MoodLight: Exploring Stress Management through Interactive Ambient Light

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Abstract
Recognized stress management techniques include cultivating mindfulness, breathing exercises, and meditation. While these approaches have been shown to mitigate the negative effects of stress, they can be difficult to learn or consistently apply. To address this challenge, we developed MoodLight, a playful system that uses ambient colored light to provide feedback regarding an individual's current stress levels. In this paper we use MoodLight to frame a discussion of *visual disclosure*, the process by which a representation of an individual's current internal state is made sharable through the visual display of biometric or other low level personal data.

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Stress management, personal informatics, ambient display

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Research has also shown that cultivating a sense of non-judgmental mindfulness of present-moment experience can produce substantial improvements in

Figure 1. Ten hues representing the MoodLight color range, with red at the top of the circle, moving clockwise to orange, yellow, green, white and blue-violet

Figure 2. Personal Input Pod (PiP), an electrodermal activity sensor that uses skin conductivity to measure an individual's experience of arousal

wellbeing for people suffering from pain and distress [1; 4]. Mindfulness, a term with originals in Eastern meditative practice, refers to "clearly perceiving the mental components and associations making up everyday perception and experience" [3]. Although cultivating a greater sense of awareness has been shown to have a positive influence on mental health, many people report finding mindful practices, such as meditation, difficult to learn and apply in daily life [5].

MoodLight is an interactive lighting system that provides an ambient visual representation of an individual's momentary experience of stress or relaxation. Electro-dermal activity (EDA) sensors collect biometric data about an individual's current arousal level; this information is fed into a programmable lighting system; and fluctuations in arousal level are interpreted as changing colored light.

The ambient display of personal information provided by MoodLight presents an opportunity to explore the social implications of sharing information about an internal affective state in an external, visual, and potentially public, format. We refer to this process as *visual disclosure*. This position paper presents preliminary observations regarding the mechanics of visual disclosure revealed through the use of the MoodLight system.

Tracking personal health experiences

From small wearable devices that track physical activity and sleep (such as Fitbit One) to weight trackers (for example, the Withings scale), an increasing number of products are coming to market that provide quantitative data on health-related information. Many of these approaches for tracking personal health have focused on measurement and analytics. Social interactions in and around these tools is primarily provided by online communities where people post their progress, share goals, and earn rewards.

We are interested in challenging the ways in which low-level biometric data is presented as a representation of self, especially when the data being presented has to do something as difficult to quantify as mental health. We are also interested in exploring the ways in which alternative forms of visual display can serve as a vehicle for self-reflection and as a means to start conversations within social support networks about individual experiences of stress.

Design of the system

MoodLight uses the Philips HUE interactive lighting system hardware and API. Three types of LED, produce a relatively wide range of colors and intensities [9]. The MoodLight system has been initially optimized to map to ten discrete hues within this color profile (Figure 1), with transitions moving from magenta-red to blue-violet. EDA readings are collected via a small hand held sensor (Figure 2) and are sent automatically via bluetooth to an Android device, which in turn sends information to the programmable LED lights. This information is used to control the hue of ambient lighting conditions in a room, essentially controlling the output of the lights with input representing the participant's current experience of stress or relaxation (Figure 3). As a person becomes more aroused ("stressed") the lights move towards the red end of the spectrum. As a person becomes less aroused ("relaxed") the lights move towards the blue violet end of the spectrum.

Figure 3. Participants using MoodLight in pairs and singly

Method

A recent design probe explored the ways in MoodLight can support mindfulness practices among college students. Our study included an observational investigation of the ways that participants use the MoodLight system both singly and in pairs. The goal of the design probe was to explore potential tensions and opportunities for future design of the system. Therefore, participants were not asked to complete a specific task, but instead were prompted to playfully engage with the system.

Visual Disclosure

The observational portion of the study highlighted the notion of visual disclosure as an important consideration when designing personal visualization systems.

Negative feedback loops

There are multiple theories regarding the mechanics of color, emotion, culture and physiology [cf. 2; 7; 10]. Further complicating matters, researchers have shown that exposure to light has both *visual* and *biological* effects [6]. This means that in addition to emotional and cognitive effects, there can also be non-visual, biological impacts of being exposed to certain colors or levels of light under different circumstances, for example circadian rhythms, where exposure to light at certain times can impact one's internal biological clock [8].

Negative feedback loops are created when a user picks up the EDA sensors and the lights immediately transition to red. For some, this was very disconcerting and the longer the lights remained red, the more stressed they became, although we had intended for MoodLight to be reflective of a person's momentary experience. Through these feedback loops we discovered that our system not only had the ability to *describe* a person's current condition but also *cause* a shift or change in a person's baseline condition. This becomes especially important to consider when visual displays are large, ambient and embedded in the real world.

Self-representation

When using MoodLight, it was not unusual for users to ask reflective questions that indicated they were pondering the relationship between how they felt and the color displayed by the lights, evident in statements like, *"I thought I was stressed, but I guess I'm actually relaxed"* and *"I guess I've gotten better at not being totally enraged."* Statements like these raise issues regarding the *authority*, *credibility* and *agency* users are willing to give to the system. Because seeing is so closely entangled with believing, how do we ensure that our users fully understand and appreciate the limitations of visual representations which involve varying degrees of data reduction and transformation?

Personalized encodings

As mentioned above, the process of mapping specific colors to an individual's experience of stress or relaxation is complicated by a number of factors. Data collected during our design probe through a series of experiments (designed to identify systematic associations between specific colors and experiences of stress or relaxation) supported findings from previous psychological studies. People tended to associate red with increased levels of arousal and blue-violet with decreased levels of arousal. However, the colors falling between these ends of the spectrum were

characterized by highly idiosyncratic associations. For example, colors such as green and orange had no clearly discernable patterns of correlation with state of arousal.

We recognize that consistent and discernible feedback is important through statements like this: *"When I saw the red lights, I was, like, happy and I thought I was achieving what I wanted to do, so then I could relax and just take a deep breath."* This describes the type of self awareness that we are interested in cultivating. However, we also heard statements like this, with regards to having MoodLight at home: *"I don't want to wear my emotions on my sleeve."* This was mentioned by a number of participants in relation to not wanting to bring their stress or anxiety home to family members or roommates.

Further, while feedback is important for developing the non-judgmental self-awareness on which mindfulness relies, there is a danger in revealing too much, in a too-public way. How can we support both social practices and personal privacy as we create visualizations designed to support engagement and build community?

Conclusion

Our observations of users interacting with MoodLight are helping us to understand the mechanics of disclosure related to the visual presentation of personal health information. We believe that these observations raise important ethical and social issues to be considered in the design of personal information visualizations.

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