

SCAARF: A Subtle Conditioning Approach for Anxiety Relief Facilitation

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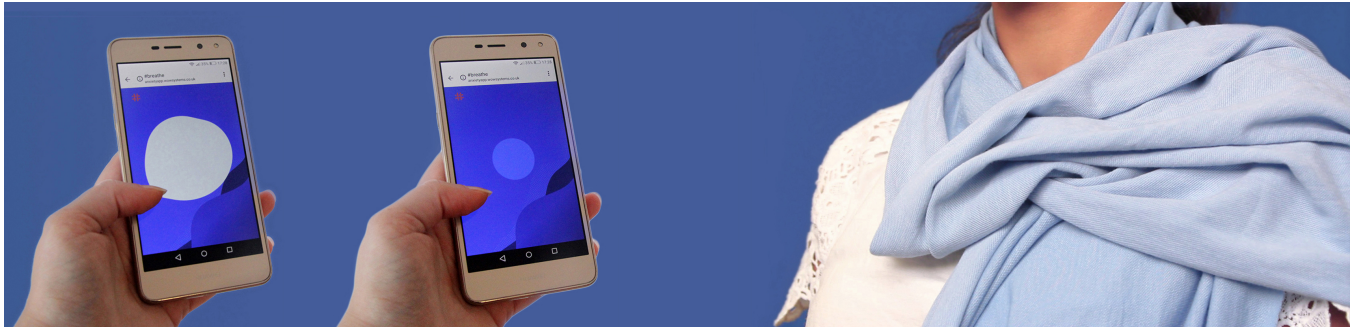


Figure 1: SCAARF's mobile and wearable prototypes.

ABSTRACT

Anxiety disorders are one of the most prevalent mental health conditions, affecting more than 280 million people worldwide. This paper presents a novel approach to assistive technologies for mental health. In our approach, the paired combination of a wearable device – in the form of a scarf – and an accompanying mobile app, helps mitigate anxiety symptoms whenever they start to arise. This approach differs from conventional ubiquitous technologies developed for dealing with mental health, both in the role the mobile app plays in the process and in the way the intervention is delivered to users. SCAARF offers a more subtle, less obtrusive method for coping with anxiety. We discuss the results of an initial (three-week-long) evaluation of SCAARF with anxiety-suffering users. Qualitative results suggest that the SCAARF mobile app is effective in helping users relax and cope with anxious states of mind.

CCS CONCEPTS

• **Applied computing** → **Health care information systems**; • **Human-centered computing** → *Ubiquitous and mobile computing systems and tools*.

KEYWORDS

anxiety disorders, mental health, assistive technologies, mobile, wearable, subliminal

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1 INTRODUCTION

Anxiety disorders represent a significant public health issue and are one of the most prevalent mental health conditions. According to World Health Organization's estimates, by 2015, 264 million people were struggling with some form of anxiety disorder, 14% of which were European. A similar research, made by the Institute for Health Metrics and Evaluation, showed that, by 2017, this number had risen to an estimated 284 million individuals who experienced anxiety disorders. This 7.5% increase in just two years shows the critical pace at which mental health is deteriorating worldwide, and turns anxiety into a major public health concern.

Even though conditions such as panic disorder and generalized anxiety disorder (GAD) are usually non-fatal, individuals who suffer from anxiety can experience symptoms like shortness of breath, chest pain, muscle tension, fatigue, confusion, irritability and nausea. These symptoms can not only lead to debilitating feelings (such as fear of dying) but also increase the likelihood of situational avoidance and behavior change [4].

Although mobile and wearable interfaces have long been developed to improve mental health issues, most of the current approaches still operate in the so-called “reflective mind” [5]. However, learning about self-regulation techniques and coping strategies for dealing with and learning about stress can be counterproductive when it comes to anxiety disorders, since reflecting on your own health data can enhance stress and anxiety symptoms.

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This work introduces an alternative method to mitigating anxiety symptoms through the use of a smart wearable interface, SCAARF, which implements a subconscious, less invasive approach in the design of assistive technologies for mental health.

This paper is organized in the following way: Section reviews the current approaches in the field of assistive mobile and wearable interfaces for the mental health domain, and discuss the importance of designing garments embedded with technology. Section 3 presents the SCAARF prototypes, which exploit haptics and classical conditioning as a way to mitigate anxiety symptoms. Section 4 describes the experimental setup and presents the initial test results, that were conducted in multiple environments. Finally, we discuss limitations and potential improvements to our system and draw conclusions about this work.

2 WEARABLES AS SUBTLE INTERFACES FOR IMPROVING MENTAL HEALTH

When talking about mental health, the form-factor plays an important role in the success or failure of wearable devices. Several wearable interfaces have been developed that capitalize on the unobtrusiveness, familiarity, and social acceptance of designing garments embedded with technology [13, 15, 16].

Lightwear [10], for example, takes advantage of this approach and presents an alternative to light boxes, the predominant yet outdated method of treatment for Seasonal Affective Disorder (SAD), which no longer constrains users to a sitting position nor requires them to learn new skills in order to operate and interact with such objects.

SWARM [16] and Essence [3] are another example of how everyday items can be embedded with technology and the importance of such an approach in the design of assistive technologies, as people with disabilities already experience a fair share of stigma and discrimination in their everyday lives.

Although other wearables [2] aim to help users cope with stressful situations, they take on a less subtle approach and act almost as a social statement, instead of blending in, which — in the mental health domain — can draw unwanted attention to individuals who already feel self-conscious.

A systematic review of the literature (N=1108), performed outside the scope of this poster, showed that even though work has been done that uses a combination of mobile applications and wearable devices to deliver interventions based on cognitive behavioral therapy principles, there is still a lack of truly non-intrusive wearable assistive technologies being used to help treat anxiety disorders.

Moonglow [8], for example, uses cognitive behavioral therapy principles to mitigate panic-related symptoms. It does so by sensing physiological changes through a wrist-worn device and actively asking users to select an emotion when their heart rate increases. If the feeling reported is sad, the mobile app asks users to do a breathing exercise as an intervention, and to write a digital diary entry about how they are feeling.

This is also what happens with PanicPal [14], where a Zephyr BioPatchTM wearable chest-worn device gathers data to predict panic episodes up to one hour before they occur. By doing so, they aim to provide users with a respiration-based intervention, which is

delivered as a notification in a graphical user interface to individuals who exhibit panic-related symptoms.

According to Cruz et al., this enables users to better manage and act on escalating stress-inducing symptoms. However, while having the ability to predict a panic attack can be considered a breakthrough, not being able to intervene at the right time and with the right tools can make this prognostic ineffective.

Although such approach is effective in improving an individual's thought patterns in the long-term, it falls at risk of increasing anxious states, as the realization that a panic episode will probably occur in the near future can further intensify anxiety symptoms and even trigger a panic attack sooner than expected.

Simm et al. [18], on the other hand, developed a fully customizable wearable assistive technology to help individuals with autism self-manage their anxiety. This is of great importance, since the way every person experiences anxiety is unique, and why their work followed a participative design approach.

Even though their bracelets use haptic distractions to promote more meaningful tactile interactions, they still require individuals to actively trigger the system and reflect upon their health information. Again, notwithstanding the validity of such approach for the long-term reduction of stress (as it can help users break negative thought patterns), our research interest lies in achieving the same goal below the threshold of conscious perception.

Nevertheless, the review allowed us to identify gaps in the existing scientific wearable approaches in mental health domain, showing that most wearable devices — developed to assess and help treat anxiety disorders — are either intrusive, as they require individuals to use uncomfortable devices such as head-mounted displays and chest-worn devices [1, 7, 14], or, when this is not the case, are still used mainly for sensing and monitoring purposes [9, 17, 18]. Moreover, the majority of those wearables need mobile applications, which are used mainly to merely record data and deliver interventions through a graphical user interface that help users deal with stress and self-manage their anxiety.

With the development of smart textiles that allow for ever smaller and softer sensors and actuators, it would be expected that there would already be wearable interfaces operating at the subconscious level, capable of improving mental well-being without the need for constant self-monitoring (which can overload users with the access to unnecessary health-related information). This is where our work comes in.

3 SCAARF

3.1 A Subtle Conditioning Approach for Anxiety Relief Facilitation

Cognitive behavioral therapy (CBT) and drug-based approaches have been the prevailing practices to help treat anxiety disorders cases. Since CBT, much like classical conditioning, is built on the notion that all behavior is learned — where patients are taught that the way they feel is directly connected to the way they think [6] — and seeing research has shown a person's behavior also revolves around information they do not process consciously [11], we aim to subtly help shift a person's negative thought patterns by replacing an existing negative conditioned stimulus with a positive one.

The innovation behind our contribution stems from the paired combination of a conditioning phase, where users are repeatedly exposed to a mobile app user interface, and an intervention phase, delivered by the wearable (Figure 4). SCAARF — a subtle conditioning approach for anxiety relief facilitation — goes against the dominant narrative of reflective-based approaches, and uses only positive reinforcement signals to subtly mitigate anxiety symptoms.

The two separate interfaces share the same affordances and, when combined, can help individuals to cope with stressful situations by using a subconscious, less-invasive approach, where the physical manipulation of a wearable device is unconsciously associated with a relaxed state of mind as a result of the previous mobile conditioning phase.

This approach is particularly attractive for mental health issues, as the reflective mind — as defined by Kahneman [12] — does not bring solid results for anxiety, since reflecting on your own anxiety data can induce even more stress.

3.2 The Mobile App

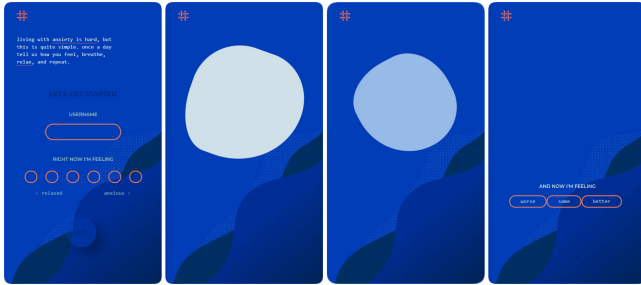


Figure 2: SCAARF’s mobile app screens: landing page (left), breathing exercise (center) and the last screen (right).

To evaluate the feasibility of our research hypothesis, a mobile application was developed to provide a deep-breathing exercise (Figure 3), used to prime users during the conditioning phase of the experiment.

The SCAARF mobile application was designed as a responsive website, for testing purposes, so it would be able to run on the two main operating systems currently available for smartphones (iOS and Android). This helped ensure users could test the platform without restrictions.

The mainstream treatment for anxiety disorder cases, cognitive behavioral therapy, and classical conditioning are both built upon the notion that all behavior is learned.

With the SCAARF app, we aim to replace a negative conditioned stimulus with a positive unconditioned one, in the form of an audio clip. The same clip, played at the end of a 50-second deep breathing exercise, is then triggered in a smart scarf, delivering the intervention, when the user touches its fabric in a repetitive way, i.e. when anxiety symptoms occur (Figure 4).

A breathing exercise was selected to prime users, since it is currently one of the conventional methods for dealing with anxiety available at Google Play and the App Store.

The app is also used to record participant’s mental states in a SQL database during the conditioning phase, in which users are

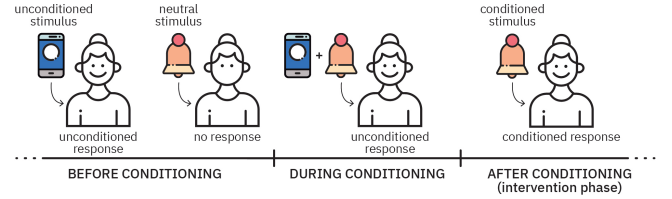


Figure 3: The SCAARF system before, during and after conditioning. It works by priming users to associate a previously neutral stimulus with an unconditioned one.

assigned a personal identification code and surveyed about their mental well-being, prior to the breathing exercise and after being exposed to the positive audio reinforcement signal.

A six-point Likert scale was selected to help prevent users from choosing a neutral response while selecting their mental state. At the end of the breathing exercise, and in order to access the effectiveness of our approach and consequent feasibility of the wearable prototype, users are asked if they feel worse, the same, or better than before.

This divergence from the dominant reflective-based mobile approaches is exciting in the mental health domain, as it enables users to perform more manageable tasks seemingly unrelated to their mental state.

3.3 The Wearable Prototype

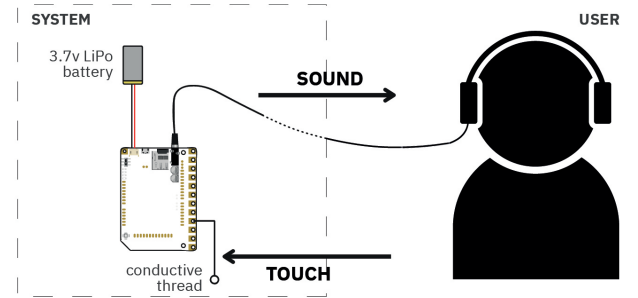


Figure 4: System architecture.

The smart wearable prototype was developed using conductive thread and a touch board by Bare Conductive. The board is connected to a 3.7V Li-Po battery and has a headphone socket, which allows the audio clip to be triggered in the scarf when the user touches its fabric in a repetitive way (Figure 5).

According to informal interviews conducted with therapists during the prototype’s various iterations, this is a promising direction for the design of novel assistive technologies for mental health, since it does not require any sensing and acts almost as a placebo to help individuals cope with stressful situations.

4 EVALUATION AND RESULTS

To assess the user’s perception of the systems, and evaluate the feasibility of our approach, a set of tests were conducted. SCAARF was evaluated in a mobile, everyday life context and throughout

multiple environments, following our institute’s rules and guidelines for designing interventions for individuals with mental health conditions.

To ensure we obtained viable results, participants who displayed higher levels of trait anxiety were chosen to evaluate the prototypes, since they tend to perceive stressful situations to be more dangerous and more threatening than they actually are. They are also more likely to develop General Anxiety Disorder (which is the clinical presentation of trait anxiety).

Since the evaluation process lasted a total of 3 weeks (for each subject), all participants were compensated with a 10€ gift voucher for their time and effort.

4.1 Data Collection

Participants were recruited via a computer-based survey. From 32 individuals who completed the self-evaluation questionnaire, 18 volunteered to test the prototypes. Among the 18 volunteers, the ones who scored higher levels of trait anxiety ($M=49.3$, $SD=8$) were selected, but only 7 (6 females and 1 male, with a mean of 31 years old, $SD=13.2$) signed the informed consent form. The ones who did were given a personal code to test the mobile app.

During 5 days, the mobile app recorded the subject’s state of mind prior and after the breathing exercise, and primed users to associate a previous neutral stimulus — in the form of an audio clip — with a positive unconditioned response, so that the results could be later compared to the use of the wearable.

After testing the mobile app, participants received the SCAARF wearable prototype and were asked to use it once a day, for at least 10 minutes (intervention phase), for the same amount of time. At the end of the three week-long trial, a series of semi-structured interviews with the participants were conducted, in order to assess, among other issues, the usability, comfort and intrusiveness of the prototype, as well as to better understand whether the approach had been actually subliminal — below the threshold of conscious perception — or not.

4.2 Results

The initial evaluation results suggest that the SCAARF mobile app is indeed effective in helping users cope with anxious states. 77.4% of the time, users reported feeling better after the breathing exercise. In the only cases in which this was not true, and the emotional state remained the same, users reported feeling either relaxed or mildly relaxed prior to using the app.

Those findings are in line with participant’s comments at the time they received the wearable prototype, when they stated “focusing on the movement during the breathing exercise made me not think about anything else” and “made me feel calmer afterwards”.

Initial feedback shows that participants are receptive to the idea of using the wearable, considering “it’s already something I would wear in real life” and “something I feel comfortable wearing”. Participants also acknowledged feeling “more relaxed” and “calmer” after wearing the prototype, since “the sound is tranquilizing”.

4.2.1 User Experience. When asked to describe the experience of wearing the scarf in different contexts, all participants stated having used it indoors and alone. While two of them wore it mainly “during the night, whenever I felt overwhelmed” and at home, one of the

participants also used it “at the office, seen that I gravitated towards it at times when I felt more anxious”.

Users described the wearable as easy to use, comfortable, light, soft, satisfying, practical and simple. When asked what they liked best, user 2 said it “was the feeling of comfort the scarf provided”, and “the tactile part [of the scarf], mainly the button part, because it worked as a distraction for me, and helped me calm down” (user 3). Although participants said they would wear the scarf, users 1 and 3 also stated their favorite part of the experience was the breathing exercise since “it made me really focus on what was happening” and “the graphics had calming colors. I also liked that there was an animation to follow and helped me breathe”.

4.2.2 Awareness. When asked how aware they were of the scarf, user 1 said she was mostly unaware “because I was doing other things [while wearing it]”, whereas user 3 said she “was aware, because when I feel anxious I like having something to touch and play with”. Similarly, user 3 reported being “very aware of the scarf when I stopped to use it and focused on it. However, when I wore it while I was at the computer, sometimes I would forget it wasn’t just a normal scarf”.

Regarding participant’s awareness of the sound, they acknowledged having immediately recognized the sound as the same one played after the breathing exercise of the mobile app. Interestingly enough, the user’s perception of the sound was what made them feel more relaxed, seeing that it acted as an immediate reminder to stop and breathe.

5 DISCUSSION

We presented SCAARF, a subtle conditioning approach for anxiety relief facilitation. Our aim was to design a wearable, mobile intervention for mitigating anxiety symptoms, by combining the persuasive power and convenience of mobile applications with a fashionable wearable that can induce better mental states anytime, anywhere. Psychologists provided useful input and positive opinions regarding the suitability of such approach, which can pave new avenues of research in this field. Qualitative results suggest that the SCAARF mobile app and wearable are effective in helping users relax and cope with anxious states of mind.

Even though initial feedback shows that the improvement of mental states after using the wearable prototype is closely related to user’s awareness of the audio clip being the same from the breathing exercise, one might argue that this process is effortless and somewhat subconscious [12], since it instantly reminds users to stop and breathe. However, future work includes a longer-term evaluation with multiple users and contexts (in particular assessing the influence of the audio conditioning on sudden symptoms that can arise at the beginning of an anxiety crisis) against a baseline condition (i.e., the prototype without sound).

The results presented in this paper are encouraging and open up discussion on how mobile ubiquitous multimedia can be explored towards improving human well-being in the context of an ever-increasing number of people who experience anxiety symptoms throughout the entire world.

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