Affective Health – designing for empowerment rather than stress diagnosis

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CHI 2010, April 10–15, 2010, Atlanta, Georgia, USA.
ACM 978-1-60558-930-5/10/04.

Abstract
When designing Affective Health, a mobile stress management tool using biosensors, we gradually understood how severely limited inferences can be when we move from laboratory situations to everyday usage. We also came to understand the strong connection between our subjectively perceived resources for dealing with stress and healing. Therefore, rather than employing a diagnose-and-treat design model, we propose that designers empower users to make their own reflections and interpretations of their own bio-sensor data. We show how this can be done through encouraging reflection, alternative interpretations and active appropriation of biosensor data – avoiding a reductionist, sometime erroneous, mediation of automatic interpretation from bodily data to emotion models or, in this case, stress diagnosis.

Keywords
Stress, empowerment, health, biosensors, ubiquitous

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI)

Importance of lifestyle awareness

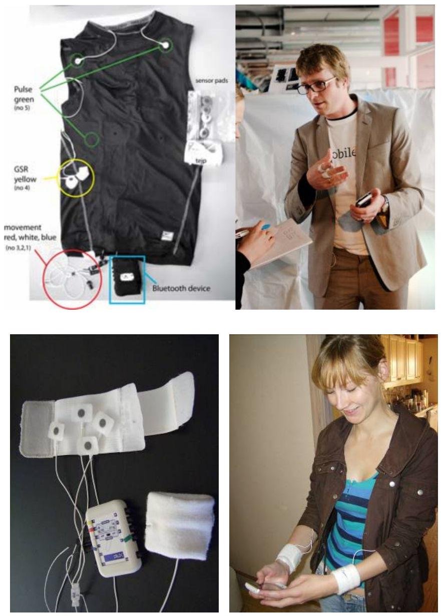
Stress is a natural reaction of the body to changes in the environment. It prepares us to deal with the change, activating all the available body resources to confront it and adapt [e.g. 6,10]. Unfortunately, when placed under such strains for longer time periods the effects can seriously affect our health. But in the midst of a busy life style, it can be quite hard to get a grip on what is stressing, what really makes us feel good, and what lifestyle choices and behaviors that we perhaps should alter. It might be that we are not allowing ourselves to sleep properly, that we use alcohol to relax, or stay in a work place that we perhaps should have left long time ago – and some of these behaviors we might not even want to recognize or alter [3,12]. Sometimes, this also means that we suppress or ignore the stress signals our body emits. It is important to alter such a negative trend before it damages us. But how can we empower users to deal with this kind of situation? To be able to build some kind of life-style application that supports users' own reflections and helping them to find positive and negative patterns in their behavior, we first need to make clear what kinds of feedback that will really be helpful, relevant and reflect users' everyday experiences in a truthful way.

The first medical models that attempt to explain stress date back at 1936 [9]. These consider only physiological aspects of the physical adaptation to threats. Observed bodily reactions included increased heart rate, dilation of pupils, and perspiration. Nearly half a century later, new models of stress [7,10] were proposed that also consider factors such as the individual perception of the stress experience. The way the stressor is perceived, as well as how you feel you can cope with it, can either be aggravating or attenuating factors for a potential negative impact on our physiological state.

Below we will substantiate our claims on the difficulties of designing a mobile everyday lifestyle application using biosensors. Our exploration is an interdisciplinary mix of (1) the *medical understanding* of stress symptoms, (2) investigating the capacity of existing *biosensor solutions*, and (3) iteratively *designing and testing versions of the Affective Health system* with users. While we present them as independent of each other, in reality these three lines of investigations where intermingled in a complex exploration mainly driven by our design considerations – a designerly exploration [11].

Sensing stress

Stress is a term used to describe a whole continuous experience happening on our bodies where brain waves both influence and are influenced by hormones, muscle and nerve contractions, among many other reactions [6]. It is a non-trivial problem to measure stress and its damage using biosensors. Arousal is the basic manifestation of short-term stress – a combined physiological and psychological state with a direct relationship to increased responsiveness and alertness leading to increase of heart rate, blood pressure, and perspiration. The problem arises when the arousal reaction is not shut down, releasing stress hormones, such as cortisol, for a sustained period and thus keeping the blood concentration of these hormones high [8]. By analyzing the amount of cortisol in blood or saliva it is possible to assess how intense and frequent are stress responses [*ibid*]. However, these kinds of measurements are typically too invasive or require medical expert interpretation in order to make



Two different sensor configurations are shown. The top pictures show embedded sensors in a sports t-shirt. The bottom pictures show wrist measurements of all the bodily data, for integration with bracelets or watches.

sense. In fact, there is no evidence that supports the belief that it is at the moment possible to correctly measure stress, or its negative effects, in a non-invasive way. Similarly, long-term stress damage can manifest itself in a number of different ways, influenced by coping strategies and personality, giving rise to different patterns in bodily reactions [6,8].

Finally, sensing bodily data in a ubiquitous way throughout everyday life poses problems that go beyond noisy signals. In order to blend with daily life, people should either not feel that they are using sensors or enjoy using them, as if they were jewelry or a piece of clothing. Given those considerations, our quest so far led us to the use of 3 types of sensors: ECG[1], GSR[2], and accelerometers. Accelerometers can measure movement (in various ways depending on where on the body they are placed) and can be used to understand why ECG or GSR increases for other reasons than psychological stress factors. We have tried different placements, which would correspond to pieces of clothing or jewelry with integrated sensors. These potentially more wearable solutions than the traditional ones used in clinical settings, lead to less quality in the data. The challenge is then how to represent scattered and noisy data from an unpredictable context in a way that still makes sense to the user and helps her connect the dots of events and bodily reactions and reflect on what is happening in her life.

Design for empowerment

It is problematic to assume that any system will be able to determine whether a stressful situation is indeed harmful or not at any given moment. The point of life is not to avoid stress entirely – some of it can be necessary and even desirable. As explained before, many pleasant everyday activities have seemingly the same physiological reactions as a negative stress experience. On top of that, today's sensors are not robust enough or fine-tuned enough to always produce correct and reliable readings. We are therefore left with a whole range of issues that need to be solved. First, we cannot expect to diagnose stress reliably in everyday life – no matter how well the sensors work. Second, we do not know exactly what our end-users should do once they have been told that they are stressed. In our view, we need to take a different approach to the overall design of these kinds of systems.

The approach we took and the one we maintain when designing Affective Health aims to empower users through recognizing our being in the world as an embodied social, bodily and cultural product [2,5]. By seeing well-being as a holistic state, we avoided picking apart bodily and emotional experiences and instead aimed to provide users with materials that stimulate reflection rather than having the system interpret and diagnose the user. Since we know from research on stress that for a state of physiological arousal to correspond to negative stress one has to consider the individual coping skills and the expectations of the

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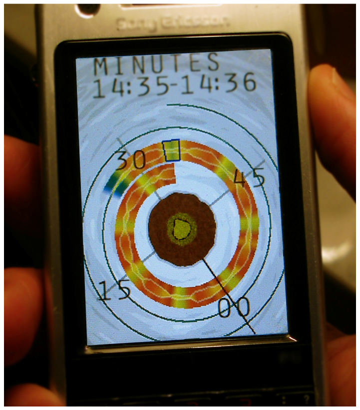
[1] Heart rate is both a fairly easily measured feature strongly related to arousal and stress, as well as a graspable conceptualization that will make sense to end-users.

[2] When a constant voltage is applied at two points of the skin, the result is a current flow that changes over time due to variations in skin conductance. These fluctuations, called galvanic skin responses (GSR), are caused by dilatation and perspiration in special sweat glands called eccrine glands, directly connected with emotional arousal [1].



In this interface, the organic shape in the center displays real-time feedback, pulsating with each heart beat and growing with the amount of sensed movement. Past bodily data is represented in a circular shape that spirals outwards, allowing users to change the time scale from minutes to days and scroll between reoccurring behaviors, events, emotions and so on. GSR data is represented by color: red is mapped to high arousal and blue to low arousal. Past movement and heart activity can be read by looking at the volume and progression of semi-transparent bars that run across the spiral.

person to overcome the problem. Therefore we avoided simplistic interpretations of users' activities to determine what is bad or good stress – and instead aiming to support interpretive flexibility. Interactional empowerment helps dealing with the lower level issues such as the accuracy of the sensing, and not just the accuracy of the inference discussed above. By providing a systematic, coherent but seamful mapping between the sensed data and the representation, the user gains the ability to notice when data is lost or noisy.

Finally, our work highlights a demand for biosensors that not only satisfy the requirements of correctness, but also of wearability and social acceptance. Only then can we enter confidently the world of possibilities that wearable computing promises and come closer to its ubiquitous vision. Initial studies [4] show promising results. Users become involved with two different processes. First, they can look at their own data in real-time and get into a bio-feedback loop, e.g. taking a deep breath and immediately seeing the effects on ECG or GSR. Second, they can start recognizing patterns in their own behavior related to real-world events. We are currently extending the system so that it will show mobile data in the same representation: text messages, photos, etc., so that users can start inferring when and why their arousal increased.

If accepted, we will bring the live system to the workshop and demo the interaction.

Acknowledgements
We thank all the anonymous subjects who have participated in our studies.

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