Insights from the Design and Evaluation of a Personal Health Dashboard

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Abstract

We present the design and user study based evaluation of a personal health dashboard aimed to support reflective behavior change. Rather than providing direct actionable instructions, we target to present health data in such a way that the users infer their health status and create their own actions from the data itself. User interviews revealed a wide range of potential challenges with the adoption of personal health dashboards in general. Features that enabled a single view to health data from multiple sources and the comparison of trends in different parameters over the long term were highlighted as desirable. Our study provides data on an alternative approach to health data presentation and behavior change for researchers and designers working in the area.

1. Introduction

Over the last century, average life expectancy has increased while birth rates have declined. In 2011 average life expectancy exceeded 80 years across Organisation for Economic Co-operation and Development (OECD) countries, which is an increase of ten years since 1970 [20]. As people live longer, the number of people suffering from chronic medical conditions has increased. Diseases such as diabetes and dementia are increasingly prevalent. In 2011, almost 7% of 20–79 year-olds in OECD countries, or over 85 million people, had diabetes [20]. Lifestyle change is essential for disease prevention, but it also remains a central part of the treatment of chronic diseases, such as Type 2 diabetes, high cholesterol levels, and high blood pressure [11]. It has been stated that lifestyle change is the single greatest opportunity to improve health and reduce premature deaths, whereas medical care plays a relatively small role [26]. In addition to demographic changes, also the fact that the focus of medical services has moved towards diagnostic and curative functions rather than preventive functions, has been a factor in the continuous rise of health care expenditure [7].

Recently, there has been more and more effort to empower citizens to manage their own health. The goal is to give patients control of their health-care information and foster collaboration between the individual and professional health care team, through integrated national health information systems [25]. Traditional Electronic Health-care Records (EHRs) have been extended to become Personal Health Records (PHRs), which aim to support patient centred health-care by making medical records and other relevant information accessible to patients and thus, assisting them in the self-management of health [1]. Studies have shown that also health care practitioners value information provided by the patients and would recommend patients to keep such [9]. However, many PHR systems are physician-oriented and do not include patient-oriented functionalities, which are crucial in self-management of health and disease prevention [1]. Ordinary people have become more and more interested in monitoring their health. Various personal health and wellbeing technologies, such as activity monitors, heart rate monitors, and home blood pressure monitors, have become commonplace. There are more possibilities to measure and manage people’s health than ever before. It has been stated that some people collect this information, because they strive for self-knowledge [12]. They collect information about themselves i.e. their behaviors, habits and feelings, and use this information for self-reflection. Digital technologies can facilitate this activity, through advances in sensor technologies, the ubiquity of access to information via the Internet, and improvements in data visualization. However, people face challenges with these kinds of technologies. For example, they have difficulties to decide what data to collect, they lose data when changing between monitoring devices and they have difficulties in integrating the information for further analysis. Especially, scattered visualizations and the management of multiple data sources are challenging [12].

In this paper, we present our approach to the design of a personal digital health dashboard and its evaluation in a laboratory based user test (n=10). Our
work was carried out in an exploratory manner to gain in-depth knowledge of people’s responses to our concept visualizations of personal health data, and to begin to collect insights into its function as part of a health self-management service.

This paper is structured as follows:

- Firstly, we present the results of semi-structured interviews where data was gathered on participants’ current usage of health and wellness monitoring, focusing particularly on the challenges they face when using existing solutions.
- Secondly, we introduce the design of a personal health and wellness dashboard concept and highlight key design decisions made to address limitations with existing solutions.
- Thirdly, we evaluate our dashboard concept in a task-based user test and via semi-structured interviews, in which participants were directed to consider the potential benefits and challenges related to the dashboard concept.

The majority of prior art in the area of health dashboards has focused on their use by medical professionals and members of the Quantified Self movement, who are capable to sift through large amounts of detailed data. In contrast, we target our design to the average citizen. To the best of our knowledge, the presentation of the design and evaluation for an overarching personal health dashboard, incorporating data both from professional medical sources and self-monitored data, has been rather limited. Hence, we believe our work offers valuable insights for both researchers and design practitioners in the area personal health data dashboards.

2. Related Work

2.1. Behavior Change and Self-Monitoring

Information and communication technology can be developed with an intention to change people’s attitudes and behaviors. So-called behavior change support systems (BCSSs) provide content and functionalities that engage users with new behaviors, making them easy to perform and embed in their everyday lives [21]. One of the key methods that have been presented for developing BCSSs is the Persuasive Systems Design (PSD) model, which defines four design principle categories for persuasive systems: primary task support, dialogue support, system credibility support and social support [22]. Supporting users’ primary tasks refers to main user activities within the behavior change system; giving feedback is the most prominent way of dialogue support; system credibility consists of e.g. reliability and trust of the system; and social support category deploys social influence features. Altogether, these feature categories affect the perceived persuasiveness of the system, and further contribute to adoption intention. Consumers’ perceptions of a virtual health check have been studied using PSD model derived constructs as a measurement instrument [13].

Recently, wearable technologies have significantly eased the burden of monitoring one’s behavior. The behavior change technique these trackers often employ is self-monitoring: by measuring the activity, behavior and internal factors such as heart rate. Thus, self-awareness is increased by visualizing behaviors, and this knowledge can be utilized for making improvements. In BCSSs, self-monitoring is often combined with other self-regulatory techniques like intention formation, receiving feedback and the setting and reviewing of goals. The combination of self-monitoring with other self-regulation techniques has also been associated with improving the effectiveness of health interventions [18].

The devices and systems used for collecting personal data are referred to as personal informatics and defined as “systems … that help people collect personally relevant information for the purpose of self-reflection and gaining self-knowledge.” [14]. Among such tools are e.g. Fitbit and Jawbone trackers and the most common measures used are heart rate and step count. Trackers are usually accompanied by mobile device application or web service, which visualizes the collected data and offers feedback and support for the user’s aspirations. The stage-based model of personal informatics [15] identifies stages of preparation, collection, integration, reflection and action. While the collection phase is facilitated by automatic sensing technologies, integration and reflection on the collected data is becoming increasingly challenging. The focus of research has been mostly on the reflection stage ([3],[14],[23]) but the problematics of integrating different data sets to meaningful combinations have also been addressed ([4],[5]). However, it is relatively unclear how to create such designs that encourage and enable reflection. Reflection needs time and it is a developmental process that has different levels. Technology solutions may support reflection on these different levels by simply recording events; asking reflective questions; and giving new, multiple perspectives on issues [6].

3. Research Setting

3.1. Research Process and Methods
The personal health dashboard prototype was developed as part of an iterative process, where the designers were able to develop a better understanding of the requirements as the process proceeded. The development process consisted of the following phases:

- Requirements analysis
- Concept design and prototype construction
- Evaluation of the prototype in a user study

Our process followed a general user-centric rapid-prototyping based approach where initial prototypes are created directly after requirements analysis and concept design phases. The initial prototype aims to present those functionalities that are visible for the user, and is then used as the basis for refining requirements. This iterative cycle is repeated until the prototype satisfies the requirements.

3.2 Requirements Analysis

Although our final target was to produce a personal health dashboard which would be capable to present an extremely wide variety of data, types, including data from personal health monitors, medical data from health professionals and Electronic Prescription Services (EPS), for our initial concept design we chose only a subset of this. This limitation enabled us to develop our design rapidly with a manageable amount of data sources. This imposed limitation, hence created a requirement that the data sources that could be included to our dashboard concept should be extensible in both amount and type.

In this phase, we wanted to focus on finding the optimal presentation of the data itself. Here, our target being that the data would be presented in such a clear and concise way that the user would themselves be able to infer cause and effect relationships between the data and their daily lifestyle. Thus, we selected to scope out features that included any form of analysis of the data such as expert systems, and potential persuasive functionality such as gamification and social sharing. Consequently, the core requirement for our design was that it should present the data in such a way that the user is able to infer maximal insight into their health status. In this way, rather than presenting the user with explicit instructions on how to change their behavior, we target a design that encourages self-reflection.

3.3 Concept Design

3.3.1 Design drivers. Guidelines for the design of graphical dashboards in general have been well documented in prior art and [8] has demonstrated area specific concepts for the health and wellness domains. A typical main view of our dashboard design is shown in Figure 1. Compared to a prior art baseline implementation, our design approach sought to provide improved user experience through the introduction of alternative design approaches in the areas detailed in the following sections.

3.3.2 Trend Comparison. Many health and wellbeing parameters are interlinked, i.e. changes in one parameter can only be fully understood when considered in conjunction with changes in other measured parameters. Being able to clearly identify this interaction between parameters can be key the diagnosis of certain health conditions, either through self-diagnosis or by a medical professional. Additionally, the temporal interplay between parameters serves to visualise the effectiveness of interventions, for example a trend of increasing daily activity may result in a trend of decreasing weight. Clearly, being able to recognise such causal responses, in as prompt way as possible can provide a strong motivational factor for individuals to continue the adoption of positive behavior or desist from detrimental behavior.

To address this issue our, dashboard design presents charts of daily data measurements stacked within a single chart area (see Figure 1, A.). The stacking is made such that the line and bar charts are situated as vertically close to each other as possible, such that relationships between the chart lines may be easily apparent to the reader. Here, the design avoids placing borders between the individual parameter chart lines that would detract from the visibility of inter-parameter differences. As fixed rectangle placeholders are not reserved for each chart line, this approach enhances the vertical packing density of the chart lines, potentially reducing the need for the reader to scroll to see data displayed below the visible display and maximising the potential to recognise trends between the parameters.

3.3.3 Threshold Labels Rather Than Axis Labels. For our target user segment, presenting multiple vertical axis labels for each displayed parameter in the main chart area (Figure 1) would create a visually unattractive and overly complex experience. In general many parameters that may be presented in such a dashboard are rather individual in nature, and comparison with global norms may not be the primary goal, either from clinical or motivational viewpoints. Thus, introducing the visual clutter of vertical axis scale labels is perhaps not of overall benefit. Rather than absolute values, individuals may find more value in relative references e.g. to their weight at some
previous occasion, such as their wedding day or to their weight compared to a family member. Similarly parameter thresholds are often used in colloquial discussion e.g. ‘It has been several years since my weight was below 90 kg’.

Thus, in our design we chose to incorporate threshold based labels on parameter charts, rather than axis labels (Figure 1, B.). Here the labels mark the values at e.g. highest and lowest points on the chart, or at particular thresholds e.g. whole number parameter values. The use of such ‘in data’ markers has a further potential advantage in the case of horizontally scrollable charts, in that they enable the reader to more easily navigate within the data as it is scrolled without constant referral to both horizontal and vertical axes.

3.3.4 Parameter Trends. Extending the approaches described above, our design also introduced textual summary trends for parameters. Here, rather than fix either the value step or the timescale over which longer term changes in data are reported e.g. ‘Blood pressure 1.2 mmHg compared to last month’s average’, our design included the possibility to present changes over a variable time period selected such that the changes are meaningful (see Figure 1, C.).

3.3.5 Extendability. A key requirement for our health dashboard was that it should be extensible, allowing different data sources to be added in future. To address this, rather than create a hierarchical data architecture we choose to use a solution whereby the user would select up to 5 data parameters to be shown simultaneously in the UI (see figure 1, D.). Here, we assumed that over a particular time period an individual user’s interest would be targeted towards

Figure 1. Our personal health dashboard design concept

discussion e.g. ‘It has been several years since my weight was below 90 kg’.

As we were interested in collecting initial user comments on our design we selected to evaluate our design as a paper prototype. This prototype consisted of different views of our dashboard design in different states. When a user in our evaluation study interacted with the current view of the paper prototype, for example by touching a printed button in the UI, the test moderator would replace the paper sheet showing the current view with one showing the target view resulting from the button press.

The prototype was evaluated in a user study, which consisted of a pre-questionnaire, a task based usability evaluation and a final interview. The pre-questionnaire contained basic demographics, questions addressing the participants’ smart phone and health related services use. Also participants’ current health status and chronic illnesses were asked as background information. The questionnaire also surveyed which data the participants were currently collecting and which type of information they wished to collect. The task based usability evaluation contained five tasks, which were loosely moderated and thus allowed free
discourse (see Table 1). The evaluation followed the think-aloud methodology and the test participant was encouraged to describe their actions during the test process. Following the tasks, the users answered a set of subjective 5-point Likert-scale questions which addressed persuasive system design constructs: primary task support, dialogue support, perceived credibility, perceived persuasiveness and intention to adopt [13]. The final part of the user study was a semi-structured interview addressing the ways users collected and used their personal data. It also concluded the design evaluation by asking users to reflect on how this type of system could help them to manage their own health information, and what the potential threats and challenges of such a system would be.

The sessions were recorded and additionally the researcher made notes of participants’ comments and responses. Their duration varied from one hour to 1.5 hours. Each participant was compensated with a movie ticket. Analysis of the data gained from the sessions focused on analysing how well the participants completed the defined test tasks and the identification of potential usability problems. Recordings from the final interviews were transcribed by the researchers and analysed using qualitative content analysis. The analysis focused on 1) identifying meaningful information on personal health data management including users’ needs, current practices, discomfort-factors and challenges as well as 2) studying the value of the proposed personal health dashboard and identifying future improvement ideas.

### Table 1. Usability task descriptions

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>View the weight and sleep graphs.</td>
</tr>
<tr>
<td>2</td>
<td>View your activity level. How do you select which parameters to view?</td>
</tr>
<tr>
<td>3</td>
<td>View your blood pressure and (resting) heart rate graphs.</td>
</tr>
<tr>
<td>4</td>
<td>View all the data sources. How much did you weight on August?</td>
</tr>
<tr>
<td>5</td>
<td>Accept the data request from your company health clinic.</td>
</tr>
</tbody>
</table>

### 3.4.1 Participants

For the study 10 participants (7/10 female) were recruited via a local test participant recruitment service. The age range of the participants was 25 to 64 years (M:42, SD:12) and 4/10 held a university degree. All except for one participant had a smart phone and all used email and Internet daily. Three participants had a chronic illness, which required monitoring (type 2 diabetes, hypertension, hypothyroidism). All were very satisfied or satisfied with their current health status and 8/10 rated their life style as good or very good. All participants had heard about health and fitness mobile applications, games and service portals with 4/10, 4/10 and 3/10, respectively, having tried or used those. All participants had tried some form of tracker, such as pedometers or heart rate monitors, but only half of them (5/10) had used them on regular basis.

The data the participants currently collected about themselves consisted mainly of sport activity and weight logging; in addition, they were aware of personal data collected automatically by service providers e.g. shopping records and energy consumption. The participants mostly wished to collect data on their sleep, activity and vitality levels. Additionally, stress levels and genetic information were mentioned by several as desired personal data.

### 4. Findings

#### 4.1 User Needs and Current Practices

Considering their current practices, many participants reported that they currently monitor several health related parameters over the long-term, in order to recognise deviations from their typical levels and to ensure that the value is in the normal range. As one user put it: “If I’m thinking about the basic data and when it becomes useful, is that if it falls from this kind of normal ranges” (#6). Tools that people used for collecting and managing personal health information included paper-based systems e.g. writing notes (#1), digital note books, diaries and Excel-sheets (#1, #4, #5), training and activity monitors (#1, #7, #9) and pedometers (#1, #10).

Weight was the most popular monitored parameter among the participants, with 7/10 mentioning it when describing their current practices (#1, #2, #4, #6, #7, #8, #10). The participants monitored their weight for several reasons: when trying to lose weight (#1, #4), to make sure that it decreases in the long-term (#2), to manage weight i.e. to recognise weight increases and change behavior accordingly (#8) and because it is interesting (#6, #10). One participant specifically mentioned that she monitors weight when she is actively dieting, but not after she has achieved her target weight: “(I collect) weight information when I’m dieting, but not after I’ve reached that weight.” (#4)

Four participants monitored their blood pressure occasionally (#1, #3, #6, #8), because they wanted to make sure that it was within the normal range. In addition, one participant had medication for high blood pressure (#3) and measured blood pressure before every doctor's appointment in order to share this data with the doctor. One participant also monitored their
Participants also monitored their physical activity over the long-term, because they were interested in the quality of the exercises (e.g., how many “stars”) (#6), how many times they have achieved their daily goal (#10) and how active they are on a general level (#10). They also monitored their physical activities in the short-term, because they wanted to see how productive each activity they undertook was with regards to their daily goal (#10), how many calories they burnt (#1), what was the quality of the exercise, e.g., distance (#1), time (#1), location (#7), and duration (#7). Participants also mentioned that they enjoyed testing different technologies and making comparisons between them (#9, #10). As participants commented: “Then I use this device to see how it works – how it takes the activities. If you shovel snow, it is very different if you plough it.” (#9). “If I have two pedometers at the same time, they give different results. In my opinion, they give just gut-feeling, not exact information.” (#10)

There were several reasons why the participants collected health information. They wanted to get more reliable information about their related behaviors than just relying on their own perception or memory (#9, #10), to maintain an active lifestyle (#6, #10), to educate their children to an active lifestyle (#10), to follow their progress by comparing it to historical information (#5, #7), to participate in playful health competitions or campaigns with friends (#4), and to collect information just for fun (#6, #10). One participant joked about not actually using the collected information for anything, but just collecting it for fun and then bragging to other people that she has data from a ten years period (#6).

4.2 Discomfort Factors and Challenges

Participants faced many practical challenges with managing their health data: written notes are difficult to read and papers get lost (#1, #4), paper is not necessarily available when it is needed (#5) and technology is expensive or new devices are not compatible with the user’s existing ones (#1, #8, #9). Also other challenges were identified: setting up the technology and maintaining it, such as changing batteries, is difficult or laborious (#9, #10), turning the application on and off is inconvenient (#7), carrying a smart phone while jogging is inconvenient (#7), getting used to the technology and especially wearable sensors takes some time (#9), transferring data from sensors to data storage is laborious (#1, #6, #7, #10), difficulty combining information from different sources (#5) and loss of motivation to use the technology (#7, #10). However, some participants also had a very positive self-image as technology user. They mentioned that they don’t have any problems to collect and use health data (#2) and the technologies they have selected are easy to use (#4).

Participants also noted that they often loose motivation to maintain healthy behaviors (#1), self-monitoring technologies don’t help them to improve the effectiveness of their exercises or make changes to their lifestyle (#3, #6), improvements will only be realised in the long-term (#9) and that people are not interested to improve the effectiveness of their exercise in the first place (#7). As one participant commented: “Or then you exercising should be so bullish, but it doesn’t somehow motivate me... There’s a fault in me that I don’t get excited in group classes and increase my weights in there all the time.” (#7)

When participants were asked about what they have learnt based on data they have collected, the answers were not always positive. Participants mentioned that they have learnt that they are lazy (#1, #6), have a short span of motivation (#1) and that improvement typically doesn’t happen (#7). On the other hand, participants mentioned that they have learned new things about diet and age-related changes (#8) and that self-monitoring technologies have made them think more about their own exercise behavior (#9). One participant had also learned that whenever she sets a goal, she would achieve that (#4). As participants commented: “(I have learned that) I’m quite lazy, short-spanned, but when I begin to work hard, I’m able to do that for a month or two”(#1). “Mostly I have noticed age-related changes in the long-term. Maybe I have learned something about diet. As an example, nowadays I try to avoid eating all kinds of junk and extra fat and sugar” (#8).

Participants had some doubts regarding the accuracy of the information provided by measurement devices (#1, #2, #7, #9). One participant mentioned that when measuring blood pressure at home, he had to select a peaceful moment to achieve reliable results (#3). It was also found that lack of medical expertise might cause problems, as people can make an incorrect self-diagnosis and then begin to treat an illness that he or she doesn’t actually have (#8).

Participants stated that getting access to their old medical data, such as magnetic images (MRI) and laboratory results, is difficult (#4, #10). Participants also expressed frustration about this issue: “But having access to information in our digital society is really challenging nowadays... I tried to get my magnetic images or even the statements from 2004 and [specific service provider] does not even exist anymore. Perhaps, they have been shredded or something” (#4). Similarly, one participant mentioned that even for a health care professional it is difficult to access information that has been stored in a patient
information system in another organisation, e.g., accessing occupational health information from a hospital (#10).

4.3. Evaluation of the Prototype Design

4.3.1 Task Completion. Generally, the participants were able to complete all defined the tasks without help. Only Task 4, which required changing the time range displayed in the main chart area, was difficult for most of the participants (6/10). Other issues raised by the participants included: 1) the lack of reference values to compare the measured data to, and hence to understand if their health was good or bad, 2) missing measurement scales, and 3) difficulties of visually linking the textual descriptions in the left column with the data displayed in the charts. It was observed, however, that the missing measurement scale did not cause problems in the views with several graphs. The participants also mentioned that the main view is not necessarily suitable for colour-blind users because of red and green colours. Users valued viewing multiple graphs in one view and comparing data sets and they spontaneously started finding correlation and causal connections in the graphs. In the future, the scales could be differentiated visually or the overview scale could be located in a different place.

4.3.2 Persuasive System Design Constructs. The results from the persuasive system design constructs [13] are presented in Table 2. Because of low participant number, mean and standard deviations were calculated at the construct level. Overall, the above middle value means imply positive impressions of the UI. Perceived credibility and persuasiveness have the highest mean values, implying that using the evaluated design as a self-monitoring tool for targeting to change behaviors is justified.

Table 2. Persuasive system design constructs Likert scale results (1 - 5)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Mean</th>
<th>Std. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary task support</td>
<td>3.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Dialogue support</td>
<td>3.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Perceived credibility</td>
<td>4.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Perceived persuasiveness</td>
<td>4.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Adoption intention</td>
<td>4.0</td>
<td>1.3</td>
</tr>
</tbody>
</table>

However, the evaluated UI concept lacks both primary task support elements like goal-setting and dialogue support like feedback, and that was noticed by most of the users: it was mentioned several times, that they don’t get enough feedback and advice on how to change their behaviors: “This is a pretty descriptive view, but I am very goal-oriented, I think I need something like - You should walk more tomorrow” (#4). And, “This does not show any goals and or references or recommendation value, nothing to compare with, so it is basically up to you how to react” (#8).

4.3.3 Semi-Structured Interviews. Participants expected that the personal health dashboard could teach them new things about their physiology by showing correlations between different health parameters (#4, #5, #8, #10). Participants were especially interested to know how dieting, activity and sleep influence the other parameters (#4, #8) and how illnesses influences activity and sleep (#10). The dashboard would also bring additional value compared to current technologies, because it would extend the amount of measured parameters (#7). Information provided by the dashboard could help users to make health-related decisions (#1, #4) and motivate them to change their behaviors towards a healthier direction (#1, #5). Also the possibility to view one parameter at a time was valued (#1). One participant commented that especially metabolic changes take some time to occur and that health parameters are inter-related: when a parameter changes, the actual behavior change has taken place much earlier (#2). Thus, it would be useful if people could learn more about their physiology. However, two participants mentioned that the personal health dashboard would not have any influence on their health-related decisions (#3, #5). Participants also stated that the dashboard could help them to gain more reliable information and evidence about their health status (#6, #8, #9, #10). Additionally, one participant pointed out that the graphs alone are not enough, but it is important to see the actual values (#8).

The personal health dashboard could also meet the users’ need for monitoring their overall health situation and providing alerts when there are deviations (#6, #7, #9). As an example, having information about changes in glucose values could help people identify the onset of diabetes (#6). Participants were also interested just to monitor and view their health history in the long-term, especially if they could import data from occupational health services (#7) and e.g. view blood pressure results (#10). Information could encourage them to contact health care professionals and thus, it could help in the diagnosis and treatment of diseases (#10). One participant also pointed out that if people would start to collect data while they are still young, they would have a lot of valuable data when they are older (#7).
Ageing and self-care aspects were also identified from the data, when participants mentioned that this kind of tools are needed when people have to take care of themselves more and more in the future (#6), people become interested to take better care of themselves when they get older (#8) and it would be interesting to monitor changes in your health parameters when you get older (#10). Participants also mentioned that it would be useful if there would be an easy way to share the information with health care professionals (#2, #10). Sharing information with friends was mentioned by one participant who also suggested that it would be interesting to compare results with other people and get suggestions how to change behaviors (#9).

The dashboard could also be used for monitoring other family members’ health and wellbeing. Older parents could be encouraged to monitor their blood pressure, heart rate and sleep, and the information would be available for their children (#7). It would also be important to monitor children’s activity and sleep (#10). One participant also commented that it would important to have a possibility to add personal comments and notes to explain the data (#4).

The fact that that the dashboard would provide all information in one place and they wouldn’t need to check all other services separately was also seen as valuable by several users (#1, #4, #7, #10). One participant even expected that he could save money, because he wouldn’t need to pay a doctor to get the same information (#5). Another participant pointed out that perhaps people could sell their data for research purposes (#6).

Some participants remarked that meaning of the health parameters presented in the dashboard, such as blood pressure, are not self-evident for everybody (#7, #10) and thus, the current design would not be suitable for all (#10). Most participants also recognised that in order to view the data, they should also collect it through sensors. They had some doubts and worries regarding the sensors, their appearance (#1), usability (#2, #9), data transfer (#10), the fact that they wouldn’t necessarily have the needed sensors (#8, #10) and missing data from certain days (#5). One participant commented that a smart phone based version, using a smaller screen would be needed (#2).

Some doubts were also raised toward continuous health monitoring in general: health enthusiasts could get addicted to self-monitoring (#4, #8), self-monitoring could become stressful (#6) and users could get obsessed with achieving goals (#8). On the other hand, the dashboard was considered as rather neutral application that would not make users feel guilty (#7).

When participants were asked would they recommend the personal health dashboard to other people all of them answered yes. They would especially recommend it to their spouse (#1), parents (#10), friends (#1), older people (#7), people who want to lose weight (#4, #5), people needing support in exercising or life management in general (#5), people who want to make lifestyle changes (#8), people who already monitor their activity (#3, #7), as well as people who are active and interested in their health (#10).

5. Discussion

When the persuasiveness of the personal health dashboard was evaluated with the persuasive system design constructs questionnaire, primary task and dialogue support received the lowest values. In fact, the evaluated design did not have features of those categories, implying that the questionnaire assessed those constructs relatively well. Our design concept takes a passive approach in encouraging users to reflect on their data and learn about themselves by exploring several data sets simultaneously in the same view. Bentley et al. [4] also combined data streams but their approach was to design actionable feedback in natural language. In addition, preselected sets of data, reducing rich data streams into more comprehensible cuts, have been studied lately [5]. Both of the mentioned studies stated, that the preferred way of showing the data was highly personal and finding combinations that work for everybody was difficult. This supports the idea that to enable meaningful reflection, the design must leave space for users to make their own discoveries. Additionally, discovery phases are iterative by nature, and data needs change over time [14]. Thus, it may be that behavior change is better supported when the user finds actionable items her/himself, rather than those being indicated automatically by the system. Fleck and Fitzpatrick [6] define that “reflection takes time, benefits from guidance or support, and... needs to be encouraged” and also our results indicate, that proper primary and dialogue support is essential for these systems. The presented design is aimed for reflection-on-action [23]; it is used when the action has ended, not while gathering data. Such tools should allow more extensive ways to explore data and find meaningful correlations or causalities and may also provide ways to simulate changes in behavior. Naturally, the desire for self-reflection is a personality trait not present in all individuals and therefore some alternative automatic functionalities should be included. The reflective capabilities can, however, be emphasised by including reflective questions and providing new insights into data [6]. Dashboards combining different, sometimes unconnected data streams in the same view may serve as sources of new insights, but might require reduction in the granularity of the data. In our study, the users
were not concerned by the reduced quality of the data (measurement scales were not available in the graphs with several data sets).

Interestingly, participants mentioned that they would like to have specific goals, such as how many steps to take in a day or how much they should weigh, and alerts and reminders if they don’t meet their targets. However, one can speculate if this ‘expressed need’ is something actually supporting users in managing their health or are they just expressing a learnt opinion based on earlier experiences. With the direct ‘goal and feedback’ approach the user doesn’t need to actively think about their actions. It may thus be the case that a design encouraging people to reflect on the data themselves and choose their own behavior, may be more intrinsically motivating than telling them what to do.

Our study confirms that personal health dashboards need to be developed further. The interview findings showed that people are interested to monitor their overall health situation and get information especially if something has changed compared to their earlier measurements, or if the values deviate from normal range or health guidelines. In order to provide this information in a reliable way, it is useful to acknowledge that the health data should be collected continuously or the algorithms should be able to handle incomplete data. Many participants doubted the usability of the sensors that would be necessary to collect the data and their current technology use patterns and habits showed that they don’t necessarily collect or reflect on the data on a daily basis. Such factors are barriers to the adoption of personal health dashboards.

As future work we plan to further develop our dashboard design, taking into account the feedback received in this evaluation. As the self-reflection approach was generally positively received we will continue to explore this direction. Next steps will be to progress to implement the dashboard, including its interface to selected commercially available health monitor devices.

We acknowledge that our work is limited by its small sample size and laboratory setting. Considering our use of a paper prototype to evaluate our design, we highlight that our focus was primarily on visual design, and accordingly the graphical quality of the designs presented was at the quality and fidelity level expected from a product quality implementation.

6. Conclusion

We have presented a concept design of a personal health data dashboard that aimed to encourage self-reflection. Its evaluation showed that users could complete defined tasks using it without problems, and all of them would recommend it to other people. The dashboard design was considered particularly valuable as it visualized all the health parameters in a single view and enabled users to identify correlations between different health parameters. Users commented positively on the self-reflection driving approach, although also commenting on the need for more explicit instructional content. Users considered that information highlighting long-term correlation between their behavior and changes in health parameters was beneficial, as it would help them learn about themselves.

It was considered that the dashboard was mostly suited to people who already actively monitor their health, and the long term-usability of health data collecting sensors was questioned. However, participants felt that the dashboard could be made more suitable for average citizens by adding descriptive information about each of the health parameters and emphasising its use with health care professionals.

6. Acknowledgements

This research has been supported by a grant from Tekes – the Finnish Funding Agency for Innovation as part of Digital Health Revolution programme.

7. References


[16] Magic mirror Embodied Interactions and the Quantified Self http://haridecoded.com/Home/Portfolio/1


