GUIDED BY LIGHTS: STIMULATING PHYSICAL ACTIVITY THROUGH AN ADAPTIVE PERSONAL LIGHT SYSTEM

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Abstract

Increasing physical inactivity and its subsequent health concerns have made promoting healthy and active lifestyles an important endeavour for many governing agencies. In this paper we focus on the influence of the environment to encourage people to move more. As a second iteration of an existing 'Smart Exercise Route', a 1.8 km walking and running path consisting of LED tiles in a public park, we designed a system that supports runners or walkers to set personal goals and gain intrinsic motivation to be physically active. The design focuses on aspects that positively impact motivation and/or performance: personalization, goal setting, and feedback mechanisms. An initial evaluation of a prototype placed in three public parks, showed that participants (N=35) appreciated the personalization of the route and its goal-setting opportunities. While one third of participants indicated the prototype as directly motivating, these positively experienced features are expected to indirectly increase motivation to be more active even further.

Keywords: exercise motivation, physical activity, urban environment

Introduction

Physical inactivity is a major public health concern for many governments. Amongst interventions at the individual or social level, urban planners and policy makers have started reflecting on the design of active urban environments, supported by technology. To increase physical activity and social cohesion, the Slimme Beweegroute (Smart Exercise Route) was installed in Eckart Park in Eindhoven (Netherlands) in 2017. This running and walking route resulted from co-creation sessions with the neighbourhood. It consists of LED tiles on the ground, powered by solar energy. Users can choose one of four preset speeds by stepping on a coloured tile. The LEDs will light up sequentially, matching the selected speed. The system aims to motivate people to keep their pace and exercise frequently.

Interviews with municipality representatives and citizens showed that the route has had technical issues from the start, which led to a bad reputation and low usage rate. The main issue identified when the route was functioning were the fixed speeds, not matching the user's desired pace. Interviewees also indicated the LEDs were hardly visible and some had trouble understanding how the route works, despite the information board.

We thus researched how this route could be improved to stimulate the motivation of people to run or walk in a park, focussing on making the light system adaptive and personalized. This paper provides insights in how an intervention in the environment can influence people's behaviour and stimulate them to be more physically active.

Related Work

Urban environments have the potential to strongly contribute to physical activity through their design (Sallis et al. 2016), especially with possibilities of evolving and increasingly integrated technology continuously adding new opportunities (Stephanidis et al. 2019). Technology also enables new and enhanced ways for tailored design and personalization, which are typically more impactful in design for motivation and sustained behavioural change than universal designs (op den Akker, Jones and Hermens 2014).

The research presented in this paper explores the value of a more interactive and personalized running experience. There is ample research available on personalization through interactive technology in the Human Computer Interaction (HCI) community (Stephanidis et al. 2019), that argue personalization plays an instrumental role in motivation (Sebire, Standage and Vansteenkiste 2009). Here, we position our work in research that relates specifically to physical activity and running.

Looking into enhancing advanced amateur runner's experience, Knaving et al. (2015) proposed design guidelines for future runner support technology. These include the importance of allowing runners to define personal and social goals to strengthen internal motivation. Regarding feedback, they urge designers to use non-intrusive interfaces that minimize distraction during a run.

Enhancing interest for an activity, goal setting can increase motivation, especially when the motivation is intrinsic (Sebire, Standage and Vansteenkiste 2009). The strategy of goal setting was used by another interactive running route, located in Oosterpark, Amsterdam. Bluetooth beacons with a connected app tracked a runner's speed and position. Messages via the app suggested exercises, goals, to the users (Dallinga. et al. 2016). These goals, however, are set by a system, while autonomously set goals result in better performance (Sebire, Standage and Vansteenkiste 2009).

Reflection on goals creates more awareness, helping to set the right goals and improve skills and motivation (Lee et al. 2015). Additionally, allowing goal progress monitoring promotes behaviour change (Harkin et al. 2016). GoalLine and GoalPost

are research probes used to investigate physical activity motivation using goal setting, rewards, self-monitoring, and sharing (Munson and Consolvo 2012). Using primary and secondary goal setting resulted in increased motivation of participants. However, the reward system and sharing feature relied on extrinsic motivation and did not have the desired effect.

To measure achievements and recognize reached goals, system feedback is important. During a run, haptic and visual feedback by light could motivate people to persist (Wozniak et al. 2015). The interaction can become more effective when varied feedback is used (Arroyo, Bonanni and Valkanova 2012).

Feedback systems for runners should provide simple visual output, being more effective than auditory feedback and requiring little cognitive effort during a run (Wozniak et al. 2015). Providing visual feedback for self-monitoring through an app is effective for increasing physical activity (Murray et al. 2017). However, while smartwatches and smartphones can present large amounts of data, these interfaces are not optimal for in-run feedback (Colley et al. 2018). Exploring other ways of presenting data, they developed a shoe that gives feedback on running pace through light signals. Similarly, the interactive shoe Pediluma lights up when walking as immediate positive feedback (Lim et al. 2011). It had a positive effect on the step count, yet users felt uncomfortable with the light at night and preferred a goal-reward system.

For our design, we build on the successes and recommendations of this previous work to create a lighted path that motivates people to be more active.

The Design

To research the influence of personalization of the designed route, we created a prototype of the new light route, including an improved and brighter light system and a shorter distance between the lights. The system is now tailored to each user; aware of his/her pace and lighting up accordingly. Additionally, this lets users track their progress and set goals.

The prototype-setup is 55 metres long. The user's speed is measured within the first five metres. After another five metres, a LED matrix displays their speed, allowing personal goal setting and progress tracking. The display turns off when the pace reaches the first light. From here, five poles with LEDs are placed every ten metres. These lights guide the journey of the user and provide feedback every ten metres. The lights turn on when the user should be next to it, based on their speed in the measuring section. The LEDs are red, as this colour showed to be most visible in contrast to the green park and was seen the brightest in sunlight.

Figure 1: System Setup

Method

As inspiration for this research we used the Experiential Design Landscapes approach, were design propositions are placed in people's everyday lives. Using sensors and smart technology, their experiences and behaviours are captured and analysed, identifying patterns and creating new design opportunities (Peeters et al. 2013).

Pilot Study

Eighteen interviews were conducted with park visitors, to understand their mindset regarding exercising and running in this environment. Questions about the current light route were included to investigate people's pre-existing knowledge about the route and if they used it.

Research Setup

After the pilot interviews, two observation studies of 3.5 hours each took place in Eckart Park and Stadswandelpark. A third experiment took place on the Eindhoven University campus.

The goal of the first observation studies was to observe if park visitors would spontaneously use the system and how they interact with it. Researchers observed from a distance without interacting with participants. Users that adapted their pace (N=2) also filled out subscales of the User Experience Questionnaire (UEQ) (Rauschenberger et al. 2013) related to attractiveness, perspicuity, stimulation and novelty of the system.

The third experiment was focused on motivation for physical activity and the design's appearance. Twelve participants, all students (18-25 years old) and unfamiliar with the smart exercise route, were given information on the original route and the design before filling in part of the Physical Activity and Leisure Motivation Scale (PALMS) questionnaire to measure their motivation for physical activity (Zach et al. 2012). Only the physical and individual subscales were used. Next, participants were asked to use the course at their preferred pace. Observations were made on pace and attention paid to the display and lights. After the test, participants filled out the UEQ subscales. Open questions were added to better understand participants' replies.

Results

During the first observations 23 people passed the testing area. Eight of them (34%) interacted with the adaptive light route and only two (9%) adapted their pace to the route. Mostly young people (up to ca. 20 years old) interacted with the route. Observation showed that the novelty of the setup at the second location did not significantly influence the results.

The UEQ shows that although the design is not perceived as very novel or innovative (Novelty subscale: M= 0.6; SD= 1.4), respondents found it attractive (M= 1.1; SD= 1.2) and somewhat stimulating (M= 0.9; SD= 1.3). The design scores highest on perspicuity (M= 1.4; SD= 1.6), meaning it is understandable and easy to use.

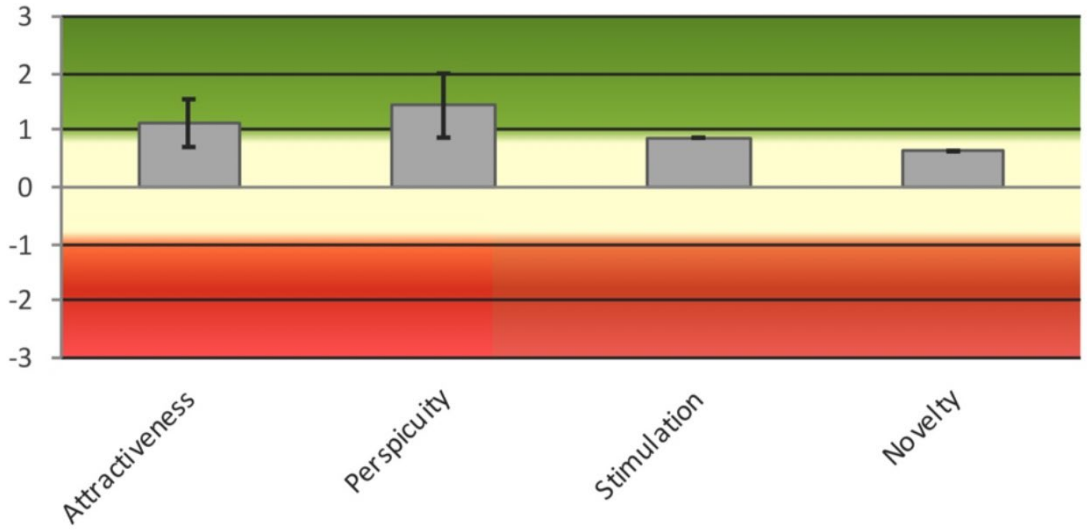

Figure 2: UEQ Scales (Mean and S.D.)

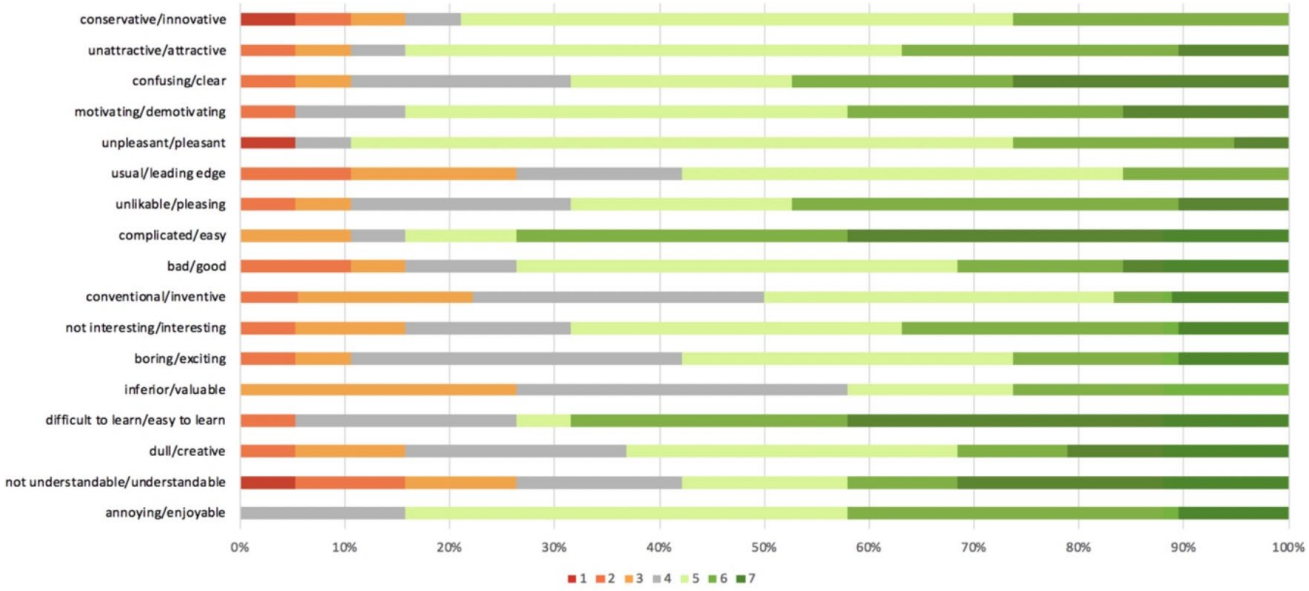

Figure 3: UEQ Answer distribution per item

Regarding motivation, responses to the open questions (N=12) can be sorted into three categories. Two participants did not find the route motivating at all: 'I'm not a running fan, design could be more innovative or fun' (participant 1). Five participants found it potentially motivating but were not sure based on this test: 'I can imagine the whole route can be motivating. The user test was such a small part that I find it hard to say anything about this' (participant 12). Five others found the route motivating and positively experienced the personalization of speed: 'nice to complete a milestone with each light' (participant 2).

People found the best time to encounter the route would be when walking, running or playing sports, especially in the evening. The most mentioned motivations to use the system were to improve oneself and using the lights for guidance during so there's no need to think about directions. Main points of feedback were the length of the prototype route and the visibility of the lights. Suggestions were given to provide more information at the start of the route, to make the design more remarkable and to further personalize the route with colours; people indicated that controlling the light colour or pattern would make them feel more connected to the system.

Discussion

Motivating people to become more active is a complex challenge, because motivational factors differ per person. Other influencing factors are uncontrollable, such as the weather. For our design, we focus on personalization, goal setting, visibility and understandability.

Personalization

In line with the literature review, the main reason for the increased motivation was the personalization of the route. However, the 55m of prototype setup was not long enough for all participants to form a clear opinion about the effect of the system on a longer circuit. Observations also showed that five metres are not enough to measure the user's speed. People did not have a constant pace, resulting in many participants not finishing alongside the light indication.

Goal setting

The related work showed that goal setting and appealing to intrinsic motivation, can increase motivation to be active, while not being forced to do so. The new system depends on the user's memory and willingness to improve their speed. Yet, some people indicated they may still need an extra push to exercise.

Because of the small sample size, generalization of this research is less reliable. While being the target users, people living near Eckart Park were already familiar with the original light route. This possibly influenced their opinion or interaction with the design during the first experiment. To get a more objective view on the project, another observation was done at the Stadswandelpark, where the visitors and participants largely represented the target users. All participants in the experiment on university campus were 18-25 years old. Even though these ages are part of the target group, this group does not fully represent the residents of the neighbourhood.

Because of ethical regulations, a sign informed people that anonymous data would be collected if they proceeded along the route. This clearly influenced the results, as people intentionally avoided the area and were less inclined to interact with the design.

While we conclude that personalization creates more motivation for people to run/walk, this does not yet show a direct relation between increased motivation and actually using the route.

Visibility

The design was enhanced to improve visibility of the LEDs and, based on conclusions from related work, also give them more meaning for the user. Observations showed that the new system was noticed more in the park setting and drew the attention of people passing-by. However, they were not always visible in bright sunlight, making the user test inconclusive for some participants.

Understandability

Despite a positive score for the system's understandability on the UEQ, it is not clear from these results to what extent this only lowers the threshold for using the design or actually affects the motivation for physical activity.

Conclusion

To increase people's motivation to run or walk more through design, multiple aspects need to be taken into consideration. The personalization of the route; adjusting to the user's speed, is experienced as more pleasant and creates a connection with the design. It also provides the opportunity to set and check personal goals. Additionally, the Guided by Lights design is more visible than the original system and efforts have been made to make it more self-explanatory and understandable. When designing for behaviour change, this combination of personalization, goal setting, visibility and understandability is essential for any similar

system to boost motivation and physical activity.

Future Work

To improve the personalized running route concept, further research needs to show the effects of a longer route and the impact of repeated speed measurements along the track. A next iteration of the design should be longer to test the effect more thoroughly. A longer run-up and speed measuring in multiple places can help staying connected to the user's pace and allow for personal training variations. Brighter lights or colour patterns can increase visibility. Next to that, patterns or a connected app could enable further personalization or a playful element in the route, motivating people to use the lights in a new way. Additional studies can also help to determine in which stage of a run this design is most effective. These iterations would create a better connection to the user, providing new and improved ways to motivate people to walk or run.

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