Project Us: A Wearable for Enhancing Empathy

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Figure 1: Users wearing the Us wristbands (wrapped in an aesthetic scarf).

Camilo Rojas
MIT Media Lab
Cambridge, MA 02139, USA
camilorq@mit.edu

Niels Poulsen
EPFL
Lausanne, Switzerland
MIT Media Lab
Cambridge, MA 02139, USA
npoulsen@mit.edu

Malena Corral
Independent Researcher
Cambridge, MA 02139, USA
malenac@mit.edu

Pattie Maes
MIT Media Lab
Cambridge, MA 02139, USA
pattie@media.mit.edu

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Abstract

Enhancing the empathy of our human interactions has been the object of intensive psychological studies for decades. The emergence of affective computing has opened the door towards technologically-enabled solutions. Yet, existing techniques struggle to attain their desired impact, often being difficult and expensive to deliver, and disconnected from daily life. Project Us' goal is to help overcome these challenges through a pair of wearable devices (in this case wristbands) that aim to trigger an empathy-enhancing effect, when being worn by two people during day-to-day conversations. The small-sized, wireless devices sense each person's electrodermal activity, associated with their level of emotional arousal, and share it to the other partner (when a threshold is exceeded) through a discreet, haptic nudge, creating a real-time feedback loop. The user study performed with 18 participants (nine romantically engaged couples) revealed that most of them found the wristbands to increase their level of awareness of the partner's emotional experience. Their interaction was analyzed based on interviews (qualitatively), and natural language processing techniques (quantitatively).

Author Keywords

Empathy Enhancement; Wearables; Affective Computing

CCS Concepts

•**Human-centered computing** → **Human computer interaction (HCI);** *Collaborative interaction; User studies;*

Figure 2: Us device on top of an aesthetic scarf.

Introduction

Our ability to psychologically connect and empathize with one another stands at the core of our existence as humans. It has dramatically contributed to our evolution as a species and remains a key driver of the way we experience life. Being empathetic is known to make us more effective at work [28], improve relationship satisfaction [8] and give us a deeper sense of connection and attachment [10]. Yet, we sometimes find it difficult to empathize with others, and for some poorly understood reasons, some people tend to face more challenges than others [15]. Technologically-enabled solutions, ranging from virtual reality (VR) to tangible avatars, have shown promise in this direction. Yet, existing techniques tend to be difficult and expensive to deliver (e.g., requiring VR headsets), and often disconnected from daily life.

We propose a new approach for studying and potentially enhancing people's ability to empathize in the form of wearable devices capable of providing cues about the emotional state of a peer, thereby creating a real-time feedback loop between two users (Figures 1, 2). Used over longer periods of time, the device pair has the potential to trigger a learning effect.

Related Work

Our ability to empathize, as well as ways to enhance this behavior have been the object of intensive studies in the past decades. Existing efforts include using biofeedback to enhance emotional awareness, regulation, social presence and interaction (e.g., through biofeedback collaborative video games for teenagers [18], raw biosignal streaming for couple counseling [16], augmented video recall for doctors [22], or inner state display through tangible avatars for managers [13]). Lux et al. [17] offers a landscape of existing approaches. Palumbo et al. [19] reviews the relationship between physiological dynamics and psychosocial constructs.

Other previous efforts rely on using immersive interventions to enhance perspective-taking (e.g., through alteration of self-representation through VR [23, 3, 26]) or triggering emotional reactions via role-playing [2, 12].

While many efforts are increasingly leveraging technology, their impact continues to be limited by some factors. Most existing technologies focus on eliciting and capturing emotions in a single individual (we refer to this approach as "human in the loop"). However, emotions such as empathy have a deep social substrate [25]. Moreover, given their reliance on bulkier infrastructure and wired technologies, most existing solutions need to be used in clinical settings and facilitated by a mediator (e.g., [9] shows drawbacks of raw biosignal streaming for enhancing empathy). This limits the usage and the ecological validity of the captured data (often the devices would only be used for an hour or so each week), as well as the affordability of the solution (the mediator often needs to be a trained psychologist), and the authenticity of the interaction (being confined to a lab setting can elicit biases not present in day-to-day interactions).

Design of "Us"

"Us" was designed and prototyped as a set of wireless sensor nodes embedded in two wristbands, as shown in Figure 2. The devices sense each partner's Electrodermal Activity (EDA), which is associated to their level of emotional arousal [5] and share it to one another through a discreet nudge, creating a real-time feedback loop. Being able to include two humans in the loop and allowing for prolonged ambulatory usage, "Us" creates a continuous loop of capturing and potentially eliciting emotions.

Each node (Figure 3) monitors the state of arousal extracting the metric "Skin Conductance Responses (SCRs) per minute" or f_{SCR} from [6, 14, 24], based on the code from [27]. We use a sliding time window of 30s for processing and a threshold of 0.05 μS. A state of high arousal is characterized by $f_{SCR} \geq 20$ and low arousal $f_{SCR} < 5$ [5].

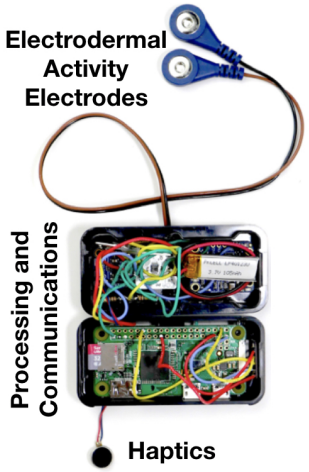

Figure 3: The device "Us" measures (in cm) 2x1.5x4. It relies on an EDA sensor [4], an in-device processing module and a WiFi transceiver [21]. It uses the haptic patterns 94 and 106 in [15].

Effects of Wearing "Us"

Reflection: prompting the recipient of the haptic feedback to analyze the emotional experience of their partner (e.g., pauses for reflection, listening, inquiry, analysis of facial gestures).

Action: triggering an action from the side of the feedback recipient aimed at de-escalating the tension of the interaction (e.g., use of a calm tone, subtle words, rephrasing).

The transitions between the two states trigger the sending of a wireless signal to its twin device, which delivers a haptic nudge (i.e., a gentle vibration, similar to a smartwatch notification, lasting 2s and repeated once after 2s). The low-to-high arousal transition triggers a nudge that progressively increases in intensity, and a high-to-low transition is signaled with a nudge that decreases in intensity.

Evaluation

Experimental setup

The experiments consisted of two 10 minute emotionally intense conversations between romantically engaged couples. The participants wore the devices in both conversations (i.e., the entire experiment), but the haptic feedback was only activated in one of the conversations. The feedback was given during the first conversation to half of the couples, and during the second one to the other half (i.e., counterbalanced condition). The topic for each conversation was selected by the experimenters after asking each participant to write three "topics that were a subject of discussion for them as a couple during the last two weeks" (methodology from [7]). The couple watched a relaxing video before the interactions to detach from previous stress factors and create a baseline for the physiological monitoring.

The experiment included 18 participants (9 couples, 9 male, 9 female, mean age 27.8 years old, $\sigma = 2.4$). We aimed for the couples to have the conversation in a language in which they could interact comfortably, resulting in five interactions in English and four in Spanish. Video and audio recordings were made for each of the interactions. At the end of each series of two conversations, couples participated in a semi-structured interview aimed at analyzing the effect of the haptic feedback.

Preliminary findings

The feedback and preliminary audio analysis revealed two broad types of impact that wearing "Us" had on the couples' conversations: Reflection and Action (see sidebar).

Reflection - Several participants reported that the system made them more attentive to their partner's emotional state. Maria (pseudonym), while explaining how exhaustion keeps them from spending time together, recalled that she "paid attention when feeling the nudge and thought about what happened with her partner". Daniel mentioned that the "device's reaction made (him) observe Oana" while discussing having children. Jen described the nudges as making her "become more attentive" during their conversation about religion. For others, the vibration acted as a reminder of a purpose they had already set for themselves. Alex called "Us" "a reminder not to escalate" [the conflict in] the conversation when discussing family visits, while Andrew said "The feedback was a reminder to listen, an emotional reconnect as an 'Emotional check-in reminder'" even though the conversation had to do with their finances. In a similar finance-related conversation, Eva and Joe recollected that "The device was a reminder to check and to be conscious" [about the emotional state], and respectively that "The vibration was a reminder to really listen, an emotional check-in".

For others, the feedback acted as a confirmation of their own interpretation of their partner's emotions. Bill referred to the vibration as "a reassurance of my thoughts" during their talk about house chores, while Ana mentioned that "The device confirmed what I thought and knew about his feelings" when discussing doing things the other dislikes. This comment highlights the need to consider users' expectations of technological authority in the device's design.

Action - At the same time, most participants changed the way they continued the interaction based on the haptic feedback. Analysis of the audio snippets showed vibrations were often followed by the feedback recipient asking a follow-up question (even those who had only made assertions throughout the conversation). Some participants, such as Ina, recollected that they would "pay more atten-

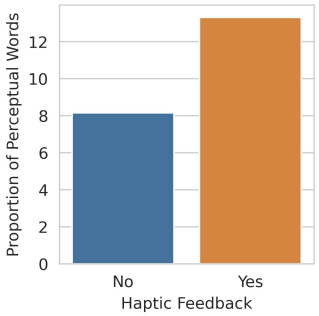

Figure 4: Proportion of words (per 1000) in conversations that belong to the perceptual process class (e.g., feel, see, hear), with (13.31) and without (8.16) haptic feedback. We controlled, by manually checking the transcripts, that results do not include mentions of feedback being felt.

Ethical Considerations

The on-the-wild monitoring of human interactions triggers important ethical considerations, especially related to privacy. We believe that the wearable design of "Us" will create novel opportunities for more effective empathy studies and interventions, while preserving the users' privacy and agency over their data. In a subsequent version of the device, we will aim to rely on in-device data processing, seeking not to store the raw information.

tion to what to say" during the conversation about religion, while Dan felt that "the device affected the conversation - I changed what I said making her more comfortable". Other participants recalled altering their choice of or tone of words to calm the conversation. Igor noticed that he "tried to be more subtle and lower the intensity of (his) words", while Jan said that he "rephrased (his) words to be more subtle" and "would pick different words to talk" (talking about family visits). Beyond trying to elicit a different emotion in their partner, some participants also worked on their own emotions. Olivia recalled that she "tried to calm (herself) when feeling the vibration".

None of the users reported any hindered movements, and they unanimously declared that they would use the device at home. These results support an on-the-wild validation by adding audio recording to the device. This would also enable delayed reflection, by allowing users to play past conversations, and provide valuable inputs for psychological therapy.

Quantitative Analysis

We used two techniques for semantic analysis, rooted in Natural Language Processing, for validating the impact that "Us" had in the conversations (Reflection and Action).

LIWC: Linguistic Inquiry and Word Count [20] was used to measure the presence of indicators showing an attempt to understand the other, or an expression of emotion, such as "perception" (e.g., feel, see, hear). In conversations with feedback, the proportion of words showing perceptual processes significantly increased (Figure 4) (one-sided paired two-sample t-test, test statistic $t = 3.497$ and p-value $p < 0.01$, methodology from [1]). At the same time, the proportion of first person plural pronouns ("we") increased with feedback, while the use of first and second person singular pronouns ("I", "you") decreased, which is a cue for empathetic responses [1]. The number of social words (e.g., friend, family) and questions also increased slightly. These results were not statistically significant, though we expect they will be with a larger sample, as reported in [11].

TF-IDF: Term Frequency Inverse Document Frequency was used to observe the importance of terms showing the expression of emotions and feelings. The mean frequency for the term "feel" increased by 60% in conversations with feedback. This result is consistent with participants' qualitative feedback (Section Preliminary findings), namely, that the haptic feedback from "Us" triggered conversations aimed at better understanding the emotional state of the partner. This analysis has been used in other studies that sought to detect and quantify empathetic behaviors [1].

Conclusions & Future Work

The first phase of project "Us" showed that enabling a real-time feedback loop of partners' level of arousal during conversations can trigger empathetic behaviors. Users may show an increased level of attention and (self) awareness, ask more questions and take actions aimed at increasing the interlocutors' comfort with the interaction (e.g., through the choice of words, tone and rephrasing).

While questions around technological authority and privacy remain a challenge for future prototype development and deployment, the on-the-wild use of "Us" during the next phase of the project is expected to reveal insights into the device's potential to trigger learning phenomena during prolonged use, as well as a potentially new venue for larger scale capturing of annotated insight about emotions in the wild. We also aim to explore the use of the devices for empathy building in other use cases, such as patient-doctors and team building (i.e., more than two people at a time).

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