CALM-ME-NOW – An Exploratory Study and Design of Stress Mitigating Interventions

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ABSTRACT
In this paper we describe the formatting requirements for SIGCHI Conference Proceedings, and offer recommendations on writing for the worldwide SIGCHI readership. Please review this document even if you have submitted to SIGCHI conferences before, for some format details have changed relative to previous years. These include the formatting of table captions, the formatting of references, and a requirement to include ACM DL indexing information.

Author Keywords
Health Care, Social Networks, Tangible User Interfaces, Haptics, Wearable Computing, Touch Therapy, Psychotherapy, Mental Health, Stress Management, Games.

ACM Classification Keywords
H.e.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

INTRODUCTION
Stress is reported to be one of the causes and/or an exacerbation factor for many physiological and psychological illnesses [X1]. Coupled to another study of ambulatory monitoring of stress we want to investigate novel HCI approaches to calm people down in the early stages of the accumulation of stress. We want to answer two questions: (1) is it possible to offset and reduce stress through novel interactive techniques such as haptic feedback, mobile games and social network support? (2) Which interface(s) are more appropriate to calm people down, and what is the best way to implement them? We believe that providing adequate support in the early phases of stress (by implementing interactive techniques that appeal to the sense of touch and social support) we will be able to attenuate or even eliminate stress outbursts. Recent studies in these topics have shown some value of haptics as a therapeutic tool [11] and previous stress studies have shown social support as a valid tool to reduce stress [17]. Additionally, games have shown to provide a distraction [YY] that could be used as a way to relief stress.

Our view of the type of stimulation that can be provided is represented in Table 1, where we have divided the types of interventions based on their level of interruption to the user, both in a personal as well as in a social fashion.

Our future goal will be to incorporate all the types of techniques described on Table 1 in a modular and intelligent fashion to provide the adequate intervention to the user based on the context and the personal situation of the user. In this study we will begin to evaluate less employed techniques, which are mainly part of the low and medium interruption level techniques:

Haptics: Designing with Haptics [10] has the advantage to provide enhanced options for HCI. The type of haptic feedback to be delivered to calm down people will take various forms, such as wearable options [11], [12] and cellphone integrated options, Chang, A. and O’Sullivan, C. [13]. Additionally we plan to use other experiments with other novel approaches, such as using electrophysiology devices to simulate a caress or massage in different parts of the body [14].

Games: Simple games that deviate attention from stressor have a potential to calm people down [XX], as well as

<table>
<thead>
<tr>
<th>Interruption Level</th>
<th>Interaction Techniques</th>
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<tbody>
<tr>
<td>Low</td>
<td>▪ Tactile stimulus</td>
</tr>
<tr>
<td></td>
<td>▪ Brief SMS text messages</td>
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<tr>
<td></td>
<td>▪ Images</td>
</tr>
<tr>
<td>Medium</td>
<td>▪ Email or Short phone calls</td>
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<tr>
<td></td>
<td>▪ Quick breathing techniques</td>
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<td></td>
<td>▪ Quick massage/exercise</td>
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<tr>
<td>High</td>
<td>▪ Music therapy</td>
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<td>▪ Breathing Techniques</td>
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<td>▪ Visualization Techniques</td>
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<td></td>
<td>▪ Games</td>
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<td>▪ Personal calls</td>
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Table 1. Table captions should be placed below the table.
games that provide very limiting challenges, which do not pose an additional load of stress [YY].

Social Network Support: Previous experiments with social support in social stress experiments have shown positive signals of the power of social stimulus to calm people down [17]

RELATED WORK
The content, manner and ways to deliver the feedback are crucial to generate the right type of behavior change. We want to use positive feedback as a way to promote a positive experience of relaxation. Positive psychology is currently emerging as a new way of facing behavioral changes [18]. Additionally, Evidence Based Therapies administered via Internet have been showing very promising positive results [19], such as Cognitive Behavioral Therapy [20] [21], which use several techniques for habit changes [22]. Additionally, a novel approach towards behavioral therapies based on narrative where the therapy is administered via a dialogue is showing promising results [23]. We plan to take best practices from all the prior techniques to develop the right type of feedback to the subjects.

IMPLEMENTATION
We will build and integrate preliminary prototypes to do exploratory work on the potential effects of the previously mentioned interfaces. For the haptic feedback we will employ vibro-tactile motors [26]. We built a bracelet (see Figure 1) with two motors to stimulate acupressure points in the wrists [31] and the chest known to reduce stress (see Figure 2) and will employ a Wizard of Oz technique to simulate the timely application of this stimulus to the participants.

![Figure 1. Vibro-tactile bracelet with two vibrating motors for acupressure stimulation.](image1)

![Figure 2. Acupressure points on the wrists](image2)

For the games we will use commercially available mobile games that have simple tasks to complete, such as: wooden tilt simulation, sliding wood sticks, paper toss and saving the wireman. We will allow the subjects to choose from the games at their own discretion.

For the social network we will enable a text-based interface using SMS using Google Voice to deliver the following message:

[ALERT] Claudia is feeling stressed. Please send John a test message OR call her. Say something positive/humorous, or motivate her to relax.

We will have to work with the subjects to enable these small networks to test their availability and responsiveness. Complementary to the individual tests we want to do a hybrid technique providing haptic feedback coupled with breathing techniques. We will coach the users to breath accordingly to well-known breathing techniques [28] supported by a haptic stimulus that allows them to maintain the rhythm of the exercise, which is one of the key elements of success for effective soothing effect of breathing. We will use the same bracelet shown on Figure 1 for this exercise.

STUDY DESIGN
To gather the baseline information we will use objective data (biometric), and subjective data (psychometric and personal assessment of stress) data:

On the objective side we will measure Galvanic Skin Response [30] and ECG information [ZZ] to later determine Heart Rate Variability. We will gather this biometric data using the ambulatory monitoring bio-signals device, Berkeley Tricorder [2].

![Figure 3. Tricorder circuit board](image3)

Voice monitoring technology using the voice pattern depression analysis system, AnalyzeThis [3].

Psychometric anxiety information from the State-Trait Anxiety Inventory scale (STAI) [4] coupled with subjective assessments of stress in a scale of 1 to 10 will be used to build the subjective axis of evaluation. Life Events Questionnaire will also be gathered to have a prior knowledge of potential permanent or daily stressors that could be built outside the laboratory [7].

To perform the exploratory research we will apply two mental stressors, (1) the Stroop Color Word Test (CWT)
The qualitative analysis will be derived from our usability

and the qualitative data will be processed both from the subjective information gathered from the different scales and from the objective information from ECG and GSR signals. To analyze the results we will analyze data in three ways: (1) inter-stage (stressed vs. non-stressed), (2) inter-phases (phase 1 with positive thinking + visualization vs. phase 2 with new interventions), and (3) inter-interventions (guided breathing vs. acupressure vs. social network support vs. games).

**ECOLOGICAL VALIDITY**

Our study will provide valuable insights on the effectiveness of different interaction techniques to offset stress in the users. First, by measuring bio-signals and analyzing voice, we can build a model to intervene before the stress gets too high. Interventions such as haptics, haptics-guided breathing, social networks, and games will show us the extent that they can individually help users and possible their effectiveness in combination. Our evaluation will address our hypothesis directly because, if we are correct, we will see a change in bio-signals and subjective assessment right after the intervention and a change in behavior.

**EVALUATION**

Recruiting was made among UCB students. We gathered 20 participants (13 male and 7 female) from different disciplines. The evaluation will have two phases. On phase one we will gather baseline information from 6 identified stages: (1) arrival, (2) calming, (3) Stroop test, (4) anticipation, (5) math test, (6) calming. During the calming phases we will force the users to speak to gather voice information and therefore we will be asking the subjects to speak descriptively about beautiful and soothing things they like. This interaction should be regarded as an intervention due to its guided positive thinking [18] and visualization approach. On the second phase we will perform the same tasks but this time we will apply the four interventions (acupressure, guided breathing, social network support and mobile games) during phases 2, 4 and 6, in order to measure both, their effectiveness to relief stress and to prevent relapse, in the case of phases 2 and 4. We expect to obtain results that are either better or similar to phase 1, which could indicate that these interventions are at least as effective as positive thinking and visualization or better. Finally, on phase 2 we will administer a survey at the end of the study, to gather closed-form (Likert scale) qualitative information about usability (likeability, direct comparison, potential usage, frequency of use) and perceived effectiveness of the interventions. We will also gather additional open-ended information about improvements for the presented interventions as well as suggestions for new interventions.

**RESULTS**

To provide rich information about the design and research methods used during this study, we will perform a qualitative analysis supported by quantitative information. Information, and the qualitative data will be processed both from the subjective information gathered from the different scales and from the objective information from ECG and GSR signals. To analyze the results we will analyze data in three ways: (1) inter-stage (stressed vs. non-stressed), (2) inter-phases (phase 1 with positive thinking + visualization vs. phase 2 with new interventions), and (3) inter-interventions (guided breathing vs. acupressure vs. social network support vs. games).

**Inter-Stage**

As seen on Figure 4, the expected pattern of stress and calmness was represented by the subjective information. At an aggregate level, stressors did raise perceived stress levels in the subjects and the calming phases did manage to lower them.

![Figure 4. Delta variation for each stage for phase 1](image)

Additionally, biometric information supports this view also at an aggregate level. The variation between stages is not statistically significant, but this could be explained due to low number of subjects used for this exploratory research. However beyond the numerical analysis at an aggregate level, it is important to note that the patterns of stress at an individual level are variable, and the gaps between objective and subjective measurements are noticeable.

**Inter-Phases**

Compared with phase 1, phase 2 presents an interesting pattern. At an aggregate level we do not observe a strong difference with the delta values of phase 1. This could indicate that overall the applied interventions at least have a similar effect to the base intervention (positive thinking + visualization). However, a comparative analysis at an individual level shows that the gaps between phases per each intervention are noticeable. As it can be seen in Table 2, the accumulated effect per each phase is variable. Green indicates an improved variation, while red indicates a reduction in the calming effect. We consider the variation
Mental Model

- In the case of social networks, it is fundamental to ensure that the user receives an appropriate message between a certain window of time, in which the user clearly relates the message with the support system. To reach this goal it is necessary to persuade the contacts to take immediate action by suggesting a simple and positive action. Due to the unreliability and the highly variable turn around observed in this study, it is recommended that the social network is expanded to several contacts which could be broadcasted with messages. Additionally, it an ACK message will be necessary in many instances to guarantee that the desired effect has been realized on the stressed subject. One way could be to use the system in a man-in-the-middle architecture, which could ease the response of the contacts and guarantee proper delivery. However it is very important to realize that privacy issues may prevent this model to take place, as many of the observed messages, although being very short were extremely intimate. Some messages received by the participants were very short phrases that did not make sense to an observer, such as “I am doing gummy bears”, “ducks and motorcycales”, or messages that are very intimate. As described by one participant, these simple yet extremely
powerful messages, if delivered on time, do not only have the power to relax people, but they also have an energizing effect, which could boost the subject’

- In the case of the haptics application, the subject’s novelty aversion factor could be reduced by clearly showing the value of acupressure and deep rhythmic breathing. Understanding that pressure points on the wrists and chest have calming effects, as well as understanding that rhythmic deep breathing has strong calming effects helps the user habituate to this tasks. Additionally, as some participants had mentioned, tying the breathing technique to another haptic feedback such as pressure, or other incremental signal, rather than a constant vibration, could have a more natural relationship with the act of breathing.

- In the case of games there is a complex paradox. Although users are distracted by the game, which in theory could help to reduce stress by not focusing on the original stressor, many users reported a different kind of stress based on the competitiveness nature of games and its addictiveness. Understanding that games should be used only to get the mind of the initial stressor is important.

Education

- In the case of guided breathing, one of the biggest problems a participant faced was their inability to breath deeply despite their efforts to be guided. As mentioned by one participant, he was unable to keep the pace and suggested that a customizable and progressive version of guided breathing is implemented.

- Regarding acupressure, some participants did not apply the bracelet correctly, which generated a diminished effect on its usage. Therefore, a training period could support users improve their interaction with the bracelet.

Guarantee usage outside the lab

- All of the interventions should be designed and tested in the field. The artificial scenarios proposed to both induce stress and calm people down help control many variables that are hard to track, such as: lack of time to use interventions, lack of connectivity, lack of privacy to receive the intervention, lack of interest from the user, changes in behavior and emotions due to context, changes in susceptibility to interventions due to context, learning effect that reduces efficacy of intervention over time. All these constraints can easily translate a calming intervention into a very stressful situation. Therefore further research in this area must be executed initially by flushing out the details of a specific intervention, and later combined with more than one intervention.

Attribution of effectiveness to intervention

- Users in this study did attribute many of the effects of lowering (or raising) their stress levels to the interventions. To ensure these characteristics it is fundamental that the interventions could be used in a timely way, and that delays in their usage do not generate the effect described in the previous point of transforming a calming intervention in a stressful situation. Additionally it will be relevant to keep track of the interest the user has in the interventions. A combination of technology based interventions and an encouragement to modify other patterns of behavior that improve emotional awareness may be necessary to improve the person’s perceived benefit. Additionally alternation of these innovative interventions with traditional ones, such as reading, listening music, visualization, etc. could benefit to maintain a level of satisfaction on the overall calming system and attribute long-term positive benefits rather than transforming the system in an analgesic to be used only during situations of high distress.

Promising Interventions

From the results of this study, it can be observed that despite a noticeable better performance of the social network intervention, the remaining interventions should not be discarded as they all present strengths that can be exploited to counteract some of its weaknesses. Including them in suites of applications that can be used in different situations by the user could help improve the adoption and adhesion to its usage.

CONCLUSION

In general we observe in this paper that Social Networks has a tremendous potential to provide effective and widely used support for stress reduction, due to its intrinsic support of meaningful humor and intimacy. Customization and choices for users are important. Different interventions could have different effect in people. Therefore having a suite of potential interventions could be a much stronger proposition than a single tailored application. The disparity between perceived, psychometric and objective metrics shows us that there is a lot of room for interpretation, so the system should be designed with the ability to empower its user to be more than a passive receiver, but to become also an activator of the network. Finally the need for education and training is not a trivial task, as it demands resources and time. An appropriate calming system should embed the ability to make continued progress towards a final objective that is the perfection of the calming technique. Privacy is an element of key importance, as a simple phone call could become stressful if there is not enough privacy to take it, or if there is not enough time to be comfortable talking or chatting with the loved one. It is important to conclude this section by noting that the gap of separation between a stressful and a calming sensation is very narrow. Extremely opposed effects were observed in individuals using breathing, where one person almost fell asleep, while other was completely stressed by not being able to keep the pace of respiration. Therefore, designing for stress reduction demands a keen knowledge of the personal view of stress of the person, which in turn demands a system that is highly customizable by the client itself.
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