Designing calmworklight: Signaling Focus With A Desk Light

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Abstract
While working, we are not always in line with our ability to focus. Being more mindful of own cognitive abilities, including the ability to focus, may contribute to a more pleasant work experience.

This paper presents calmworklight, an initial design proposal for dealing with this issue. calmworklight is a desktop lamp that responds to changes in peoples' focus strength as captured by a commercially available EEG device. The lamp's expression depends solely on the user's level of focus. If it is strong, the lamp returns a steady, calming warm light. If not, the light emission follows a breathing pattern, aiming to encourage the user to be more mindful of their breath and to cultivate a meditative focus. We conducted 3 user studies to get a better understanding of calmworklight's usage and benefits.

The most striking outcome of the study is the worker's need for a regulating system that helps them plan when to socialize and when to focus, which should be considered for future workplace designs.

Author Keywords
Attentive user interfaces; workplace; brain-computer interfaces.

CCS Concepts
•Human-centered computing → User centered design; Participatory design; *Empirical studies in HCI;* User studies;

Introduction
Light designs are in use in many settings, some -that include traffic lights- are used to regulate communication [14] and some guide meditation sequences [13]. Light's non-intrusive nature is a good companion for designing calm technology [11, 12]. Light design is critical for work environments, wherein a large part of the population spends the majority of their daytime [9].



Figure 1: Participants at the Ideation Workshop.

In our explorative research, we strived to investigate how work environments could turn into places better-suited for focusing on the task at hand, while also providing time for socialization, collaboration and inspiration. In an Ideation Workshop, participants designed, discussed and voted for concept designs that set out to support workers' focus ability at work environments. While we decided not to pursue with designing the emerging 17 designs, we extracted 3 design objectives out of them to inform calmworklight's design.

Our research contributes to HCI community in exploring work environments to design more useful work-accompanying objects. Additionally, future work environments should allow for an increased awareness of own ability to focus as well as planning better focus and socialization periods.

Related Work
Attention is treated as a limited resource in designing attentive user interfaces, e.g. by employing biosensors to measure users' attention span and order of priority [10]. Exploring the role of interruptions to attentive work intervals in the workplace, Gloria Mark et al. demonstrated that interruptions lead to "more stress, higher frustration, time pressure and effort" [4]. In another line of research, scholars came up with designs that cultivate a meditative focus, helping their users de-stress and reach a calm cognitive state. Mentionable designs hereof are MoodLight [6] that uses ambient light and skin-based biosensors to measure users' level of arousal. Breathing Light [7] explores how ambient displays monitoring users' breathing patterns can promote somatic experiences and meditation. Lastly, Delight [13] utilizes an ambient lighting environment and heart rate variability-based biosensors to measure users' stress levels.

Meditative focus cultivation has, to our knowledge, not been utilized in an attempt to increase well-being in workplace settings by regulating focus and interruptions.

Ideation Workshop
We decided to organize an Ideation Workshop with designers and office workers to obtain insights about and collectively ideate on designs related to the office workers' capability to focus.

Participants
We conducted the workshop with 11 participants; 4 designers (2 interaction, 2 industrial), 4 office workers, 2 psychologists and 1 architect.

Procedure
We conducted the workshop at an open-plan office. We asked participants to (1) discuss the positive / negative sides of office environments in groups, (2) ideate on concepts to enhance their capability to focus individually by using the provided Concept Design Template, (3) present their own concept and (4) vote for the 3 concepts they favor the most. The workshop, comprising of above 4 tasks with discussions in between, lasted a total of 3 hours.

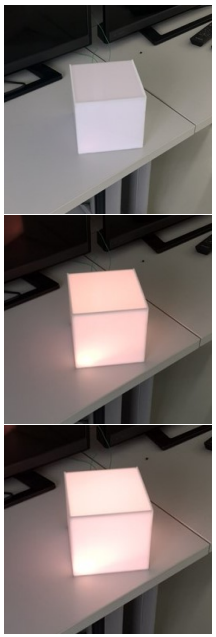


Figure 2: When a user has a weak focus, calmworklight is pulsing from low (1) to a higher (2, 3) light emission.

Outcomes and Analysis
Discussing the positive aspects of workplaces, one group stated that being in the proximity of focused people helped them motivate themselves to try to focus. Another group expressed that the high possibility to interact with and be inspired from neighboring workers is a positive side. Discussing the negative aspects, one group put forth the visual and auditory crowdedness. Further, another group claimed that they found it hard to sustain attention at workplaces.

17 concept designs were conceived during task 2 and 3. One concept titled the "Orange Elephant" summoned the largest number of votes and was appraised the most. Investigating the commonalities between the design objectives, we were able to extract the following:

1. *Signaling availability for conversation by using shared meanings* was a prominent objective in 2 concept designs. One design featured color coding (yellow for "I'm open for chit-chats", green for "I'm open for work-related discussions" and red for "Do not disturb / need to focus on my own"). The other concept design included a palm-sized object (in its designer's words: "for example a small statue of an orange elephant"), available at every desk drawer. Users take the orange elephant out of their drawer and put it on a visible area of their desk to signal their need for peace and quiet in the workplace.

2. *Identifying co-workers' need of a pause from the work and unobtrusively encouraging them to take a break together* is a common objective (as elaborated in the Concept Design Template) of 3 concept designs.

3. *Priming the worker to focus* is the objective of 1 concept design. Following the design presentation, 2 participants described how they change the light setting in an attempt to prime themselves to focus. Another participant explained how they start chewing a gum to make clear to themselves that they need to focus for the task at hand.

Designing calmworklight

We chose the third objective for our first design iteration, as it draws attention to the level of the individual worker, whereas the other two objectives touch upon social communication within co-workers.

We started out by defining a simple physical and temporal form for calmworklight [8], that sought to explore whether workers can be supported in focusing. The minimalist shape of a cube was a deliberate choice to prevent the design from causing unwanted distractions. Further, light is a useful medium in "calm technology" research [12, 11]. Thus, our initial hypothesis follow the logic that a slow pulsating light might function to promote relaxation and guided attention [13] and support the user into concentrating more, while the steady-state encourages sustaining the concentration.

Previous studies further demonstrate light objects' non-intrusive communication abilities [12, 11]. Following this reasoning, we chose to build a desk light-based solution aiming to prime the worker to focus.

Prototype development
Earlier research has proven the Neurosky EEG devices' applicability in interactive experiences where brain data is inputted, e.g. in [3] and [5]. The NeuroSky Mindwave [1], functioned as the technical focal point while designing calmworklight. Processing was used to create the communication between the EEG output (brainwave activity for delta, theta, alpha, and beta waves) from the Neurosky Mindwave headpiece and the computer.



Figure 3: Preliminary user test.

We used the technical setup to listen specifically to the EEG-output 'Attentionlevel', which is an inherent NeuroSky algorithm, ranging from 0 ('strongly lowered') - 100 ('elevated' level of concentration). This output monitors the user's focus and concentration [1]. For the sake of the experiment, we created a threshold-value (50) and a basic function, that parcels a value to the Arduino.IDE program. Further, a simple algorithm with a count limit of the accumulation (50 instances) was created in order to prevent frequent state-switches, that might result in unintended distractions. Value 'x' (under the threshold) initiates a slow light pulsation of the lamp, whereas value 'y' (over the threshold) initiates a steady light-function.

User Study

Participants & Procedure

A total of 3 participants (nicknamed N, H and A) took part in the user tests (35-60 minutes), to evaluate calmworklight's current features. We explained that we study the self-awareness of own focus capability with calmworklight. We asked the participants to act according to their normal working routines during the user test. Afterwards, we conducted semi-structured interviews [2] (20-35 minutes) to understand the users' experience with calmworklight. The interview was structured to gather some initial feedback on *the understandability of calmworklight's different states*, *calmworklight's ability to support the self-awareness on focus abilities* and *desired features for calmworklight*; as summarized in the following.

Results

All 3 participants didn't realize that the lamp had different emission states. This suggests that the lamp isn't communicating its intention clearly. Some participants thought that the lamp was trying to distract, or even entertain them. Further, 2 out of 3 participants showed dissatisfaction with the lamp's monitoring abilities. One participant noted, "I don't like to be encouraged to be self-aware of my own ability to focus". All participants described how the lamp was useful in the beginning, however, distracting in the end. Further, all 3 expressed their wish to be reminded when to take breaks. 2 out of 3 of the participants (A, N) argued that studying made them unnecessarily exhausted, since they did not know when to take breaks. As (N) explains it, "I think I would be more productive when I get back to work (after a timely break)."

These results are in line with the current design iteration's objective of priming the user to focus (keeping in mind that priming is only effective for the beginning of the work session and not throughout accompanying).

Conclusion & Future Work

We tested one of the design objectives, "priming the worker to focus" with our prototype in 3 user studies. Our most interesting finding is the need for a communication regulation system to regulate focus and socialization times based on shared meanings, as highlighted in the three design objectives extracted from the workshop outputs.

We plan to conduct further design iterations and user studies to better understand users' feedback and to further develop the prototype. Especially, we hope to understand whether calmworklight can actively encourage taking breaks through cultivating a meditative focus with the user. Additionally, we hope to explore different light designs as well as visual patterns that are understood naturally and correctly by individuals, as well as within a social context that includes multiple individuals. Last but not least, we hope to work on designs with different selections of biosensors, hardware and software elements to help generalize the idea to be utilized by a wider community.

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