From Sensing Bodies to Reading Minds: The Social Life of Biosignals

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Abstract

Biosensors are now a common part of everyday electronics. But what do people think their data can reveal about the inner parts of someone's mind, their mood, their thoughts, their identity? Through our findings from two studies on shared heartrate, we advocate for this question as one avenue for developing a theoretical understanding of how signals from the body, and the devices that collect them, can come to feel sensitive, personal, shareable, and situated across the variety of situations that people encounter in day-to-day life. We discuss the goals and aims of an ongoing project, a survey of a large (n>10,000) pool of subjects who voluntarily share data, including from self-tracking devices, to medical researchers.

Author Keywords

biosignals; biosensing; computer-mediated cues

ACM Classification Keywords

H.1.2 [User/machine systems, software psychology.]: Miscellaneous

Introduction

As of 2016, 'smart' wearables such as watches and fitness trackers come with numerous sensors that measure everything from heart rate to galvanic skin response, and many come with applications in which these signals can

be shared socially. Yet, we know very little about how, and why the users of these devices share these data (or refuse to), in part because we do not understand how people think biosignals reflect an individual's moods or identity. What is the expressive capacity of, for example, an elevated heartrate? [8] How and why social, contextual meanings arise from physiological metrics, both novel and familiar? [3, 2, 6] In what situations might an elevated heartrate be too personal to share?

In this position paper, we advocate for these questions as an avenue for understanding how biosensing technologies might come to matter in everyday life. We discuss two studies in which a socially shared elevated, versus normal, heartrate affected social attitudes and behaviors in different interaction contexts. We use these findings to motivate our current work, a large survey that explores the believed capacities of multiple sensor types to reveal details of a person's mood, thoughts, personality and identity.

The Social Meaning of Biosignals

The meaning of signals from the body are, in any given context, both socially informative and highly ambiguous. While existing work establishes the centrality of context in shaping interpretations of a shared signal like heartrate, our understanding of what such signals can mean as a computer-mediated cue, and how these meanings might affect social behavior, remains extremely limited. In contrast to projects that aim to detect and algorithmically categorize emotions, we opt instead for a frame of affect-as-interaction, which treats emotion as contextually situated and intrinsically social [1].

The following two sections look in detail at two pertinent studies from the authors of this proposal, which investigate the social meaning of an "elevated" versus "normal"
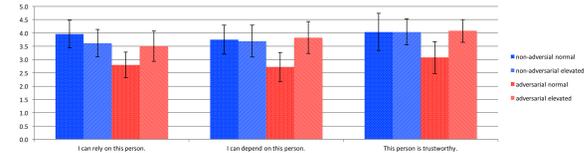

Figure 1: Attributions of trust given heartrate (normal/elevated) and interaction context.

heartrate. These studies reveal details about how context interacts with prior beliefs about particular signals to bound and shape the social meaning of a heartrate. Together, these studies surface a broader agenda for future work far beyond heartrate, the budding of a framework for probing how people interpret biosignals, and glimpses into the consequences these interpretations might have in an increasingly sensed world.

Two Cases from the Heart

Our initial study [4] employed a vignette experiment in which subjects were asked to make assessments about an acquaintance based on an imagined scenario about waiting for an acquaintance who was running late, and who had shared their heart rate information. We analyzed qualitative and quantitative results for adversarial and non-adversarial scenario contexts, for "normal" or "elevated" heartrate information. We found that in all cases "elevated" heartrate was seen as related to mood by participants. Surprisingly, we find that for "normal" heartrate conditions participants had more negative trust-related assessments of the acquaintance, but only in an adversarial context (Figure 1).

This experiment highlights the role of context, and social expectations, in shaping the meaning of an "elevated" versus normal biosignal. In our vignette experiment, when the partner had a normal heartrate, participants viewed it as

evidence that s/he is not concerned about being late, not taking the situation seriously, perhaps even lying. In the non-adversarial context, we find that participants took elevated heartrate as a token of their acquaintances' genuine desire to arrive on time. In short, social expectations seem to shape interpretations of the heartrate biosignal to create highly contextual, socially-specific meanings.
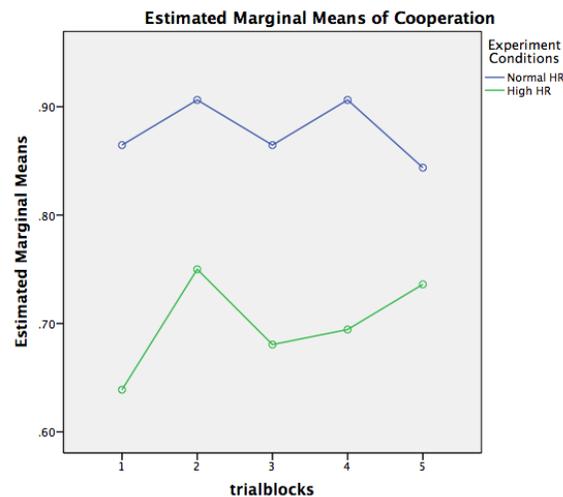
Trust Your Heart

Figure 2: Cooperation rate over time for partners with a normal (blue) versus elevated (green) heartrate.

In a follow up study [5], we examined heartrate sharing in the context of a trust-building game. Through quantitative and qualitative analysis, we find that "elevated" (versus "normal") heartrate is associated with less frequent cooperation. To investigate the specificity of our findings to heartrate (as opposed to some other "elevated" signal from the body), we replicated our initial experiment with a fictional biosignal. We found that both heartrate and the fictional signal were associated with negative mood attributions, but we observed a decrease in cooperative behavior only with elevated heartrate.

Our qualitative results indicated that individuals may learn an association between our fictional biosignal and the cooperative, trusting behavior of their partner, This study indicates that pre-existing beliefs about the body are powerful in shaping and bounding people's interpretations of what these signals might mean in any given context. Our results suggest that participants bring their own expectations about what particular biosignals mean, and that these biases cannot be quickly overcome, even when behavioral evidence sends a positive message (e.g., high cooperation and trust from the partner).

At the same time, this study suggests that designers can, perhaps inadvertently, associate ambiguous signals with arbitrary social meanings. In our study, participants in the fictitious signal ("SRI") condition associated whichever signal they saw (elevated or normal) with cooperativeness and trustworthiness. Unlike with heartrate, where people seemed to have preconceived notions of how SRI should affect the social behavior of their partner, we observed participants discovering what SRI "means" by watching their partner's behavior in relation to the biosignal.

Current Directions
Our past work shows that biosignals can act as social cues, which are highly contextual and ambiguous. We find also that the meaning of signals can be learned from a mix of prior beliefs and social context. From research projects like the sociometer, which produce "social metrics", to consumer devices like the Spire, which compute "calmness" or "focus" quotients, developers are throwing novel biometric

signals at people faster than they can learn what the signals mean in context. What is the relationship between the beliefs about what signals can mean, and individual decisions to disclose these signals to others? To friends? To researchers?

In this vein, we are currently exploring beliefs about sensors through two surveys. One survey on Mechanical Turk; the other, on a Health-e-Heart, a project run by UCSF, in which 40,000 people voluntarily share data, some from their self-tracking devices, for use by researchers. Our two different surveys address questions about the attitudes, motivations and beliefs about biometric data sharing among (1) a focused sample who currently have devices and share their biometric data with researchers for possible scientific benefit (HeH) and, (2) a broader sample of those who may or may not yet have biometric devices, but who can offer important insights about the future of sensor data sharing among different groups of people.

Conclusion

The social meanings of biosignals could not only inform design decisions, but lead to a greater theoretical understanding of how, why, and when data from self-trackers can come to seem sensitive, private, personal, and why people might share such data anyway. Biosensing technologies are beholden to the attitudes of users, who have power to define the criteria by which these systems are accurate, or effective. For this reason, it is critical that we continue to question the attitudes of users, determining where user beliefs align (and fail to align) with empirical findings from fields such as affective computing [7].

Data relationships

(1) Caregiver/cargivee. Surveillance as care, mobile health, aging in place, etc.

(2) Service provider / service providee. How, when and why do handoffs exist in social space?

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