Augmenting the Perception of Other's Anxiety with Subliminal Interfaces

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Abstract

Adoptive parents often care for children with attachment problems who have had traumatic experiences and in many cases, have problems communicating their emotions. Moreover, attachment problems are intimately related with behavioural dysregulation and the development of anxiety disorders later in life. To help in the mediation of relationships, therapies such as the Video Interaction Guidance stimulate positive interaction within families.

In our research, we investigate how quantified-self devices can be used in combination with multimodal interfaces to augment the perception of the internal state of a child with attachment problems who is emotionally shut down. We are interested in the use of subliminal multimodal interfaces that can be used pervasively during psychotherapeutical interventions. With such interfaces we want to enhance the throughput of physiological information that adoptive parents receive in real time from their child, who is wearing a quantified-self device. We hope that over time, adoptive parents can acquire a better understanding of the internal state of their child, which they would not be able to perceive otherwise.

Author Keywords

Affective computing; quantified-self; technological interventions; mental health

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous;

Attachment and Anxiety

With quantified-self devices it is possible to monitor aspects of one's physiological state, as well as that of others. This opens up potential for systems that encourage attunement in adoptive relationships [13]. Attunement is the kind of relationship between carer and infant that encourages a positive exchange and learning of important experiences for the normal development of the infant. Although this learning happens in the first months of life [6], it's effects carry on into adulthood. Children in adoptive families often have traumatic backgrounds that results in them having attachment problems [24], and are likely to experience developmental difficulties and impairments in many areas of their life [9]. Attachment can be seen as an affectional bond that animals form with one another [1],[7]. When people form an attachment they seek proximity and feel afflicted or even develop anxiety when they cannot be together. However, if a person cannot form a secure attachment in childhood this can lead to reduced behavioral regulation later on in life [17]. Children who cannot emotionally rely on an attachment figure become confused and insecure, not knowing what kind of treatment to expect and are susceptible to develop social anxiety [8].

An anxiety disorder is a distressing condition of uncontrollable worry or fear that can reduce concentration, change behavior and alter a person's way of acting towards themselves or others [10],[33]. The reasons for feeling anxious are often environmental stressors (preparation for an exam, commute, socioeconomical circumstances, etc.). While the relation between attachment disorders and developing anxiety is evident, some people are more prone to developing attachment problems given their genes, circumstances or experiences [21]. Individuals with an anxiety disorder show a characteristic physiological footprint; their heart rate variability decreases and their electrodermal activity increases when a stressor is presented more so than that of others without the disorder [31].

Stress Response in Anxiety

Physiological stress is anything that brakes the homeostasis of a cell or organism, this disturbing factor might come from within the organism or from outside [15]. Causes of stress may be environmental, intrinsic to development, and aging. Environmental stress is associated with the "fight-flight-or-freeze" response. If an external factor is considered a threat, the stress response is triggered as an attempt to bring back the homeostasis of the organism with the environment. Therefore, under threat an organism might try to fight back or to escape from the stressor or to freeze until the threat has disappeared. For this response to happen quickly enough to be successful, a complex intercommunication between organs and muscles is required. The "fight-flight-or-freeze" response is coordinated hormonally by the sympathetic nervous system (SNS) and the hypothalamic-pituitary adrenocortical axis [30]. As the SNS takes over the energy management of the body, the activity of the parasympathetic nervous system (PNS) is inhibited. Thus, the stress response decreases the tone of the PNS. The vagus nerve is the key component in the PNS. It relays information from most of the internal organs to the brain [27]. This nerve innervates among others, the esophagus, lower airways, heart and aorta [4]. The tone of the vagus nerve is an indicator of stress in the body. This can be quantified with the heart rate variability (HRV) index [26]. Cumulative stress, given by negative events in life and chronic stress, is correlated with a decrease in HRV [18].

Recall that some stressors can activate the activity of the SNS. The sympathetic arousal level is a physiological indicator of stress that can be measured through the skin. Changes in the level of sympathetic arousal are reflected as a modulation of the sweat glands. This modulation can be measured from skin conductance and is referred to as electrodermal activity (EDA) [11]. Therefore the arousal level can be inferred from EDA [14].

Sympathetic arousal and HRV are related to the stress level but the difference between the two indices relies, physiologically, on the innervation of each one. The heart is regulated by both parasympathetic and sympathetic nervous systems, but the sweat glands are uniquely controlled by the sympathetic nervous system. These two components can be used as indicators for anxiety. People who suffer from generalized anxiety disorder do not show a coherent EDA in response to laboratory stressors [12]. Increased EDA and reduced HRV are indicators of social anxiety in children [23]. Furthermore, with the HRV index it is possible to differentiate children who have attachment problems from those who do not when they are undergoing a stressful task [22].

Conveying Physiological Information through Wearable Devices

Piccard [25] describes a scenario where a child with autism shares their physiological information with a teacher and this act helps the teacher to sympathize with the child. The teacher is able to better encourage the child based on the information from a wearable device that the child is wearing. Sharing personal information is important in creating engagement between people. In a conversation, cues such as which topics we choose, how often we talk, our posture and body language andthe tone of the voicehelp us to feel if a person is relaxed, happy, or stressed and not attentive. We learn these cues from repeated experiences with people, the same way children learn a language from being exposed to it. Sharing information in real time is very valuable for our communication. When we cannot infer emotional states from face to face interactions, we can still feel engaged by knowing that the other person is present. A coherent physiological response from another person helps us feel connected. Sharing sounds from the thoracic cavity as vibrations on another person's wristband and sharing breathing rate with compression patterns in an arm band encourage physical connectedness between people [19]. Feeling the other person's heart beat as vibrations helps in the link formed by two people when they live far away [5], [2]. Others have explored the idea of labelling emotions based on physiological information. Encoding facial expressions into specific emotive characters in chat messages improves the quality of the emotional content expressed in the messages [16].

All previous research aiming to help populations with impaired communication of emotions has been done for people on the autism spectrum. For instance, to help empathy with a person who may feel uncomfortable communicating, the level of EDA of a person with autism was presented on the screen of the Google Glass of the person that wants to interact [29]. By doing so, people with greater emotional regulation can see a numerical representation of what is going on under the surface of a person with less control and can better adapt to the ups and downs during the interaction. Further, mapping skin temperature, heart beat, electrodermal activity and breathing pattern into meaningful music features such as melody or drum beats helps people intuitively detect anxiety in others [20].

Electromyographic information can be used to infer a child's smile. When this event is detected a vibrational device can help to attract the attention of a person playing with the child. Being aware and reacting positively to the events that make a child with autism smile imrove in the communication between dyads [32].

Research Questions

- Could a subliminal display of physiological data from one person tell another in real time about the level of anxiety experienced by the former?
- Could this representation of physiology be used in intervention therapies to help in family attunement?

System Design

Minciacchi [20] show elegantly that meaningful features from music can be used to represent physiological signals that are significantly different between anxious and relaxed people. Their participants can tell which sample of music represents what within 20 seconds, after having trained for only 10 minutes. Their study show that this display can be used by non-clinicians to identify anxiety in people with autism who cannot communicate how they feel otherwise. Our approach is to develop a pervasive multimodal interface that, during a psychotherapeutical intervention such as Video Interaction Guidance (VIG), informs parents subliminally and in real time about the state of anxiety of their child. We draw on ideas from the VEST (Versatile Extra-Sensory Transducer) device developed by the company NeoSensory. This device maps a real time flow of information (sound, drone orientation, twitter feeds...) into patterns of vibration around the torso. In this way, for example, following a period of training, a deaf person can learn to recognize vibration patterns corresponding to sounds of specific words.

We would like to use interfaces such as the VEST to map physiological signals that are related with anxiety. By subliminally presenting children's physiological signals, we expect adoptive parents to be able to learn to subconsciously recognize the child's level of anxiety during VIG.

The first interface that we have devised maps EDA onto a change of temperature given by a Peltier heat pump (from SMAH engineering services).

First Experiment

We want to know if by mapping EDA onto a change in temperature we can infer the level of excitement of others in real time. In the setup of our first experiment we will use the Remote Collaborative and Affective Interactions (RECOLA) dataset [28]. From this dataset, we have 17 five-minute videos of people performing an online collaborative task. In these videos, collaborators were asked to agree on a list of items to bring with them onto a ship. While they were performing the task, a video of their face was recorded along with their voice, EDA and heart rate. The participants of the dataset were all French speakers.

We will play 8 randomly selected videos from the RECOLA dataset to each of our participants. While they watch the videos, they will also receive the recorded EDA signal of the person in the respective video (mapped onto temperature). The temperatures used range from 20 to 40 ◦C, so that the EDA levels recorded for each person are scaled to this range. We will present the raw EDA values in 2 of the videos and we will extract the tonic and phasic values of the EDA as calculated by Benedek and Kaernbach in [3] for 4 other videos (2 for each of the extracted signals). For the remaining two videos presented our participants will feel a constant temperature of 30 ◦C. Two Peltier modules will be placed at a comfortable distance to the participants so that they can touch them with the base of the palm.

While the participants are watching the videos, they will be asked to rate how excited they think the people in the videos are on a continuous scale from 0 to 10. To do so, they will be provided with a slide potentiometer where the left-most side represents very low excitement and the right-most side represents very high excitement. Since the people in the videos are french speakers, for non-french speaking participants the rating of the excitement state will be based solely on body language and prosody and not on verbal content. We will select our participants from a pool of non-french speaking students at the University of Glasgow. For training, the participants will practice with a demo video for 1-2 minutes before beginning the experiment.

At the end of the experiment, participants will answer questions related to their experience with the system and if it was useful to feel more connected with the people whom they were watching in the videos.

Additionally, we will collect responses from psychologists with experience evaluating emotions in people to correlate the responses of our participants and quantify how well people can learn to use our interface to evaluate the level of excitement. This ground truth would be valid if we observe a convergence between the ratings of the psychologists. If we observe no convergence we will proceed to collect our own database of physiological signals from participants performing a stressful task (giving a speech in front of an audience) or a relaxing task (mindfulness meditation).

Future Work

We are investigating other interfaces and other mappings of physiological signals. If one of the interfaces proves to be useful to express excitement, an exciting step forward in our project will be to test the system in a real psychotherapy intervention such as VIG. We will also extend the scope of the project to help parent-infant dyads to cope with anxiety in non adoptive families where there is a genetical predisposition to developing anxiety disorders.

Conclusion

Numerous devices are available to gather personal data and many studies focus on monitoring, classifying or informing users about their own physiological information to enable them to learn to regulate physiological responses such as stress. No studies to date use subliminal interfaces to enhance the perception of anxiety in others. Moreover, we propose the use of such interfaces in the context of psychotherapy interventions to enhance the parent's perception of the internal physiological state of their child.

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