Expressive Biosignals: Authentic Social Cues for Social Connection

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ABSTRACT

My research introduces *expressive biosignals* as a novel social cue to improve interpersonal communication. Expressive biosignals are sensed physiological data revealed between people to provide a deeper understanding of each other's psychological states. My prior work has shown the potential for these cues to provide authentic and validating emotional expression, while fostering awareness and social connection between people. In my proposed research, I expand on this work by exploring how social responses to biosignals can benefit communication through empathy-building and social support. This work will scope the design space for expressive biosignals and inform future interventions for a variety of social contexts, including interpersonal relationships and mental health.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; **Collaborative and social computing devices**;

KEYWORDS

biosignals; physiological sensing; interpersonal communication; social cues; social connection

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INTRODUCTION

Good communication is exceedingly important for society to function, but all too often difficult to achieve. Social cues that are key to communication tend to be muddled when conveyed to physically or socially distant others. In the worst case, these issues can lead to loneliness, interpersonal conflict, or a lack of trust in others [2, 4].

I propose *expressive biosignals* as a new approach to improving communication. Due to the autonomic nervous system (the system largely responsible for controlling our fight-or-flight response) biosignals such as our heart rate and skin conductance inherently change with our emotional and cognitive states [5, 6]. With the growing popularity of consumer-grade wearable sensing technologies, we can reveal these underlying changes in social contexts in order to better understand each other's subjective experiences. In my research, I have shown how expressive biosignals systems can promote social connection between people by helping them become more open with and aware of each other. At the same time, I have identified major challenges in communicating ambiguous biosignals data in a meaningful way. My proposed work builds on this research by quantifying the impact of expressive biosignals on social perceptions, and exploring social responses to expressive biosignals that can be beneficial to interpersonal interactions.

PRIOR WORK

Using techniques from computer science, design, and psychology, I have built and tested expressive biosignals systems to explore how people react to and use biosignals in social interactions. These include empirical studies focusing on how people subjectively interpret biosignals [7], people's willingness to share biosignals [8], and communication patterns afforded by sharing biosignals on smartwatches.

My research has demonstrated the potential for physiological data to empower more intimate and meaningful expression and communication between remote users. In a two-week field study with 13 participants, I deployed a mobile application system that prompted users to text their heart rate to their close contacts [8]. In a second field study with 17 dyads, I deployed Animo, a "mood-sharing" smartwatch application that represents mood through a shape that animates and changes color according to a user's heart rate (see Figure 1). In both of these studies, I collected and analyzed qualitative data through questionnaires and interviews about participants' experiences using the systems in their daily lives.

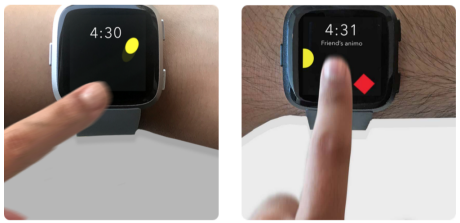

Figure 1: Example Animo smartwatch application usage, for sending and receiving heart rate-driven "mood" animations.

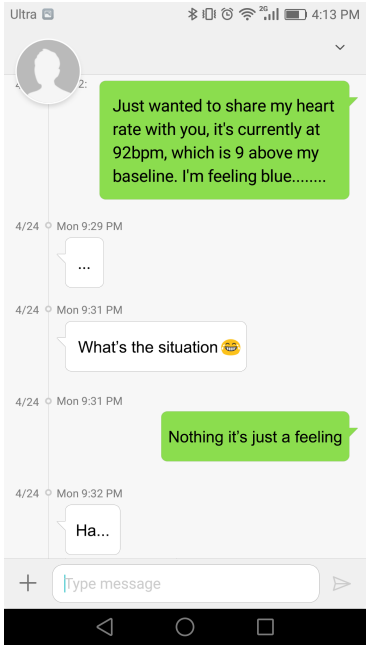

Figure 2: Screenshot of a participant who texted her heart rate to a contact in order to express that she was feeling sad and "imply that [she] might need help." [8]

Results from both studies showed that sharing biosignals can enable social connection through emotional expression and social awareness. Participants used the systems to express and objectively validate their feelings to both themselves and their contacts (see Figure 2). Additionally, they felt that sharing their biosignals provided a new and playful means to keep their contacts up to date with their status. Correspondingly, receivers of expressive biosignals became more aware of the sender's presence and state, often initiating follow-up conversations to check in on them.

ONGOING AND FUTURE WORK

My work thus far has explored both the sender's side of communicating and expressing themselves through biosignals messages, and the receiver's side of interpreting and reacting to those messages. In the next stages of my research, I will investigate and expand on the variety and depth of receivers' options for responding to biosignals. I will conduct three studies that clarify specific responses that expressive biosignals can elicit in receivers, and the potential for subsequent actions that can be taken to facilitate communication, including embodied support and physiological synchrony.

Study 1: How do expressive biosignals affect empathy?

My prior work has drawn from qualitative methods to show that people can infer someone else's psychological state from their biosignals, and subsequently feel more aware of them. However, little is known about the impact of expressive biosignals on people's perceptions and understanding of each other. Thus, in my present work, I am conducting a controlled study to explore and quantify the effects of biosignals on social outcomes such as empathy.

Drawing from empathy research [1], this study consists of an online survey where undergraduate participants read a story about a fictional student who is injured from a car accident. The study has a 2x2 between-subjects design, where the factors include whether participants view a graph of the fictional student's heart rate, and whether the student is socially distant (e.g., same or different section of their class). Participants will answer questions about social presence, empathic concern towards the student, and willingness to volunteer their time to help the student. Results from this study will clarify the mechanisms through which expressive biosignals might affect understanding in communication.

Study 2: How can embodied expressive biosignals influence social support?

In my heart rate texting and Animo research, I found that users enjoyed keeping up to date with each other's states, but were unsure about how to act on it. In particular, users desired for the systems to provide them with tools to give support to their contacts when their biosignals indicated stress. Thus, I will explore how expressive biosignals systems can be used for social support.

I will build a mobile application that enables social support in stressful moments to promote positive well-being. The system will detect a user's stress using their biosignals and context (e.g., current activity), and nudge users to express themselves in these moments by sharing their biosignals with others. I will explore gesturing as a supportive response to biosignals messages. Following embodied cognition theory [9], gesturing could be a lightweight means to simultaneously experience and express emotional responses (e.g., lifting arms as a supportive cheer). I will deploy this system in a longitudinal field study with undergraduate students, who are known to face various academic stressors, and measure its effects on social connection (e.g., social presence) and well-being (e.g., life satisfaction).

Study 3: How does synchrony in biosignals affect social interaction?

Synchronizing with another person's biosignals could be a new means to help people connect with each other. Physiological synchrony could promote empathy through a shared emotional experience [9], or liking and rapport by mimicking another person [3].

I plan to create a virtual reality game to explore the socal impact of synchronizing biosignals. Virtual reality provides unique affordances to heighten users' perceptions of each other's biosignals and represent synchrony, such as through changes in avatars or the virtual environment. The game will require two players to cooperate by synchronizing their biosignals as they undergo different narrative experiences (e.g., navigating a maze, fighting enemies). I will test the impact of the game by deploying it to pairs of participants who do not know each other, and measure its effects on social and behavioral outcomes, such as liking, desire for future interaction, and collaboration during the game.

EXPECTED CONTRIBUTIONS

Given the increasing ubiquity of physiological sensors, my work on expressive biosignals contributes an exploration into the future of communication technologies. My proposed work will expand the scope and range of possibilities for the design space of expressive biosignals and their potential to impact social perceptions and facilitate positive social interaction. I expect to contribute new expressive biosignals systems and design implications that will inform future interventions in various social applications, including remote communication, intergroup communication, and mental health.

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