Illuminated Ring – A Wearable Display to Support Fluid Intake

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Abstract
Insufficient drinking remains a widespread problem. Reminder signals help to remind a person to drink, but are often experienced as obtrusive and impractical in everyday life. We designed Illuminated Ring, a wearable display that supports fluid intake in that it displays the time elapsed since the last drink via single point lights. In a user-centered design process, we developed an interactive ring, which we evaluated in an exploratory field study. Initial results show that Illuminated Ring is perceived as an unobtrusive display which can help to drink sufficiently.

1 Introduction

Sufficient liquid consumption is essential to the human body's health. Nutritionists advise to drink up to 2 liters a day (EFSA, 2011), but only few people actually meet their drinking needs. In many cases, making people aware of their drinking behavior can already have a positive effect. As drinking is an everyday task and happens in various situations, a system for making its user aware needs to work properly yet discrete in various situations.

In this work, we propose Illuminated Ring: a display of single point lights discreetly integrated into a ring. Illuminated Ring displays feedback on the user's drinking behavior in an unobtrusive and always accessible way, while being small and pervasive at the same time.

2 Related Work

Ring displays aim to improve everyday tasks by miniaturizing traditional displays to the size of a ring. Smarty Ring[1] displays notifications of a smartphone as illuminated icons on a ring. Ring Clock[2] displays the time by illuminating the corresponding numbers engraved in a ring.

[1] http://smartyring.com

[2] http://www.ringclock.net/

While these indicator displays keep the visualization simple, their discrete visualizations do not resemble the level of a person's fluid intake, which has a progressive character. There are several wearable devices that serve as drinking reminders. Ah!Qua[3] is a fashionable wristband that prompts a user to have a glass of water by gently vibrating. The W+Plus anti-dehydration monitor concept[4] displays a configurable countdown on four ring-mounted seven-segment displays. While these systems tackle the issue of insufficient drinking, none of them supports continuous awareness because they trigger to a designated time and don´t show a progression.

To fill this gap, we propose Illuminated Ring: a light-based wearable display integrated into a ring that unobtrusively supports daily fluid intake.

3 Design

The following section presents the design process of Illuminated Ring. We describe a survey, the implementation of two prototypes, and a user study in which we evaluated the designs.

Survey
In order to reveal the users' needs and expectations, we conducted an online survey in which 53 people took part (Males: 21, Age: from 16, most in range *21–25*). 62% of the participants stated they would like to drink more. Most of the participants were students from Germany and Russia.

54% of the participants opted for a notification interval of 1-2 hours. 15 participants found green and blue LEDs most intuitive. We gave the participants the choice between different design features: The ring could have one or several LEDs on the inner or outer side of the palm. The LEDs could blink, fade or change color. The button to enter a drink could be on the opposite or same side as the LEDs. The participants did not show preference to either of these choices.

Implementation
As there were no clear preferences according to the ring and light design, we built two ring prototypes with four different light designs. We used silver ring blanks that were about 3 mm wide and had a platform of about 1 cm in diameter on top. The triple-LED ring had three blue SMD-LEDs and a button underneath (Fig. 1). The single-LED ring had one 5-mm Duo-LED (blue and green) on the bottom side (Fig. 3) and a button on the top side (Fig. 2). The light designs for the single-LED ring were two blue to green gradients, one in a linear and one in an exponential fashion (Fig. 4 top left and top center). The two light designs for the triple-LED ring were a countdown switching the blue LEDs off one by one and a runlight

[3] http://www.ahqua.at/

[4] http://www.folkwang-uni.de/de/home/hochschule/projekte/vollanzeige/?projektid=176&showdetails=1&%20backlink=268&cHash=e6c0373

orbiting the finger at increasing speed (Fig. 4 top right and bottom). We connected the ring via a flexible cable to a wristband that carried a lithium-polymer battery, a voltage regulator circuit and an Arduino LilyPad microcontroller as they would not have fitted on the ring.

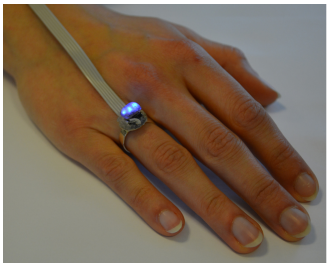

Figure 1: Triple-LED ring with 3 LEDs and a button underneath

Figure 2: Single-LED ring (top side with button)

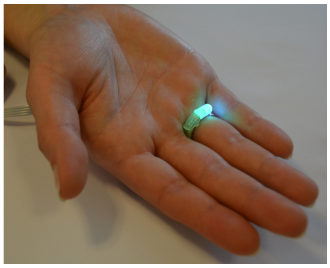

Figure 3: Single-LED ring (bottom side with LED)

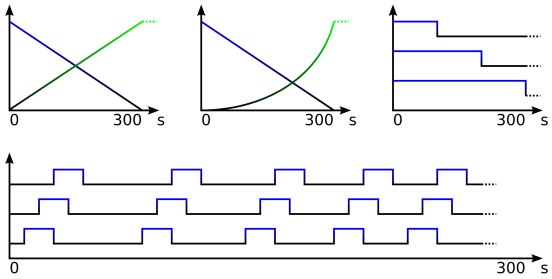

Figure 4: Light designs – line color indicates if LED is on (blue or green) or off (black), ***top row****: blue to green linear, blue to green exponential, countdown****;*** ***bottom row:*** *runlight*

User Study in the Lab

The following section describes the laboratory user study we conducted to find usability issues and to determine which design features our participants preferred.

We programmed the LilyPad so that the four light designs were displayed in random order and for 5 minutes each. Based on the "framework for evaluating ubiquitous computing applications" (Scholtz & Consolvo, 2004), which covers e.g. "Application Robustness" and "Appeal", we prepared interview questions about each light design, each ring and the wristband. The user study was conducted with 6 participants (Males: 5; Age: 21 to 32, M: 26, SD: 3.4). Two study conductors met separately with each participant in a well-lit and quiet room. The participant got handed out an informational sheet, signed a written approval and got verbal introduction. The participant was given the task to build with Lego bricks for 5 minutes while wearing the wristband and the ring which displayed the light designs. This activity should simulate an everyday, manual task. It ensured that the ring moved in the user´s field of view, but hindered the user to focus it for longer than a glance. After 5 minutes, the participant was interviewed. This process was repeated for each ring and light design. At the end the participant could give additional feedback.

The participants were always able to fulfill their task. Most felt that a small ring is suitable to show information on drinking behavior. Many participants wanted to drop the wristband or the ring, forcing all electronics in one component. Single participants criticized the light as being too bright. The triple-LED with the countdown light design was liked most. The LEDs were favored to be on the inner side of the hand and the button to be on the opposite side.

4 Field Study

The following section describes an exploratory field study we conducted to evaluate the practicability of the revised prototype when used in real life situations.

Based on the results of the user study, we built a revised prototype with three blue LEDs facing inward opposing a button. The light design period was set to 90 minutes because that was the preferred drinking interval in the survey. The LEDs' brightness was lowered to 25%. The field study was conducted in Oldenburg, Germany, with 11 participants (Males: 5; Age: 22-83, M: 42, SD: 22), which we gathered from personal circles of acquaintances. When we met the participants at their homes, we introduced the study, handed out an informational sheet and let the participant sign a written consent. Participants were equipped with the revised Illuminated Ring and instructed to use it in their daily life and to push the button once each time they took a drink, which would (re-)start the period of the light design. We then left the participant with the system for a full day and met again for an interview.

The revised prototype was perceived as a suitable display for fluid intake. Although we had lowered the brightness since the initial implementation, it was still subject to criticism. Many participants estimated they drank more when wearing the ring, e.g. a participant said: "Even though I am aware of my drinking behavior, I drank more using the ring."

5 Conclusion

In this paper we presented Illuminated Ring, a light-based wearable display to support fluid intake. In a user-centered design process, we designed two ring prototypes covering alternative designs, evaluated them in a user study and based on the results built a revised prototype. We tested it in an exploratory field study and found it to be a suitable display for fluid intake. Further improvements we would like to make are to lower the brightness further or even adapt the brightness dynamically to ambient lighting conditions. In the next step we want to conduct a field experiment to investigate Illuminated Ring's effect on a user's drinking behavior.

6 References

EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA)(2011). *Scientific opinion on the substantiation of health claims related to water and maintenance of normal physical and cognitive functions.* EFSA Journal 9, 4, 2075.

Scholtz, J., Consolvo S. (2004).*"Toward a framework for evaluating ubiquitous computing applications."*. Pervasive Computing, IEEE 3.2: 82-88