Personal Informatics And Reflection: A Critical Examination Of The Nature of Reflection

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Abstract
Personal informatics systems that help people both collect and reflect on various kinds of personal information are growing rapidly. Despite the importance of journaling and the main role it has in tracking one's personal growth, a limited number of studies have examined this topic in the area of personal informatics in detail. In this paper, we critically examine the process of reflection on experiences, thoughts and evolving insights through a qualitative research study. We also present the design research process we conducted to develop the *Wandering Mind* as a support tool to help individuals record and reflect on their experiences.

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Personal informatics; reflection; journaling

ACM Classification Keywords
H5.2 [Information interfaces and presentation]: User Interfaces. – User-centered design; J.4 [Social and behavioral science]: Psychology

General Terms
Human Factors; Design

Introduction

Reflecting on oneself is an ongoing quest through life. Most of us spend time daily reflecting on who we are, what we have done, our experiences and expectations. In many cases we do this based on what we remember has happened today, yesterday or earlier. However, relying on our own memory has several limitations such as forgetting or ignoring some information, and losing track of specific patterns or trends of information. In an effort to overcome memory limitations, personal informatics systems as an emerging area in the field of human-computer interaction, have done research and design of systems that help people to collect and store personal information for the purpose of self-reflection [13].

One of the challenges in the area of personal informatics, however, is developing a deeper understanding of what type of self-information people need and what questions can be answered by that information. Li, Dey, and Forlizzi [13] reported four categories: exercise, general health, finance, and journaling as the most relevant and interesting aspects of daily life for people to reflect on. Despite the importance of *journaling* and its main role in reflection on one's past experiences, thoughts, and insights, only a limited number of studies have been done on this topic in the area of personal informatics. Therefore, the main goal of this study is to, through design research, critically examine the collection and storage of one's thoughts, experiences, and insights, and to provide means of exploring and reflecting on this type of self-information.

In this paper, we first provide a short review of studies in the area of personal informatics. We then explain the process of reflection, which is the main concept of any personal informatics system. We also describe how a deep understanding of the process of reflection, in addition to a qualitative approach helped us to design *Wandering Mind,* a journaling tool to support reflection on experiences, thoughts and evolving insights.

Background

Personal informatics

Personal informatics has been gaining popularity in HCI since an earlier research on Life Logging as a memory aid for capturing data [10]. Personal informatics systems, however, go beyond remembering information about oneself; they focus on collecting data for the purpose of gaining self-knowledge through reflection. Data collection and reflection are regarded as a whole process in personal informatics [13].

Personal health and exercising are two popular domains in personal informatics. Fish'n'Steps [15] and UbiFit Garden [6] help people collect their exercising data, and provide various visualization of their progress to provoke self-reflection. Anderson et al. [1] developed Shakra, a mobile application that tracks one's daily exercise activities and enables shared activity information amongst friends, to encourage reflection through social comparison. The Lullaby [11] captures environmental data during one's sleep without intervention and reconstructs the unconscious events through a playback interface.

Personal informatics has also been discussed in the area of emotion and mood tracking. MoodJam [14] is a website that allows users to keep track of their mood represented by different colors; users can also add notes to their moods at different times. Affective Diary

[20] records a user's bodily memorabilia and then maps and visualizes the data, and lets users add scribble notes to this digital diary as they reflect on their bodily memorabilia. AffectAura [17] uses a multimodal sensor set-up to continuously log audio, visual, physiological, and contextual data of a user, and then predict user's affective states at different times and present them on an interface for user reflection on their emotion.

Finance is another interesting area that is the focus of several personal informatics systems. Financial related systems help users manage their consumptions in different areas. For example systems and devices were designed to focus on sustainability of lifestyle by recording and presenting people's energy consumption. Coralog [12] detects the duration of a user's computer idle time and utilizes the visualization of the health states of coral reef to communicate the energy consumption behavior. WattBot is an iPhone application that monitors people's home energy usage and encourages them to reduce consumption through a summary visualization [19].

In spite of rapid growth of personal informatics in different areas of general health, exercise, and finance, journaling has received limited empirical scrutiny in this field. Journaling is an activity to record one's experiences, thoughts and evolving insights; it helps one record the narrative aspect of an experience and make sense out of it. Although some applications such as MoodJam [14], affective Diary [20], and AffectAura [17] allow users to enter their personal notes, the main focus of these systems is capturing and reflection on one's affective states. This study focuses on journaling as a tool to record and reflect on one's experiences, thoughts, and insights.

Reflection

The process of reflection is the central concept of personal informatics, however there are a limited number of studies that focused on the process of reflection in designing personal informatics systems. We conduct a critical examination of the nature of reflection in this section.

While reviewing the literature, we found different definitions of reflection. One of the definitions that focuses on personal experiences is presented by Boyd and Fales [7]. They define reflection as a process in which one thinks and explores an issue of concern to make a meaning in terms of the self that leads to development of a new conceptual perspective. Atkins and Murphy [2] reviewed the literature of reflection and explained three key stages of the process of reflection: awareness of uncomfortable feelings and thoughts, critical analysis, and development of a new perspective.

Stage I – awareness of uncomfortable feelings and thoughts

Reflection starts with the awareness of uncomfortable feelings and thoughts, which is caused when one realizes that his knowledge is not enough to explain and understand a unique situation [2]. Boyd and Fales [7] explain this step as feeling an inner discomfort that is triggered by an experience.

Stage II – Critical analysis

In the reflection process, following the inner discomfort stage, one tries to gather information and gain different perspectives on one's unique situation in order to analyze it. As Atkins and Murphy [2] explain, this phase is about examination of one's knowledge and feelings. Boyd and Fales [7] describe this stage as identification

and clarification about the concerns of one's experience, and openness to new information.

STAGE III – DEVELOPMENT OF A NEW PERSPECTIVE

At this stage of the process of reflection, based on the critical analysis of Stage II, individuals develop a new perspective on their issues, which is called learning; this is the outcome of the reflective process [2]. Boyd and Fales [7] called this stage the "aha" point, when one develops a new perspective, learns a lesson or gains a new insight. This stage leads to affective and cognitive changes, but may or may not change the behavior [5].

Similar to other studies in the area of personal informatics, the main goal of this study is to develop an application to help people improve their self-knowledge through reflection. However, this study aims to extend the previous studies in two aspects. First, this study specifically focuses on the reflection on narrative part of life experiences. Narrative part of an experience is the internal thinking that one does to give shape and meaning to an event and make sense out of that [4]. Journaling is the most common strategy to record and reflect on this type of personal information. It can be used as a tool to track one's personal growth and help him to elucidate feelings, personal values, beliefs and traits [7]. Despite the importance of journaling in the process of reflection and learning, this topic has received surprisingly limited attention in the personal informatics area. Second, *Wandering Mind* is designed as a tool to support reflection on experiences, thoughts and evolving insights. We conduct a design research by focusing on the process of reflection and applying user-centered approach; and communicate our design thinking in an explanatory approach.

Approach

We used semi-structured interviews [4] to gather the data and establish requirements. Ten females and five males, age range of 20-50, with the mean of 31.75 years participated in interview (II). We tried to select our participants with different ages and backgrounds. Open-ended and close-ended questions were asked to cover all three stages of the reflection process. We had a basic script for guidance, so the same topics and questions were asked of all interviewees. Each session was started by pre-planned questions, and we probed participants to tell us more until no relevant information was forthcoming. The following are some of the interview questions that were asked: What would make you think about yourself and the past experiences you had in your life? How would you feel when you recall different past experiences you have had in your life? How would your current situation or emotional state affect your thinking? What strategies would you apply to deal with your emotions (positive/negative) or the situation you encounter? How do you learn lessons from the mistakes you have made in the past? What are the tools that you use to record your thoughts, experiences, or evolving insights and what are the limitations of those tools?

Interview analysis

We created affinity diagram and identified three themes from the data that can be mapped to the three-stage model of reflection [2]:

- Triggers-inner discomfort
- Mind wandering-critical analysis
- Learning lesson and changing behavior-development of a new perspective.

We also identified another theme that presents available tools that support reflection.

TRIGGERS- INNER DISCOMFORT

Participants reported that recalling the past experiences, thoughts, or insights are usually triggered by different experiences such as life challenges and hardships (e.g. failures, loneliness), achievements, visiting a familiar place, talking to a friend, seeing a picture, or special events (e.g. birthday or wedding anniversary). For example, "Every time that something bad happens that hurts my emotion and makes me feel negative, it makes me think about myself and what I have done." P5 said.

MIND WANDERING- CRITICAL ANALYSIS

Triggers make one's mind wander from one thought or memory to another. We identified that one of the main strategies participants apply to critically analyze their situation is to recall related past experiences they had in their lives and connect them together; "Sometimes when my family gets together…I know I can't be there and I really miss them; I go back to the journals that I wrote when I was leaving India and try to make myself feel better by recalling all those memories and the goals that I came here for," P7 said. "When I passed the first semester I was like Wow I did it! I felt like it was worth it to have all those hard times I had during the semester, like being far from my family, studying hard and…." P7 said.

Based on the interview analysis, participants also reported they sometimes discover the pattern of their experiences at this stage that can trigger more reflection. "I used to date guys not more than 3 or 4 times…recently after my last break up I was like "what's going on?"…" P5 said.

Note that recalling one's own life experiences, thoughts and insights is not the only strategy that helps one analyze the situation; participants reported that they sometimes seek for others' perspectives and thoughts by talking, or reading. "When I get sad about something or get mad at someone I talk to my wife…when she is not available, sometimes I talk to a stranger... if I don't find someone to talk to, I get on the Internet to find some other perspectives…" P1 said.

LESSONS LEARNED AND CHANGING BEHAVIOR- DEVELOPMENT A NEW PERSPECTIVE

Mind wandering and analyzing the situation eventually lead to gain a new perspective and learning. Note that analyzing the situation is necessary for learning; however, it may or may not lead to behavioral changes. Based on the interviews, participants learn from their life experiences and try to improve themselves from different aspects. However, they are more likely to change their behavior when they encounter a critical situation (for example when they make a huge mistake) or they notice their repetitive mistakes. "I used to date guys not more than 3 or 4 times…recently after my last break up I was like "what's going on?"…I thought about all the relationships I have had…and noticed that this is because I am really afraid of long relationship…I am actually working on myself now" P5 said.

AVAILABLE TOOLS TO SUPPORT REFLECTION

All participants agreed that some times it is necessary to review their experiences or thoughts. They reported that it would be helpful to record their thoughts and insights that they gain through life experiences.

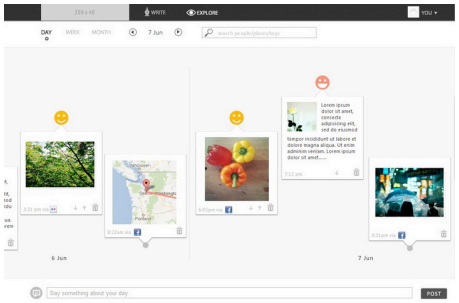

Figure 1: Journal entries are presented on a timeline, with the emotion curve to indicate mood changes.

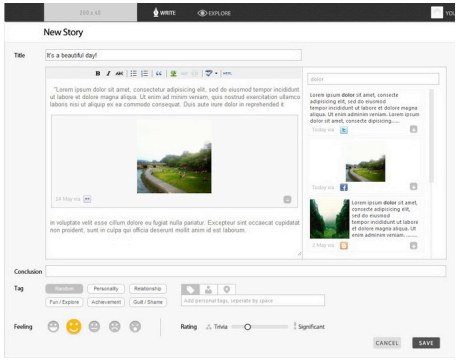

Figure 2: Creating a story in Wandering Mind. User can reference content they created on the connected social networks in a story; they can also apply different tags.

Journaling was reported as the main strategy that participants use to record this type of self-information. Journaling tools such as traditional pen and paper, blogging, and social networks are the most common tools that participants apply for journaling. However, there are some limitations using social networks as journaling tools. Participants are less likely to capture and share their sad moments in social networks, while they try to capture both positive and negative experiences in their blogs or journaling notebooks. Hurting their friends, distorting their own image, or privacy issues are some of the reasons that they are reluctant to share their sadness in social network. "Facebook is the best picture of me! I usually talk about my positive feelings with my friends but not about my negative feelings…maybe I don't want them to know I'm sad, upset, or broken," P2 said. Participants are also less likely to reflect on their social network timeline compared to blogs or written journals.

Wandering mind- a tool to support reflection

In this section, we focus on the design process of *Wandering Mind*, a journaling a support tool to record and reflect on life experiences, thoughts and evolving insights. We explain how a deep understanding of the process of reflection, based on the literature review and interview analysis inspired us to design Wandering Mind. We discuss our design strategies and features in the framework of three- stage model of reflection.

Stage I – awareness of uncomfortable feelings and thoughts

Awareness of inner discomfort is the first stage of the process of reflection. Based on the interviews, different life experiences may trigger the uncomfortable feeling and lead to the process of reflection. Life experiences may also trigger one use different journaling tools to record his experiences, thoughts, and evolving insights. *Wandering Mind* supports journaling as the main data collection method. In creating a journal (Figure1), users can also search for and add content from social networks, such as photos or status. Each journal entry can also be annotated by tagging related people, locations (contexts) and topics; users can also add emoticons representing their emotions. Annotating an entry not only encourages user reflection but also guarantees more structured data that can be used for information retrieval and visualization; however, it increases the workload of the user.

Participants also reported that some times, followed by an experience, noticing a pattern of similar experiences might trigger the process of reflection. *Wandering Mind* uses data visualization to showcase the patterns of one's past experiences, thoughts and insights as a potential trigger to encourage self-reflection. The main goal of our application at this stage of refection is not to relive the past experiences one has had in his life, but to frame the individuals' experiences, thoughts and insights in a different way to encourage them to start the process of reflection [9]. *Wandering Mind* visualizes journal entries in two ways: timeline and bubble chart. The timeline displays the journal entries with a temporal emotion curve (Figure2) that includes daily, weekly and monthly views. The bubble chart reveals the major emotional states of users associated with different user annotations. The visualized data represents one's life stories and personal growth. The importance of the life stories as a strong trigger of reflection and self-improvement has been discussed in several studies [8, 16].

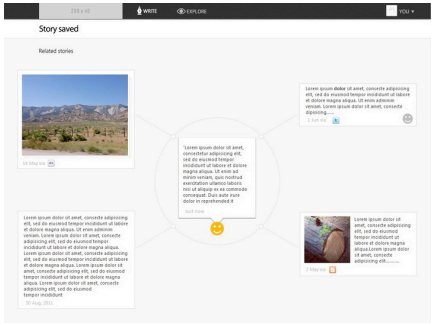

Figure 3: User can review related stories when she submitted a new one.

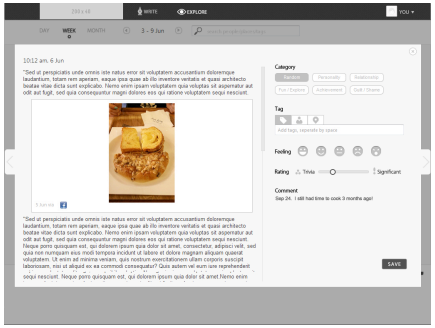

Figure 4: User can add comments to a story when they review it later.

Stage II – Critical analysis
The second stage of the process of reflection is critical analysis. Participants reported how their minds wander through their past experiences, thoughts and insights to gather information and analyze their situation in this stage. The conceptual model of our design is based on the analogy of the mind wandering; and that is the reason we named our journaling tool *Wandering Mind*.

Wandering Mind assists users in exploring their journals and finding the similar experiences they had in the past. To support exploration of different journals, different strategies were designed. *Wandering Mind* enables users to easily explore and search for any journal entry based on a specific keyword, emotion, tag or time range. Users can also explore their journals while they are writing new entries. It also aims to make the exploration easier by automatically extracting and showing some related journal entries after the user submits a new entry (Figure 3).

Stage III – Development of a new perspective
The third stage of the process of reflection is developing a new perspective that may lead to behavior changes. Based on the interviews, pattern visualization can help users a lot to identify their wrong behaviors or mistakes and may lead to learning and changing behavior. Recording and visualizing users' insights and lessons learned from their past experiences would also help them in the learning process; it encourages them to reflect on their experiences more often and try to develop a new perspective and change their negative behaviors earlier in their lives. Wandering Mind enables users to record their lessons learned and evolving insights along with journaling. It also creates a visualization of these for subsequent reflection. Users can also comment on any experiences, thoughts or insights later when they refer to those journals (Figure 4).

Preliminary user evaluation
We conducted an explorative usability evaluation with seven users. Users were asked to interact with the *Wandering Mind* prototype through three main scenarios and five tasks. The tasks included exploring the prototype, adding a new entry, exploring related journals, and interacting with different visualizations. The results of the usability test were decidedly positive about the use of *Wandering Mind* for journaling and self-reflection. The post-test questionnaires showed that most of the users found the interface easy to understand and intuitive; and they found the visualization components especially interesting. Besides minor technical issues, the most common concern, especially for users who had no journaling experience, was the time limitation for data entry if they just wanted to write some short notes about their thoughts or evolving insights. To address this issue, we added a feature that enables users to create a quick journal without adding annotations.

Discussion and future studies

Although our study should be seen as an initial effort to examine the process of reflection on the narrative side of experiences in personal informatics, more overall conclusions can be drawn from the results. In this section we present some challenges in the process of designing and evaluating *Wandering Mind* that may provide insights for future studies on designing personal informatics systems and specially journaling tools. We also organized this section based on the three-stage model of reflection to emphasize the

importance of considering the entire process of reflection in personal informatics systems design.

Stage I – awareness of uncomfortable feelings and thoughts

Potential triggers of reflection need to be identified by designers in different contexts and considered as opportunities to engage users with the process of reflection. Journaling no doubt is an efficient tool for self-reflection; based on the literature review and interview analysis, any life experience may trigger journaling and reflection. However, in both the design and the evaluation processes of *Wandering Mind,* some participants were concerned about their lack of time. Participants reported that it takes time and effort to record their thoughts and experiences. To address this issue, we added a feature that enables users to create a quick journal by recording only thoughts and evolving insights, and not the whole experience. Other plausible design solution to this issue may be making better use of available ubiquitous computing technologies and existing content the user has generated on different social networks. *Wandering Mind* could serve as a hub that integrates various types of data the user has already created, but are scattered throughout different applications, and then visualizes them for user reflection.

Note that, triggers may work differently for different people in diverse contexts; for example, a trigger that may make one person start a reflective process may be unhelpful for someone else. Designers of personal informatics systems need to consider the appropriate triggers for their application in order to create the right level of inner discomfort, and to help one start the process of reflection.

Another challenge that was identified through the design of Wandering Mind is information visualization. Visualizing unstructured narrative side of life experiences is challenging. The visualization of journals has received very positive feedback from users and was considered as an important feature to trigger reflection. Data visualization in *Wandering Mind* is based on users' journals that rely on manual generation and may require pattern analysis algorithms to turn into structured data. The current study has acknowledged the effectiveness of visualization, but automatic content analysis technology is needed to help the system better interpret the journals for later visualization.

Stage II – Critical analysis

Designers need to make sure they provide users with enough information to analyze the situation in this stage. For a journaling tool, recalling past experiences is not the only information that users can attain to analyze their situation; talking to their friends, reading books, exploring different websites, or counseling are some other strategies can also facilitate the user's analysis of the current situation.

Note that, in this stage, the lack of information may result in people quitting the process; also, overwhelming information may lead to destructive self-reflection or self-rumination [18]. Therefore, designers need to be careful to provide the right amount of information at the right time in different contexts and situations to engage users with critical analysis of their situation.

We also identified that the effort and time that participants put into analyzing their situations depends on different factors such as the availability of required

information on the issue and one's ability to analyze it, and the importance of the issue. Participants reported that they usually don't spend much time and effort analyzing the situation that they are not passionate about, or they cannot find enough information to analyze the situation; they usually apply some strategies (e.g. eating, listening to music, and walking) to move on from their issues in these situations. For example, "If there is no one I can talk to, I eat or drink to forget my problem!" P2 said.

Stage III – Development of a new perspective
Changing behavior is the outcome of the critical analysis on the situation and developing a new perspective. Designers need to consider reflection as an overall process. However, we agree that designing applications that enable users to critically analyze their situations, develop new perspectives and change their behaviors in different contexts is challenging.

Conclusion

To conclude, this study critically examined the process of reflection on one's experiences, thoughts, and insights through design research; and *Wandering Mind* was designed as a support tool to facilitate this process. This tool provides users with an initial framework to think about their past experiences, thoughts and insights and to analyze their current situation to develop new perspectives and changes their behaviors.

A qualitative approach we applied in this study presents our design research and provide a framework for future studies in the area of personal informatics, especially those developing journaling tools. We also developed *Wandering Mind* as a journaling tool to support reflection on experiences, thoughts and evolving insights. Although it was an initial effort in developing a journaling tool in the field of personal informatics, potential ideas and visions can be inspired from the literature review and the results of interview analysis for future studies.

Although this study and similar studies in the area of personal informatics aim for designing applications that help users improve their self-knowledge through self-reflection, there are other factors that inform how deeply an application can affect one's self-reflection. Atkins and Murphy [2] claim that in order to apply reflection as a learning tool, one needs to have several skills such as self-awareness, description, critical analysis, synthesis and evaluation. Improving self-knowledge also requires a more knowing and critical view of past experiences with the purpose of clarification of feelings, personal values, beliefs and traits. The plan for future studies is to focus more on the learning aspects of reflection, and to evaluate whether personal informatics systems and tools can help users improve their self-knowledge in the long term.

References

[1] Anderson, I., Maitland, J., Sherwood, S., Barkhuus, L., Chalmers, M., Hall, M., Brown, B., and Muller, H. (2007). Shakra: tracking and sharing daily activity levels with unaugmented mobile phones. *Mobile Networks and Applications*, *12*(2-3), 185-199.

[2] Atkins S., and Murphy K. (1993) Reflection: a review of the literature*. Journal of Advanced Nursing, 18*, 1188-1192.

[3] Baur, D., Seiffert, F., Sedlmair, M., and Boring, S. (2010). The Streams of Our Lives: Visualizing Listening Histories in Context. *IEEE Transactions on Visualization and Computer Graphics*, *16*(6), 1119-1128.

[4] Bernard, H. R. *Research Methods in Cultural Anthropology*. Newbury Park, CA: Sage, 1988.

[5] Boud, D., Keogh, R., and Walker, D. *Reflection Turning Experience in to Learning* Kogan Page, London, 1985.

[6] Consolvo, S., Klasnja, P., McDonald, D. W., Avrahami, D., Froehlich, J., LeGrand, L., Libby, R., Mosher, K., and Landay, J. A. (2008). Flowers or a robot army?: encouraging awareness & activity with personal, mobile displays. In *Proc.* 10th international conference on Ubiquitous computing 2008, ACM: Seoul, Korea. 54-63.

[7] Boyd, E. M. and Fales, A. W. (1983). Reflective Learning: Key to Learning from Experience, *Journal of Humanistic Psychology*, *23*, 99-117.

[8] Habermas, T., and Bluck, S. (2000). Getting a life: The emergence of the life story in adolescence. *Psychological Bulletin, 126,* 748–769.

[9] Harper, R., Randall, D., Smyth, N., Evans, C., Heledd, L., and Moore, R. (2008) The past is a different place: They do things differently there. In *Proc.* Conference on Designing Interactive Systems. ACM Press, New York, 271–280.

[10] Hodges, S., Williams, L., Berry, E., Izadi, S., Srinivasan, J., Butler, A., Smyth,G., Kapur, N., and Wood, K. (2006). SenseCam: a retrospective memory aid. In *Proc* 8th international conference on Ubiquitous Computing 2006, Springer-Verlag: Orange County, CA, 177-193.

[11] Kay, M., Choe, E. K., Shepherd, J., Greenstein, B., Consolvo, S., Watson, N. F., and Kientz, J. A. (2012). Lullaby: A Capture & Access System for Understanding the Sleep Environment. International Conference on Ubiquitous Computing.

[12] Kim, T., Hong, H., and Magerko, B. (2009). Coralog: use-aware visualization connecting human micro-activities to environmental change. In *Proc*. 27th international conference extended abstracts on Human factors in computing systems, Boston, MA, USA, 4303-4308.

[13] Li, I., Dey, A., & Forlizzi, J. (2010). A stage-based model of personal informatics systems. Proceedings of the 28th international conference on Human factors in computing systems, Atlanta, Georgia, USA, 557-566.

[14] Li, I. (2011). Personal Informatics and Context: Using Context to Reveal Factors that Affect Behavior. PhD Thesis, Carnegie Mellon University, Pittsburgh. Retrieved from http://ianli.com/thesis/

[15] Lin, J. J., Mamykina, L., Lindtner, S., Delajoux, G., and Strub, H. B. (2006). Fish'n'Steps: encouraging physical activity with an interactive computer game. In *Proc.* 8th international conference on Ubiquitous Computing, Orange County, CA, 261-278.

[16] McAdams, D. P. (2001). The psychology of life stories. *Review of General Psychology*, 5, 100–122.

[17] McDuff, D., Karlson, A., Kapoor, A., Roseway, A., and Czerwinski, M. (2012). AffectAura: an intelligent system for emotional memory. In *Proc.* 2012 ACM annual conference on Human Factors in Computing Systems, Austin, Texas, USA, 849-858.

[18] Morin, A. (2006). Levels of consciousness and self-awareness: A comparison and integration of various neurocognitive views. *Consciousness and Cognition. 15,* 2, 358-371.

[19] Petersen, D., Steele, J., and Wilkerson, J. (2009). WattBot: a residential electricity monitoring and feedback system. In *Proc.* 27th international conference extended abstracts on Human factors in computing systems, Boston, MA, USA, 2847-2852.

[20] Ståhl, A., Höök, K., Svensson, M., Taylor, A. S., and Combetto, M. (2009). Experiencing the Affective Diary. *Personal Ubiquitous Computing*, 13(5), 365-378.