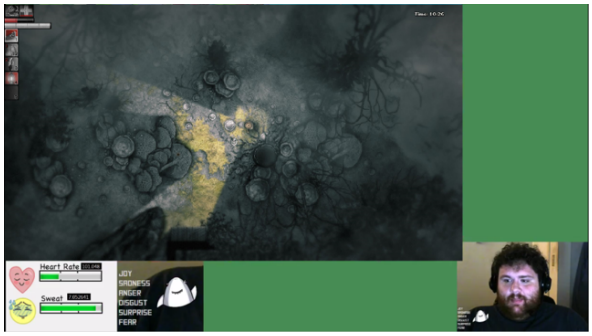

Figure 1. Current version of All the Feels. Lower left portion of the screen shows the heart rate, GSR, and facial expression data of streamer.

Combining both physiological signals and bodily movement as input to the game, Zangouei et. al [25] created an emotional game experience for co-located players in which they solve riddles to progress.

All the Feels

All the Feels is a tool I created in my master's work that provides an overlay of biometric and webcam-derived data onto the interface of the popular video game streaming service, Twitch [16]. This overlay provides visualization of heart rate, skin conductance, and facial emotion recognition. The tool consists of the Empatica E4 wristband capturing the heart rate and skin conductance (sweat), and a tailored version of the Affdex software capturing levels of the emotions: joy, sadness, anger, disgust, surprise, and fear (see Figure 1). These levels are displayed as a side bar graph, filling up when one of the emotion levels is at maximum. To the right of this, an emoji displays the prominent emotion of the player at the time. For example, the player smiles, the "joy" bar fills up, and a happy face emoji displays to the right. The addition is intended to enhance the spectator experience and improve streamer-spectator connection. I conducted a preliminary live test with the tool involving a female streamer and 25 spectators. I found that All the Feels seemed to increase perceived connection between the spectator and the streamer, while offering an engaging and enjoyable experience for spectators. These preliminary results of the study align with prior work done, showing increased enjoyment, engagement, and viewership among live stream spectators [16]. The player did not find the software obtrusive and appreciated the supportive dialog that ensued from spectators who saw her emotion data. I believe this research shows that All the Feels is a promising addition to gameplay streams, to be proven out in more in-depth, extended field testing which I will describe in a later section. The results of this research support that biometric data could be used as an additional layer of information to spark conversation and enhance streamer and spectator experience.

CURRENT WORK AND TIMELINE

For my Ph.D. I will focus on three projects that expand on All the Feels: In the Same Boat, Twitch Plays 'All the Feels', and Turnin' the Beat Around. For all projects, players/spectators will fill out a mixture of validated scales asking about trust formation and social connection. With these projects, I plan

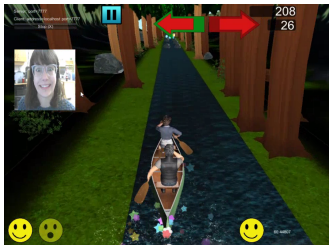

Figure 2. Example of game In the Same Boat. Here one player is syncing a smile with their partner (pictured off screen) and together they are jumping over a whirlpool.

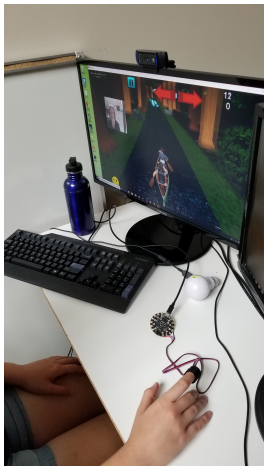

Figure 3. Game setup: Webcam, circuit playground with pulse sensor attached to finger, and game on screen.

to explore several research questions, including: I) As social closeness is important for an individual's health and well-being, how can we best design games to support and foster social closeness? II) In what ways do streamers communicate with their audience and what ways can we augment this experience in terms of emote usage, extensions, and Twitch chat in general add to the social experience? III) In which live-performance contexts does haptic heart rate feedback provide the most value?

Project 1: In the Same Boat

Building off work by Isbister [8], Mandryk [4, 13], and Robinson [16], we created an embodied mirroring game—In the Same Boat—to explore social closeness between players over a distance. We leverage the synchronization of both players' physiological data (heart rate, breathing, facial expressions) mapped to an input scheme to control the movement of a canoe down a river. The game is a two-player infinite runner, played over a network, in which players use their physiological input to control a canoe riding down a river, while dodging obstacles along the way (see Figure 2).

This work aims to validate the following hypothesis:

- *H1: Using biometrics as a control schema in an interdependent and cooperative game will further increase social closeness amongst distributed players.*

The two players must sync their facial expressions to dodge obstacles that occur in the middle lane of the river, and they must sync their heart rate (or breathing rate in an alternate version) to stay in the middle of the river. If they fail to synchronize in time, the canoe will move to either the left or right portion of the river, which has more obstacles and therefore increases the game difficulty. The synchrony of physiological input acts as the mechanic that realized cooperation and interdependence (both dynamics which support trust formation and social closeness in games [4]) in the game. In the Same Boat was designed to promote an intimate interaction, by focusing on embodied interaction using physiological input, mirroring emotions through synching, and networked play. The game was coded in Unity, and the Circuit Playground Express by Adafruit (biometric controller), Affdex (facial recognition technology), the Pulse Sensor Amped (heart rate sensor) are the hardware used in the game (see Figure 3). The heart rate is calibrated for each player to their baseline beats per minute (BPM). For each player, if they are within 20BPM of their baseline heart rate, they are considered synchronized with the other player by the system. The Circuit Playground has a built-in microphone which picks up peaks when blown into and calculates a breath rate value based on that.

Currently, preliminary studies have been conducted with 6 groups (12 participants). This game version (using emotions as a controller) is compared against one using the keyboard as a controller. We use Likert scale ratings to measure participants' perceived feelings of trust before and after the game, relatedness, and enjoyment. These studies have shown that trust formation increases from before to after playing in both versions of the game, participants enjoy the emotion controls version more than the keyboard controls, and overall people communicated with each other well to maneuver the canoe. This shows that using biometrics in this social context *can* further enhance the social closeness between players over a distance. To the best of our knowledge, this game is the first to leverage physiological syncing over a distance and has the potential to help geographically-distributed friends, family, and partners to feel closer through playful interaction. Further iteration and testing will allow us to explore different physiological input methods and gain more insight into designing for intimate distributed play experiences. This project is in progress and will complete by April 2019.

Project 2: Twitch Plays 'All the Feels'

The second project will test All the Feels within the horror genre, which was the genre spectators indicated as most interesting in our prior work. This project is in collaboration with Jessica Hammer at Carnegie Mellon University, using inspiration from a game their lab created called 'What Lurks in the Dark' [5], which is a Twitch-based horror game that allows for audience participation.

Using their game as a design inspiration, we explore the following hypotheses:

- *H1: Visualizing streamers biometric data will enhance the spectators' emotional experience, making them feel closer and more connected to the experience and the live streamer.*

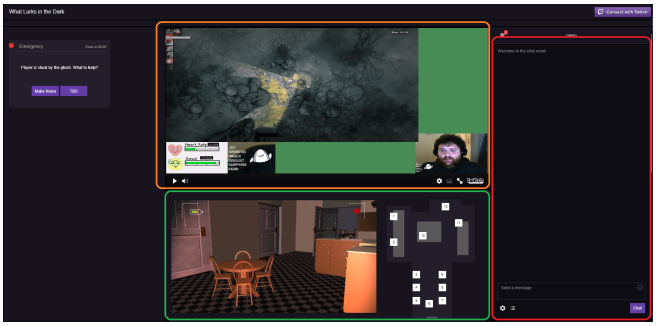

Figure 4. Example of the game map, audience voting system, and All the Feels. Orange circle shows the game plus 'All the Feels', the green circle shows the game-map, and the red circle shows the Twitch chat feed.

- *H2: Seeing the affect their decisions have on the player's biometric data will give the spectators clear feedback about how their actions affect not only the gameplay, but also the player.*

We are creating a horror game called, 'What Lurks in the Deep', which is a top down puzzle horror game where the streamer-player is trapped in a boat with monsters lurking in the depths outside. There are five different monsters in the game, each with a different set of strengths and weaknesses. The player is unaware of which monster is lurking outside the boat, so must understand and prepare for monsters based on sound alone. They will be able to use lights on the boat to hide from or attack the monster. The audience has a larger overview of the map, and has access to information the player-streamer does not, including which monster is approaching the boat.

The audience determines if they want to help or hurt the streamer and plan their actions accordingly. This game explores themes such as viewer sympathy, the challenges of teamwork in online spaces, and the balance of power between streamer and audience. Combining What Lurks in the Deep with All the Feels, I will be able to determine what dynamics change when viewers are able to see the streamers' vitals. I am interested in how seeing this internal information change interactions, decisions to help/hurt the streamer, and the overall communication in chat. The study will consist of the streamer playing the game while using All the Feels (see setup in Figure 4). This project is in the early stages, as we are currently re-designing portions of the game and changing elements of the audience interactions. This project is in progress and the user testing will be done by the end of the summer in 2019.

Turnin' the Beat Around

The third project iterates on prior work differently – testing the best ways of communicating the biometric information to the spectators in terms of modality. My preliminary work [16] focuses on visualization of the biometric information. However, other studies in this same area consider the relative effectiveness of modality – haptic vs. visuals on audience's experience. Other work has shown that haptic feedback providing additional information to users interacting with technology can provide a more enriching experience [6].

This project is in collaboration with a colleague Alina Striner, who has researched the audience experience in different contexts [21, 20]. Prior unpublished work in this area (conducted by Striner et. al) suggests that haptic heart rate information is more effective at engaging audiences over visual or visual plus haptic data. In their study, they showed participants three different videos of different sports activities: figure skating, poker, and gymnastics. Analyses suggest that the figure skating video was the only video in which seeing the performer's heart rate information *did not* enhance the spectator experience. They found a strong haptic main effect in the poker video and gymnastics video over the skating video in several metrics: Feelings, engagement-absorption, and connectedness.

Based on these findings, our work explores the following hypotheses:

- *H1: More context surrounding the drama of the experience creates more empathy with performer which may increase value of heart rate data.*
- *H2: Increased feedback about performer state (or feelings toward this state) increases value of heart rate feedback, because it provides an interpretive context.*
- *H3: Points feedback allows the viewer to better understand the stakes, which provides an interpretive context for the heart rate data.*

As a followup to this study by Striner et al, our research explores haptic heart rate in particular (as opposed to visual) to find out why heart rate information was not valuable in the context of figure skating. To study this, we will have participants watch 2 videos. One video will consist of a pre- and post-interviews with the figure skater added before and after showing the nervousness and suspense building up to the routine, as well as the feelings and reactions of the skater after the routine. This allows the audience to not only have more context behind the video, but also have increased feedback about the ice skater's emotional well-being. Having access to someone's emotional state is important for emotion interpretation, and this is not easy to detect in an ice-skating performance. Ice skaters are often hiding their internal state during the routine by smiling throughout the performance. Additionally, we will overlay a points feedback system at the upper right corner of the screen. As for heart rate data, we will communicate the skater's heart rate information to the spectators through vibrations from a haptic motor encased in fabric, vibrating in time with the skater's heart beat. Heart rate data will be faked, and peaks will be synchronized with peak moments of the performance (jumps, tricks, etc.). Preliminary studies will be run in the Winter of 2019, and the project will primarily take place in the summer of 2019.

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