
Into The Sun – A Body Worn Device for Natural Light Therapy

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Abstract

We present a work-in-progress prototype to support the treatment of reoccurring, seasonal depressions using a set of tangible proxy-objects. The system provides reminders that help users to adapt health promoting behavior. Based on findings from the field of chronobiology which indicate a relation between ambient light exposure and an individual's mood, three devices are proposed. By increasing the user's awareness for their individual exposure to natural light, our system could provide the basis for a positive behavioral change. An evaluation of the effectiveness and reception of the system is subject of ongoing work. The fully functional prototypes presented in the following serve as a tool for further studies to reassess our initial assumptions, aimed at developing a means for drug-free treatment of seasonal depressions, as well as to find and support further positive side effects.

Author Keywords

HCI; Physical Interaction Design; Tangible Interaction; Seasonal Affective Disorder; SAD; Light Therapy; Self Awareness; Behavioral Change; Human Factors.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI); Miscellaneous. J.3. Life and medical sciences: Health.

General Terms

Human Factors; Design.

Introduction

During the winter months, roughly four to six percent of the population in central and northern Europe experience a phenomenon known as Seasonal Affective Disorder (SAD), a severe, reoccurring, seasonal depression. A similar but less severe type of depression, called Subsyndromal SAD (SSAD), is even more widespread and experienced intermittently for several weeks during the winter by roughly 13 to 15 percent of the population [7]. Common treatments include various types of prescription drugs, as well as artificial light therapy. The prolonged use of antidepressant drugs is often accompanied by relapse, habituation and other unwanted side effects that can often be more harmful than the depression itself. Further, the medication does not help to prevent recurrence of the depression [12].

Whereas drug-based treatments might help to overcome some of the *symptoms* of a depression, they often fall short in addressing the underlying cause of the perturbation: a lack of exposure to sunlight during the winter months [15],[14]. Common methods for artificial light therapy address this problem, but they usually require the user to passively sit in front of a special light fixture at a defined distance for up to one hour per day. While this approach has proven to be effective for some patients, it is also often perceived as being stigmatizing and even counteracts other factors that have been described as positive influences in overcoming depressions, such as active social interaction and physical exertion and spending time outdoors [8]. In order to be effective, light therapy

appliances are usually designed for ocular reception of the light and must therefore not emit any ultraviolet (UV) light, as prolonged, direct exposure of the retina could be harmful. However, depression is often associated with a deficiency of vitamin D, which is usually linked to a lack of UV-light [6]. A holistic approach to light therapy should take this into consideration. Other factors, such as geographical latitude, social structure and daily routines also have an influence on the occurrence of SAD [11].

Current research [2] has shown that the amount of natural light on an average day during the winter is comparable to that emitted common therapy appliances ranges between 3500 and 20.000 Lux. We have conducted a series of outdoor measurements in Weimar/Germany, over a two months period in November 2012 that showed an average of around 10.000 Lux. Work in the field of Chronobiology [13] indicates that – on an overcast day – a person in central Europe needs to spend roughly 30 to 45 minutes outdoors at midday to absorb the equivalent of light from a 30 minute artificial light therapy session. The necessary timeframe is considerably shorter on cloudless days. The associated physical activity and change of environment are further beneficial in preventing or overcoming SAD. Based on this background it appears worthwhile to investigate how interactive technology could be leveraged to support health-promoting behavioral pattern.

Related Work

A mobile application that helps individuals with depression to structure their daily life has been conceived and evaluated by Løventoft et al. [9]. Their findings suggest that such systems can have a positive

effect on their users. Fahrni et al. [5] created a device that measured the wearer's exposure to harmful solar radiation and conducted a pilot study in different usage scenarios. The use of a visual lifelogging device for analyzing the effect of environmental color on mood has been described by Doherty [3]. Sensor based games for physical motivation have been designed and evaluated by Berkovsky et al. [1]. They have suggested the use of virtual rewards for enhancing real-life motivation. Extensive research on the use of technology as an agent for health related behavioral change has been conducted by Maitland [10]. Her work discusses the role of personal awareness for promoting health and provides an overview of existing approaches from various fields.

Commonly used commercially available solutions for artificial light therapy include the Phillips *Wake-up light* and *Energy light* series of products that are marketed with the promise users to "retain your energy and overcome winter blues."¹

Prototypes

We have designed and built a system to propose an alternative approach to the therapy of SADs. A dedicated device serves as a tangible reminder that could help the user to develop an increased awareness for their individual exposure to natural light during the winter period. Our system – unlike common artificial light therapy appliances – also intends to create the basis for enhanced self-responsibility by providing individual cues for a possible change of behavioral patterns to support the treatment of SAD.

¹ <http://www.philips.ca/c/light-therapy/38684/cat/en/> (Last accessed: March 23rd 2013)

An evaluation of the effectiveness of this approach is subject to ongoing work and will be conducted during the upcoming winter months.

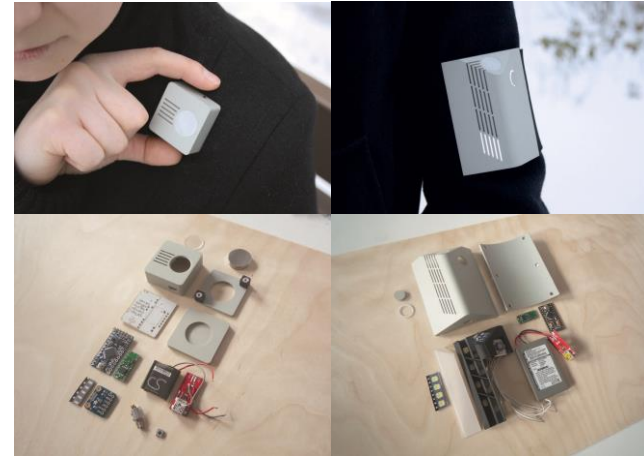


Figure 1: A. badge B. armband

At the time of this writing three fully functional prototypes have been built: two wireless data-loggers (see Figure 1) in alternative form factors: an armband and a badge that are worn above the clothes and one stationary display device. Further evaluation will examine the acceptance of both solutions and their sensing-performance in different contexts. The data-loggers consist of a robust aluminium case, equipped with a calibrated lux-meter and work as dosimeters that record the exposure of the device and its wearer to ambient light. The amount of light received by the dosimeter is displayed by a bar graph display illuminated by five white LEDs. In addition tactile feedback is given through vibration of the device whenever an additional display-segment is activated, to

direct further attention to the device and notify the user of their achievement. The bar-graph display is automatically reset before sunrise to prepare the device for the next day. The optional stationary display works as an augmented clock that shows the current time of the day in relation to the predicted availability of natural light throughout the day. This display can be used optionally to gain additional awareness while being indoors. By indicating a forecast of the most light-intense time-period for going outdoors, the device can be used as an additional aid for planning work-breaks or scheduling outdoor activities during the day.

Initial Observations

Early prototypes were provided to three individuals in December 2012, all suffering from mild to severe symptoms of SAD, to get a first impression of the effect of our proposed solution.

All subjects reported an improvement of their mood after using the system for a period of at least 14 days. They were more motivated to go outdoors in situations when they would normally have stayed indoors. One subject reported that she felt empowered by knowing that she had access to a method that allowed her to deal with the depression actively instead of just passively consuming light from a lamp. All subjects had tried artificial light therapy before and reported that they would prefer the use of the dosimeter badge as it appeared more attractive compared to the "dull" situation of sitting in front of a stationary light therapy appliance. However, the perceived attractiveness of the system and its use over a sustained period of time still need to be determined. Another subject mentioned that the dosimeter badge reminded him that he had not left the house on a given day and thereby served as a call

for action to go outside and "*recharge my personal batteries*", referring to the bar graph display on the device. He found the device helpful in breaking a "*vicious circle*" of depressed inactivity, which caused him to spend much time indoors in a dimly lit room, thereby deteriorating his mood even further, which then caused him to become even more inactive and depressed. Whereas these initial observations cannot be used to derive generalized results, they denote a tendency towards a positive influence on the daily routine and the emotional state of the subjects.

Preliminary Conclusions & Outlook

We have presented a work in progress system aimed at supporting people suffering from SAD. A field study that will be conducted in the upcoming winter months with a larger group of patients suffering from SAD and SSAD will evaluate the overall effect of the proposed solution on subjective emotional wellbeing. This will also include a comparison of our proposed solution in comparison to existing methods for light therapy. Currently, we can only assume that the observed positive effects of using the system can be attributed mainly to an increased consumption of light. A thorough evaluation would require the measurement of the blood levels of hormones such as melatonin and serotonin, as well as the formation of vitamin D in the body, which is beyond the scope of our work. However, the most important measure should be the *perceived* emotional well-being of the user. Further evaluations are subject of ongoing work to determine the effectiveness of our proposed solution and identify supporting factors. Nonetheless, it appears worthwhile to investigate whether the aspired health-promoting effect – a behavioral change based on the user's

awareness of their exposure to natural light – might even be achieved without the need for precise light measurements or by entirely omitting the measurements as long as the credibility of the overall system is preserved. Initial explorations on the implications of user expectations and placebo-effects in interaction design have been made by Dunne & Raby [4] and are subject to ongoing studies by members of our group.

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