Affect Regulation Using Technology: Lessons Learned by Taking a Multidisciplinary Perspective

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***Abstract*—We share two challenges that emerged in our work to build, design, and evaluate vibrotactile technology to facilitate affect regulation. These challenges concern, respectively, the timing of interventions and the role of technology in initiating them. First, we challenge the Just-in-Time Adaptive Intervention (JITAI) framework in HCI for affect regulation, specifically the use of technology to identify when an intervention becomes necessary. Second, we discuss the issue of user agency when initiating an affect regulation intervention, and argue that the user should ideally be the one to initiate an intervention instead of the technology.**

***Index Terms*—emotion regulation, haptics, biofeedback, vibrotactile, breathing pacer, Just-in-time-adaptive interventions**

I. Introduction

Regulating high-arousal negative affective states (which includes negative emotions and moods, as well as stress responses) is a well-known challenge. Experiencing high-arousal affect reduces cognitive abilities [1], but cognition is often required to resolve a stressful situation. In these situations, people may turn to maladaptive affect regulation strategies such as surface acting, expressive suppression, or distraction [2]. Such maladaptive strategies, however, can exacerbate the situation or lead to health costs in the long run [3]–[6]. There is significant interest in developing technology to help people regulate high-arousal negative affective states in everyday life [7]–[12].

We use the framework proposed by Miri et al. [13], [14] to consider the different ways technology can be used to facilitate affect regulation. This framework is based on the extended model of emotion regulation which proposes the following steps in affect regulation: *identifying* the need for affect regulation, *selecting* an affect regulation strategy, *implementing* the strategy, and *monitoring* how well the implementation is going [15]. In the absence of technological support, all four steps are done by the individual. Affect regulation technologies distribute the execution of these steps between a device and a user; depending on what steps a device is involved in, the interaction between the user and the device differs. According to the type of user-technology interaction, the framework clusters affect regulation technology into three types: cueing, involvement, and feedback. Cueing technology aids at either the identification or the selection stage, directing the user towards a strategy. Involvement technology guides a user through implementation of a strategy, either explicitly (with effort) or implicitly (automatically). Feedback technology uses biofeedback to monitor the success of an implementation. We find the above framework useful because devices of the same type share a similar set of design issues; we encourage creators to make comparisons between the design choices for different types of devices.

The device our team built administers personalized vibrations with which participants synchronize their breathing to lower arousal. Our device is therefore an instance of an involvement intervention which facilitates explicit affect regulation. Our decision to focus on involvement was partly influenced by the challenges we discovered that applied to cueing and feedback devices. In this paper, we would like to share two challenges that apply to cueing interventions for the consideration of future creators.

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II. Two Challenges

A. Just-in-Time Adaptive Interventions

An influential idea in the field of Human-Computer Interaction (HCI) is that of Just-in-Time Adaptive Interventions (JITAIs). As their name suggests, JITAIs are interventions that through mobile technology can be delivered when and where needed [16]. The efficacy of JITAIs depends strongly on the sensing component which decides the type and the timing of the intervention. Examples of inputs to the sensing component might include: situational context, self-reported measures, geographical location, social setting, and user mood and behavior. Although useful in many circumstances, we claim that JITAIs may not be appropriate for affect regulation, particularly when input to the sensing component involves

subjective experience, expressive behavior, or peripheral physiological responses (such as heart rate or breathing). When one or more of these inputs is used in sensing emotion, JITAIs are in danger of sensing the need for intervention too late.

Timing is crucial to the effectiveness of attempts to regulate affect. The process model of emotion regulation defines five types of strategies one can use to change one's emotion. The following strategies are listed in order of when in the emotion generation process they are believed to operate: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. As one moves further along the emotion generation process, autonomic nervous system arousal increases and the negative emotion manifests itself more strongly in terms of subjective experience, expressive behavior, and peripheral physiological responses, making it easier to detect using technology. At the same time, the process model suggests that strategies which intervene at earlier stages of emotion generation tend to require less effort and be more effective than strategies which intervene later. In other words, situation selection and situation modification require the least effort; attentional deployment requires more effort; cognitive change requires even more, and response modulation is the most effortful [17].

From the process model of emotion regulation, it is evident that JITAIs which use subjective experience, expressive behavior, or peripheral physiological responses as part of their sensing input will be unable to facilitate affect regulation in a meaningful way. While detection that uses these inputs is more effective later in the emotion generation process, emotion regulation is more effective earlier in the process. Therefore, by the time the sensing component arrives at its conclusion based on emotional expression or behavior, the detected emotion will already have surfaced and be more difficult to regulate. It would be best, instead, for an intervention to begin early, ideally before a high-arousal negative emotion is even generated. In most cases, this would be most effectively performed by the individual and not by sensing technology. We allow, however, the possibility that JITAIs which do not base their sensing on emotional expression or behavior may yet be effective at detecting the necessity of intervention in time. For instance, in the case of someone who reliably gets anxious when visiting a certain location, data about their environment would be sufficient to suggest the need for intervention.

B. User Agency

Even if effective technology could be built that sensed the need for affect regulation, should it be used to do so? From an HCI perspective, it is tempting to seek to incorporate technology to support people wherever possible, from identifying and selecting a regulation strategy to implementing and monitoring it. Yet to hand over the role of initiating interventions to technology removes the agency of determining when affect regulation is desired. We know that in many cases, an individual is able to predict their emotions and initiate an intervention early on. There will always be cases where unexpected situations arise, and in such cases when a person cannot predict their emotion, involvement technology may become particularly valuable in helping them to regulate successfully. But we ultimately believe that at no time should an individual feel controlled by their technology.

Indeed, we believe that in the same way that emotions do not simply happen to us, interventions should not simply happen to us, either. Giving the reins to technology to decide when an intervention is merited has the potential to damage individuals' beliefs about control of their emotions. Instead, we seek for our work to promote self-awareness, self-efficacy, and the belief that managing emotions is possible.

We urge creators of cueing technology to make the preservation of users' agency in initiating an intervention a central part of their design. Note that while we hold the above to be true in the present day, it is possible that in the future explainable AI will be able to provide predictions that are understandable and generalizable by humans. If this were the case, the user could learn from the technology how to make similar predictions themselves. As long as we still await the development of explainable AI, we believe in allowing the user to initiate affect regulation interventions themselves.

III. Future Work Direction

We would like to propose a direction for future work in affect regulation technology in light of the above two challenges. As previously discussed, attempting to detect emotion using emotional expression or behavior as input results in interventions that arrive too late to be effective. We see potential in a device which uses environmental (as opposed to emotional) input to *learn* when emotion regulation is desired. Although such a device would not have data on a user's emotional expression or behavior, it would combine environmental input with reinforcement from the user, so that over time it would learn to predict what types of situations lead the user to desire regulation. The device could have a prior probability of intervention being necessary in different situations, and update that probability by asking the user how they felt after the situation had passed. This design would avoid the problem posed by the JITAI devices and enable cueing technology to deliver timely interventions after sufficient learning.

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