
Empowering people to test their own quantifiable hypotheses with pervasive displays

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Abstract

Lifestyle diseases may result from inappropriate personal behavior such as poor diet, smoking, alcohol and other drugs, or lack of exercise. Modifying behavior may be all that is necessary to prevent the disease. We believe that pervasive logging and awareness interfaces can be useful for maintaining long term efforts to modify behavior and enhance health by enabling people to evaluate personal quantified hypotheses. We aim to explore which classes of interfaces are most effective for this.

Author Keywords

long-term health and well-being; personal hypothesis; pervasive; diet; nutrition; persuasive.

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction

The growth of so-called life-style diseases in western society is related to diet and physical activity. The changes that have occurred with industrialization and market globalization have led to inappropriate patterns of diet, reduced physical activity and a corresponding

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A personal quantified hypotheses in the form of:

if quantifiable behavior A,
then quantifiable result B.

For example:

if I eat 5 serves of vegetables a day (A),
then I will lose weight (B).

if I get an encouraging text message every day (A),
then I will lose weight (B).

increase in chronic diseases [13]. Examples of negative diet patterns are inadequate intake of vegetables and fruit, over consumption of sugar-sweetened beverages and high-fat foods [8].

Our approach to these long term health challenges is to enable people to formulate and test personal hypotheses. Our definition of a personal hypothesis is an individual's belief about the ways their actions affect their lives. Providing access to pervasive touch screen interfaces helps people to log and see the information about the status of their personal hypotheses. We believe this will lead to a change behavior toward their goals for health and diet. We use the notion of means and end-goals to define a personal hypothesis. For example, a person might believe that if they can see and log their intake of fruit each day (means-goal), this will improve their health (end-goal).

We aim to enable people to evaluate personal quantified hypotheses (see side bar). Ideally, we should be able to measure A and B in a *convenient* and *unobtrusive* manner. Currently it is difficult to achieve this for many behaviours. For example, food intake requires considerable effort for people to record. We aim to address this using pervasive displays embedded in homes to readily capture this type of data. In our experimental system we capture data such as the number of serves of vegetables consumed by logging this on a small dedicated touch screen mounted on the bathroom wall near the toothbrush. The location of these displays is important. Mounting it in a location that is visited at a regular time makes it more likely that the user will notice and interact with it.

Our scenario is about Alice, a person whose goal is to change to a healthier lifestyle by eating enough fruit each day. She wants to use a device in her bathroom near her toothbrush and a similar one on her desk in her office. The number of serves she had eaten each day will be displayed on the device, and she will be able to log the amount of fruit intake, when she eats some fruit.

Related Work

There is a body of work on awareness systems for behavior change for health. For example mobile phone text messaging has been used in studies such as [2, 4, 11, 12] for medication, prevention of disease and health behavior change. There are also many mobile applications, websites and devices which have been developed to help people maintain and change their behavior. These studies showed that just reminding people, for example with a SMS, help a lot in achieving their goals.

Moreover, pervasive awareness interfaces, such as calm and ambient displays have been used for influencing people to make positive behavior changes. These interfaces are capable of bringing previously inaccessible information to one's attention. The presented knowledge can be interpreted with just a glance. Breakaway [5] is an example of such an ambient display designed to encourage people who sit for long periods of time, to take breaks more frequently. It is a sensor-driven ambient sculpture which gets information from the user's chair and suggests when the user needs to take a break. Breakaway's four original design goals are abstraction, non-intrusiveness, public, and aesthetic. Its initial



Figure 1. Pervasive touch interface mounted on bathroom wall. (Implemented using a low-cost smart phone)

evaluation showed positive changes in behaviour of the users.

Consolvo et al. [3] propose design strategies for persuasive technologies that help people to change their lifestyle behaviour. They argue designing such technologies is complex and need a set of strategies. They started with the four strategies considered in Breakaway and come up with the set of eight strategies: 1) abstract and reflective, 2) unobtrusive, 3) public, 4) aesthetic, 5) positive, 6) controllable, 7) trending/historical, and 8) comprehensive. They also validated these strategies in their field studies and noted that these strategies are not meant to be mutually exclusive and can overlap at times.

Clinicians and researchers in health use techniques such as food diaries [9, 10] to understand what people are eating and measure their food intake. It has been shown that mobile digital diaries are more helpful to observe and self-reflect on eating habits, as it is easily accessible and can show the amount of foods consumed.

The quality of food intake can be measured by the amount and types of food eaten. There have been a number of scoring systems [6] to calculate the quality of diet based on the core foods that must be consumed more and the restricted items which required being limited in intake. Core foods are those identified as nutrient rich and has been categorized into five food groups of: 1) fruit, 2) vegetables, 3) dairy, 4) meat, fish, poultry, eggs, nuts or legumes, and 5) bread, grains and cereals [8]. The restricted foods are in low nutrients and high kilojoules. These energy-dense nutrient food groups should be restricted. The amount

recommended for each group is specified in the Australian Diets guidelines [8] based on gender and age. The Healthy Eating Index for Australian scoring system was designed by Allman-Farinelli [1], informed by two dietary scoring systems developed in the US. She demonstrated that this diet scoring system predicted the odds of cardio and cerebro vascular disease in a cohort of 1790 participants.

Design

In our design of our proposed logging and awareness interfaces to improve health, we consider the design strategies for persuasive systems to help people change their everyday behaviour. For example, the data which is presented to the user needs to be abstract, pleasing, positive and consider privacy issues.

As a part of personal hypothesis exploration infrastructure, our goal is to build interfaces for logging and displaying the food consumption in order to achieve health and well-being goals for a healthier diet.

We plan to place small touch screen displays in convenient locations around the home and office. These devices will be *special purpose*: dedicated to logging behavior in a single domain for a single person. Members of a family can have their own displays, located side by side and see their own data. The display and interaction is very simple and easy to use: a single tap on a square will increment a count with feedback given below the category and the colour changing when a goal is reached (e.g. Figure 1). The display resets to the initial state at midnight each night.

The data from these touch events is sent to a back-end server and entered into the user's personal datastore

where it is available to a dashboard application and other applications. The dashboard application, Mneme [7], was designed to support the user in key tasks: defining their own goals using terms of their choice; linking personal goals to pervasive computing sensor applications as they wish; linking in other applications they choose to provide additional services. The services could be notifications and reminders (e.g. congratulations on reaching your goal!), or ambient displays such as an orb that changes colour depending on personal performance.

Conclusion and Future Work

Modifying behavior is the goal of many people when treating lifestyle diseases. We are currently prototyping pervasive logging and awareness interfaces that will be used for maintaining long term efforts to modify behavior and enhance health by enabling people to evaluate personal quantified hypotheses.

References

- [1] Allman-Farinelli, M. A., Adherence to dietary guidelines and risk of chronic disease in the Blue Mountains Eye Study cohort. MPhilPH thesis, Dept. of Public Health, Faculty of Medicine, University of Sydney, 2005.
- [2] Cole-Lewis, H., and Kershaw, T. Text messaging as a tool for behavior change in disease prevention and management. *Epidemiologic reviews* 32, (2010), 56-69.
- [3] Consolvo, S., McDonald, D., and Landay, J. Theory-driven design strategies for technologies that support behavior change in everyday life. In *Computer Human Interaction* (2009), 405-414.
- [4] Fjeldsoe, B. S., Marshall, A. L., and Miller, Y. D. Behavior change interventions delivered by mobile telephone short-message service. *American journal of preventive medicine* 36, 2 (2009), 165-173.
- [5] Jafarainami, N., Forlizzi, J., Hurst, A., and Zimmerman, J. Breakaway: An ambient display designed to change human behavior. In *CHI '05 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '05, ACM (2005), 1945-1948.
- [6] Kant, A. K. Indexes of overall diet quality: A review. *Journal of the American Dietetic Association* 96, 8 (1996), 785-791
- [7] Kay, J., and Kummerfeld, B. Mneme: shifting control of pervasive infrastructure to the user for flexible, pervasive support of sisyphian goals. In *Workshop on Pervasive Intelligence*, Pervasive (2011).
- [8] National Health and Medical Research Council, NHMRC. Australian dietary guidelines.
- [9] Resnicow, K., Odom, E., Wang, T., Dudley, W. N., Mitchell, D., Vaughan, R., Jackson, A., and Baranowski, T. Validation of three food frequency questionnaires and 24-hour recalls with serum carotenoid levels in a sample of african-american adults. *American Journal of pidemiology* 152, 11 (2000), 1072-1080.
- [10] Stone, A. A., Shiffman, S., Schwartz, J. E., Broderick, J. E., and Hufford, M. R. Patient compliance with paper and electronic diaries. *Controlled Clinical Trials* 24, 2 (2003), 182-199.
- [11] Vervloet, M., van Dijk, L., Santen-Reestman, J., Van Vlijmen, B., Van Wingerden, P., Bouvy, M. L., and de Bakker, D. H. Sms reminders improve adherence to oral medication in type 2 diabetes patients who are real time electronically monitored. *International Journal of Medical Informatics* 81, 9 (2012), 594-604.
- [12] Webb, T. L., Joseph, J., Yardley, L., and Michie, S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of medical Internet research* 12, 1 (2010).
- [13] Who, J., and Consultation, F. E. Diet, nutrition and the prevention of chronic diseases. *WHO technical report series* 916 (2003).