Sitting in the Same Boat: A Case Study of a Combined Awareness System and Behaviour Change Technology

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ABSTRACT
For several years, efforts have been taken to create systems for mediating a feeling of connectedness and affective awareness among separated family members or friends. At the same time research has been carried out on designing technology to foster behaviour change, especially to increase physical activity. Numerous works on behaviour change, both in academia and in the industry, draw strongly on motivating by utilizing interpersonal relationships. However, within this research social relationships are employed *as a means of* accomplishing positive behaviour. In this paper, we aim at designing a system for supporting *both* affective awareness *and* behaviour change *with equal emphasis*. We argue that such a system can benefit from the synergetic effects between both research concerns. Our prototype application demonstrates the concept, establishing connectedness through the shared experience of positive behaviour change (in our case study increased physical activity), enabled by both mutual motivation and a *reverse rewarding* strategy.

Author Keywords
Awareness system, lightweight communication, behaviour change, persuasive technology, physical activity, television, playful elements, mutual motivation, reverse rewarding, reciprocity.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Staying in touch with family and friends is not always a trivial matter in our here-today-gone-tomorrow society. Too much work, a general lack of time and long distances can eat up social relationships leaving people separated from the ones they care about. On these grounds researchers in HCI and CSCW have been working on developing awareness systems for several years now (Hassenzahl et al., 2012). Such awareness systems employed communication technology to foster social relationships between remote family members and friends by establishing a feeling of connectedness and helping people to stay in touch.

At the same time, modern fast-pacing living conditions often hinder people in fulfilling plans and good intentions concerning physical activity. In societies around the world people are less and less involved in physical exercise. Consequently, more and more people deal with obesity, which not only is a considerable problem for the person, but for the society in general (Lakdawalla & Philipson, 2009). In recent years, the HCI community and the industry have taken efforts to deal with that challenge by designing technology for supporting motivation and behaviour change such as "activity trackers" and the like (Hekler, Klasnja, Froehlich, & Buman, 2013). Many of these works draw on or investigate motivation by involving interpersonal relationships or social influence, for example (Mueller, O'Brien, & Thorogood, 2007; Parker, 2014; Zuckerman & Gal-Oz, 2014). It is noticeable that enabling social exchange is a core concern of *both* awareness systems *and* behaviour change technology.

In this paper, we examine the intersection between these two research strands and their commonalities. We raise questions about what behaviour change can learn or adopt from successful awareness systems, and vice versa. Is it possible to enhance friendship *and* support change for a better behaviour at the same time, now that everyone is so busy? And, can both approaches mutually strengthen each other? We argue for the worthiness of combining both research areas and propose chances for creating strong *synergetic effects*. To investigate this concept, the present work contributes an exploratory case study for gathering an initial primarily qualitative description of how such a system can 'fit into the life' of potential users. We do not aim at generalizing to populations since this is case study research (Baskarada, 2014). Instead, we contribute 'anecdotal evidence' to motivate extending the initial prototype and further empirical studies.

The paper is organized as follows. First, the terminology and technology for affective awareness/awareness systems and behaviour change is clarified on the basis of related research. Second, the intersection between both research areas is examined. Third, a pilot application is introduced that aims at motivating for more physical activity *as well as* establishing awareness between distant living friends. Finally, suggestions and opportunities for further research investigations are proposed.

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RELATED WORK AND DEFINITIONS

Awareness systems in personal settings constitute computer mediated communication systems that allow people to maintain awareness about each other's activities. The communication itself was described as being lightweight, emotional, informal and at low effort (Markopoulos et al., 2004). Thus, affective awareness systems (cf. also *ambient displays*) are in contrast to more traditional forms of communication that aim at the explicit exchange of messages and data. Liechti and Ichikawa (2000, p. 13) introduced the notion *affective awareness* and defined it as "a general sense of being close to one's family and friends". Another term used in this context is *connectedness*, defined as a "positive emotional appraisal, characterized by a feeling of staying in touch within on-going social relationships" (Romero et al., 2007, p. 303).

Computer mediated awareness in a home setting has been studied extensively and widely. For example, Lindley (2012) explored the usage of a message device for supporting cross-generational communication. Octavia, Hoven, and Mondt (2007), on the other hand, conducted an exploratory study to better understand strategies of people living separately to stay in touch. A renowned study by Mynatt, Rowan, Craighill, and Jacobs (2001) captured physical activity of smart-home residents with sensors and visualized the data in an abstract fashion. The visualization was sent to a digital photography frame located at the homes of the distant family members.

Technology to support behaviour change: Fogg (2002) coined the term *captology* for technology that persuades the user to adopt a desired behaviour. In many studies this behaviour was increased physical exercise (Consolvo, Everitt, Smith, & Landay, 2006; Consolvo et al., 2008; Lin, Mamykina, Lindtner, Delajoux, & Strub, 2006; Maitland et al., 2006). In line with these efforts, the notion of *personal informatics* was coined by Li, Dey and Forlizzi (2010).

Technologies for behaviour change such as outlined above draw strongly on theories from psychology. Persuasive systems have employed classical behaviour theories such as the *Transtheoretical Model*, *Goal Setting Theory*, and *Social Cognitive Theory*. In HCI, Consolvo, McDonald and Landay (2009) and Hekler et al. (2013) have compiled a good overview on these topics.

COMBINING TECHNOLOGIES FOR AWARENESS AND BEHAVIOUR CHANGE – DESIGN RATIONALE

In this section, we identify and describe conspicuous *intersections* between systems for affective awareness and behaviour change. Consequently, due to their commonalities we will argue for designing for both target areas at the same time. Taking a look at the strengths of each domain might offer an opportunity for creating strong *synergic effects*. It is apparent that social relationships play a crucial role in both awareness systems and behaviour change. This leads to the following question: If we can design appropriate shared experiences and mediate them by appropriate communication channels, will it increase a desirable behaviour, and conversely create a positive effect of affective awareness? We go on to discuss this question as exemplified in our own prototype, explaining our ideas and assumptions in more detail.

Social relationships and social influence: the aim of awareness systems is promoting social relationships. However, many persuasive or behaviour change applications also place great reliance upon interpersonal relationships and social influence (Chiu et al., 2009; Consolvo et al., 2006; Consolvo, McDonald, & Landay, 2009; Lin et al., 2006; Maitland et al., 2006). In particular, it is argued that activity tracking for leveraging behaviour change can benefit from *social* and *collaborative* components (Rooksby et al., 2014). Mueller, O'Brien, and Thorogood (2007), for example, created a jogging application that allowed runners to exercise together mediated by spatialised audio, although they were separated by distance. Zuckerman and Gal-Oz (2014) implemented a social comparison component in their jogging app and found that this was as efficient as visualizing or quantifying progress. Therefore, the motivating force in our own prototype will draw on social influence.

Shared experiences have been reported to play a leading role for awareness systems in establishing a feeling of connectedness. Affective awareness appears to work best when people are engaged in shared experiences (Liechti & Ichikawa, 2000), as those events 'act like glue' in friendships (Octavia et al., 2007, p. 81). Sharing experiences can also be used as a major strategy in connecting separate living families (Ballagas et al., 2010; Markopoulos et al., 2004). We suggest taking those findings on by making *positive behaviour change* the *shared experience* and hence establish a strong bonding between awareness and behaviour change system.

Lightweight exchange of messages is another important component of awareness systems for sharing experiences and for fostering social connectedness. The importance of this component has been described by various authors, and it is part of several multi-participant persuasive applications such as *Playful Bottle* that let users send social reminders to their friends (Chiu et al., 2009). *Houston* (Consolvo et al., 2006) featured a commenting component allowing social influence. The authors of *Shakra* observed that "merely the knowledge that others can detect (track) one's activity (…) makes one more active" (Maitland et al., 2006, p. 7). We therefore implemented a lightweight messaging component for our prototype incorporating a chat module and an ambient lamp (see next section).

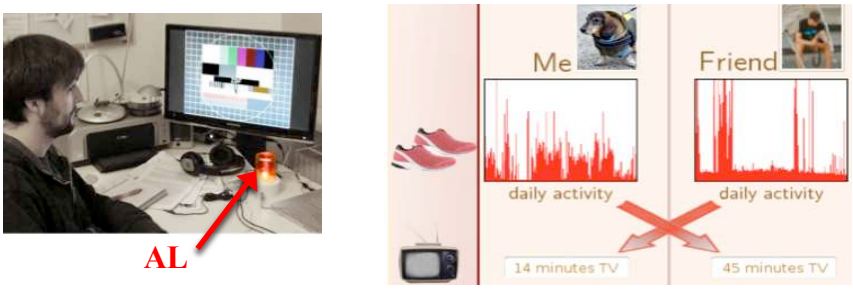

Figure 1. Left: P1 sitting in front of TV (home PC with TV tuner) with ambient lamp placed below the screen (marked by red arrow AL). Right: Detail of the application's web interface. Users can review each other's physical activity and check their television rewards. The crossed arrows indicate that participants mutually accumulated TV minutes.

Visualization of behaviour: Awareness systems as well as technologies for behaviour change deal with behaviour data visualization. Consolvo et al. (2006) found that participants of the *Houston* study valued the trending information of physical activity. The *Digital Family Portrait* system displayed a history of past behaviours on a digital picture frame. The frame of this renowned affective awareness application was populated with small icons representing current as well as past conditions of a portrayed person (Mynatt et al., 2001). As in this example, behaviour data is often represented in an abstract fashion. This applies to both awareness and behaviour change systems. *Ubifit*, for example, employed a metaphoric blooming garden to visualize agile physical activity (Consolvo et al., 2008; Consolvo et al., 2009). *Fish 'n' Steps* let the number of fish in a *virtual* tank correspond to the step count of study participants (Lin et al., 2006). Accordingly, we suggest an abstract data visualization for designing combined connectedness and behaviour change systems. In visualizing, temporal course can be motivating (Lin et al., 2006) as it might help to establish a more intense awareness of the daily routine of a person. (However, at the same time the users' privacy should be taken into account.) Summarizing, an ambient device can be a strategy in terms of affective awareness as well as motivation (Consolvo et al., 2009; Consolvo et al., 2008; Mynatt et al., 2001). Thus, our prototype made use of abstract graphs, and we also offered an additional ambient mood lamp to the participants to support the lightweight exchange of messages in form of colour-coded 'moods' at the periphery of attention (Bakker, van den Hoven, & Eggen, 2015). Similar mood lamps have been successfully used before in HCI research to convey emotional states, for example (Balaam, Fitzpatrick, Good, & Luckin, 2010).

Playful elements: A variety of awareness and motivation technologies as well as applications for behaviour change were games or consisted of game-like elements. Other applications employed playful metaphors and fun elements for motivation (Chiu et al., 2009; Consolvo et al., 2008; Consolvo et al., 2009; Lin et al., 2006). Awareness systems also requested users to play with each other (Ballagas et al., 2010) or display information in humorous or amusing ways (Gaver, 2002; Mynatt et al., 2001). Shared experiences make people feel close to each other, especially when their experiences are associated with positive emotions (Liechti & Ichikawa, 2000, p. 13). We hence decided that our prototype should utilize playful elements to motivate users to continue practicing and to support the users mutual awareness.

EXPLORATORY PILOT STUDY

The proposed prototype was designed to support behaviour change *as well as* affective awareness considering the commonalties identified in the last section. The case study was conducted to gather initial feedback on our considerations and design decisions. In this context, we were also interested in how the concept of joining awareness and behaviour change assisted users to achieve a self-defined goal (e.g., exercising more).

Description of our exploratory application

Due to the application's aim to increase a users' physical fitness *and* to connect two separately living friends, exercising (physical fitness) was made the reason for users to get in touch (social connectedness).

Our application employed a reward stimulus for motivating physical activity: the users had to earn their privilege to watch TV similar to *Telecycle* (Fogg, 2002). Allocated footsteps paid off in minutes of allowed TV consumption. In order to preserve the playful and fun character of the application time measurements were not enforced or controlled. A special feature of the application was that users (in test condition 2) did not work for their own 'TV time account'; in contrast, they accumulated TV minutes for their distant friend. This can be considered as a playful *reverse rewarding* strategy and might also lead to interesting interactions or a strengthened social connection. Figuratively speaking, both participants were *sitting in the same boat*. In addition, users could post comments or set the mood lamp to a certain colour to express their approval / disapproval of their friends' performances. Ambient coloured light has proven useful for emotional expression before (Balaam et al., 2010), and made information or signals subtly accessible.

Technically, every user had access to a personalized web page (Figure 1 right) allowing her to review behaviour data, exchange text messages and to control the other's ambient mood lamp (Figure 1 left). Physical activity was tracked with a pedometer and was made accessible on the web application updating every night at 8:15 pm. The pedometer samplings were visualized as an abstract representation of a user's physical activity over a given time period (Figure 1 right). The resolution of the visualization was fine enough to establish awareness by

conveying information about a user's daily routine and coarse enough to protect a user's privacy.

CASE STUDY SETUP AND FINDINGS

Methods. For the exploratory case study we recruited two participants (one female, one male) with the characteristics of the intended target group of the system: separate living friends (divided by distance) in their 20s 30s with an affinity to self-tracking technologies and willingness to exercise more. They participated in a first test run lasting 8 days to study how they would interact with the system in their natural context. We also established two test conditions in order to get initial feedback on different reward strategies. Condition 1 was a four-day trail during which participants accumulated their own minutes for TV consumption. More physical activity resulted in more minutes of TV consumption for oneself. Condition 2 was also a four-day trail, but it employed the strategy of *reverse rewarding* mentioned above. In this condition participants 'worked out' for their distant friend's TV consumption.

To count the steps, commercial pedometers were employed and the data was sent to a server. Every night at 8:15 pm the amount of TV reward was calculated on the basis of the number of steps and published on the web interface (Figure 1 right). The usage of the mood lamp was logged on the server as well. After the study, the server data was reviewed and assessed manually. Additionally, semi-structured interviews were conducted after the last day of the trial and subsequently analysed for salient comments and themes in the feedback.

Findings

Behaviour change: although the short duration of the study does not allow for investigating changes in behaviour, there was evidence of *synergy* between awareness and motivation. Condition 2 (*reverse rewarding*) showed slightly more physical activity for both participants. The rewarded minutes for days 1 to 8 for each participant are shown in Table 1. (Note: the values of days 5-8 have been swapped between participants due to the *reverse rewarding strategy*).

	1	2	3	4	5	6	7	8
P1	29	25	23	23	14	62	72	83
P2	50	21	77	76	34	66	53	53

Table 1. Rewarded minutes of TV. Condition 1: Days 1 to 4. Condition 2: Days 5 to 8. *(Reverse rewarding* is indicated by different colours/shades of grey.)

Rewards and reciprocity: the chat logs indicated social engagement and encouragement such as in this quote: *"What? Only 14mins TV for me? Please remember my favourite episode tomorrow"* (P1). Such a statement can be considered as a custom tailored motivation message, which was suggested to be a beneficial strategy for health behaviour change (Chua et al., 2011). Another social-motivational issue was expressed by P2: *"Sometimes I am more motivated doing something for a friend than for me"*. Furthermore, the participants reported that they felt motivated to exercise and to act responsible, because they didn't want to "spoil" the evening for the other participant: *"It would have felt very bad if he earned me enough TV time at the end of the day, while at the same time I let him down"* (P2).

Social awareness: reverse rewarding was the preferred mode since in this condition connectedness was established by the other's physical activity in addition to the web interface and the ambient lamp. P2 described it as *"you could feel the friend, because he was literally shaping the day by influencing the TV program"*. This corresponds with P1, who enjoyed both rewarding strategies, however, liked condition 2 even better, due to its more "suspenseful" and motivating character. The reaction towards the ambient lamp was positive, as "it expresses one's feelings on site at the friend's house" (P1). Still, the lamp was not considered the most important component of the prototype and P2 suggested that it could also be replaced or complemented by *"some mobile phone app or background widget"*.

In summary, the participants enjoyed both rewarding strategies, however, both preferred condition 2, due to its "suspenseful", connecting and motivating setup. P2 enjoyed the system that much that she would like to continue and would even pay for her own equipment. She was thankful for the study or application as *"it was a chance to revitalize our [the participants'] friendship"*.

LIMITATIONS AND FUTURE WORK

This paper constitutes an initial investigation of the *intersection* between awareness systems and behaviour change technology. As it is an initial exploratory case study, the findings cannot be generalized, however, provide promising qualitative indications that the system can be useful for the target group. For future work, it is crucial to refine the prototype and to run controlled experiments with a larger number of participants and to create design guidelines so that the resulting system can move beyond just 'tracking activity and then posting this' to get encouraged by friends (such a guideline could, for example, recommend *reverse rewarding*). Summarizing, in this paper, our contribution is two-fold: (1) We identified and elaborated similarities and intersections between behaviour change technologies and awareness systems. (2) We contributed an exemplary application that combined both areas and collected data from a pilot to draw out its use in a natural setting.

When designing similar new applications the targeted behaviour change doesn't have to be restricted to physical activity. Mutual monitoring and reverse rewarding could also support medication intake, quitting cigarettes (*Lover's cups* by Chung, Lee, & Selker, 2006) and other important daily routines. Encouraged by the positive feedback of the case study, we will refine the prototype and investigate the different reward strategies of our application in a long-term study to address questions as such: Is it more motivating to keep things up for another person (*reverse rewarding*) or for one self? Are we more engaged in fulfilling duties, when we want to do favours to others or when we want to avoid being admonished? Do we fear social disapproval? Should rewards be assigned by the distant friend or automatically?

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