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Health experience model of personal informatics: The case of a quantified self

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ABSTRACT

The “quantified self” movement and wearable devices with health monitoring and activity tracking functions are experiencing increased popularity, as they allow users to become more aware of their health-related behavior. This paper describes the user experience of the quantified self as examined through multiple methods. First, we surveyed people’s motivations and attitudes toward the quantified self. Second, we investigated the psychological effects of the form of health feedback (comparative vs. non-comparative) and presentation mode (text vs. image) on users’ health preservation tendencies to identify more effective ways of delivering health information to users. The results of this user model confirm the significant role of utility and hedonicity regarding their underlying link to confirmation, satisfaction, and continuance intention. A between-subjects experiment reveals that health information provided in a comparative and textual format is more effective in encouraging health preservation in participants than the identical information presented in a non-comparative image format. In addition, participants’ health-consciousness is found to be a significant determinant of health preservation. The findings show that users’ health experience relates both utilitarian and hedonic aspects of motivation. The findings establish a foundation for future wearable technologies through a heuristic quality assessment tool from a user-centered perspective.

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1. Introduction

The Quantified Self (QS) is considered one of the most potentially productive trends emerging in big data. QS refers to engagement in the self-tracking of any kind of biological, physical, behavioral, or environmental information, either as individuals or in groups, with the aim to improve self-sensing, self-awareness, and human performance within the digital health industry (Wang, Weber, & Mitra, 2016). Self-monitoring (the recording of one’s own target behavior) is becoming increasingly popular as a growing number of smart devices and applications are used to generate huge amounts of data about individuals’ behavior (Gimpel & Niben, 2013). This practice of self-tracking induces positive effects in the observed behavior. Wearable devices, such as smart watches and activity trackers, are popular tools for QS. An increasing number of people use wearables and other smart devices to quantify their daily activities. In fact, wearable devices have made a significant

contribution to the rise of the QS movement, as these devices monitor and collect health-related data and help users review personally relevant information (Li, Medynskjy, Froehlich, & Larsen, 2012). The collected data are used for self-reflection, and allow users to become more aware of their own behavior particularly health behaviors (Petkov, Köbler, Foth, & Krcmar, 2011). This enables positive changes in conduct with respect to health preservation and improvement (DiClemente, Marinilli, Singh, & Bellino, 2001; Khorakhun & Bhatti, 2015).

As with many rollouts, however, a key problem is that QS remains relatively primitive. For all of its strengths, there is an obvious weakness: poor user experience (UX). The low levels of usability and uncomfortable interface are known to negatively affect user acceptance. These lingering inconvenient problems mean that consumers must cope with what we call the burden of usability and compatibility. QS is regarded as being merely a transitional technology, albeit one with a long shelf-life. In the face of rising concerns over limited UX, the usability issues of QS viability and sustainability have not been fully addressed. Industry marketers have not yet identified how to maximize the advantages of

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QS. Consumer views regarding the services and products offered by companies hold major significance in terms of their impact on technological development and diffusion. In addition, despite fast growth in the QS market, there remain issues regarding the usage of such devices in daily life of health care, such as the motivation for tracking biological data and the accuracy of the health data tracked, the capability of managing and integrating different kinds of well-being data, understanding the collected data, and the motivation for long-term usage (Kamal & Fels, 2014). These issues are all related to user perception and attitudes towards health promoting and health behaviors.

Against this backdrop, this study examines users' health experience of QS by proposing a research model incorporating various factors that influence and determine health behaviors. For this goal, we investigate QS experience through two avenues. First, we examine the user model to understand the experience of using QS in terms of health motivations and attitudes. Second, based on the user model, we focus on the effect of application interactions on the health perceptions of users in a QS movement project from the viewpoint of human–computer interaction (HCI). The use of human data and collaborative technology has been the central focus of recent HCI research (Kamal, Fels, & Ho, 2010) and related computer-supported cooperative works (Shin, 2016a). This study models users' health experience by focusing on health information and health behavior regarding QS and eventually attempts to generalize the model to overall QS phenomena.

The following research questions (RQs) were devised to guide this study: (1) What is the human experience of using personal informatics in terms of motivations and quality? (2) How does the QS application help users promote changes in health behavior? (3) How can we design persuasive performance feedback to enhance individual self-reflection and health preservation? (4) What are the design implications of an interface for a QS application? With the RQs in place, we sought to understand the overall health experience and determine whether different social visibilities and awareness affect the interactions in a QS system. The eventual goal was to understand user motivation in order to develop an effective user interface for delivering health information. From a usability and design perspective, it is important to develop an effective user interface or method for delivering health information in order to promote preventive health. Therefore, this study manipulated feedback types and presentation modes as potential strategies for increasing the positive impact of health information, and examined the effects of these forms of feedback on users' health behavior. The results were compared with the quantified behavior patterns that occurred within each condition in order to determine whether there were differences between groups based on use of the personal informatics system. The study results provide new insights into the determinants of engagement in self-tracking through web-based software and applications.

2. Literature review

2.1. Development of the health experience model

The quantified self, often called personal informatics, refers to technologies that help people collect, monitor, and display information about their daily activities through intelligent devices, services, and systems (Swan, 2013). Thus, QS corresponds to the flow of human activity data, engagement, and motivation. Personal data can be described from a human–data interaction perspective (Haddadi, Mortier, McAuley, & Crowcroft, 2013). The rise of personal informatics poses new challenges for HCI and generates opportunities for applications in various domains related to quality of life. QS applications promote healthy behavior through the design

and evaluation of various technologies, often with embedded self-monitoring components (Choe, Lee, Lee, Pratt, & Kientz, 2014). Specifically, data collection, data analysis, and data sharing are the means through which individuals can assess, become aware of, and self-reflect on their behavior (Kamal et al., 2010). These forms of data can influence individual decisions and the social mind (Haddadi et al., 2013; Shin, 2016a,b). With QS, people record and trace their own chosen target behavior, including both subjective information (e.g., emotion, affection, situation, symptom, or disturbance that symptoms may produce, as well as inner thoughts or feelings) and objective information (e.g., frequency or intensity of a behavior under observation).

While the proliferation of personal informatics has simplified the collection of personal data, helping people to engage with these systems over a long period remains an open question. To examine which factors of personal informatics lead to engaging UX and sustained use, we employed multiple methodologies (Fig. 1). The stage-based model of a personal informatics system describes five stages of data barriers (Li, Dey, & Forlizzi, 2010): 1) deciding what information to record and how to collect it; 2) collecting data; 3) integration of data; 4) reflection or examination of data; and 5) change as a result of this new information. This five-stage framework is based on the trans-theoretical model (TTM) of behavior change. The maintenance stage of TTM relates to reflection and changes in user behavior (Prochaska & Velicer, 1997). QS studies show that the reflection stage often occurs when data are captured (Choe et al., 2014), leading to a new model for self-monitoring technology of reflection through data capture and feedback.

TTM is used to classify people based on their motivation to change behavior. Moreover, other research models on personal informatics, such as the stage-based model (Li et al., 2010), are also based on TTM. Each of the early stages of TTM (pre-contemplation, contemplation, preparation, and action) demonstrates people's willingness for behavior change. However, the maintenance stages that we consider in this research suggest that QS applications have to improve and assist the UX to better identify users' health behaviors. Thus, we focused on specific users at the maintenance stage of TTM, because they are likely to require more support to reflect on their behavior and determine what changes to make. Our measurements (health consciousness and health preservation) are matched to these reflection and determination aspects.

In addition to TTM, expectation confirmation theory (ECT) has been applied to UX modeling. ECT explains post-adoption behavior and suggests that both pre-behavior and post-behavior affect confirmation, which in turn influences satisfaction and continuance intention (Shin, 2011). Confirmation relates to the user's judgment of the actual performance relative to a pre-purchase comparison standard such as expectation (Bhattacharjee, 2001). According to ECT, higher perceived performance leads to positive confirmation. The levels of confirmation then provide the basis for subsequent behavior. Customers create a sense of satisfaction or dissatisfaction based on their confirmation levels. Satisfied customers enhance an intention to reuse the product in the future, whereas dissatisfied customers do not continue to use the product.

Applying the ECT framework to the study of how individual differences between QS users influence their continuance intention is appropriate, because individual differences are cognitive beliefs relevant to QS users' behavior (Thatcher & Perrewe, 2002). It is important to examine how the technology acceptance model guides the design of personal informatics systems so that users will continue to use them over a long period. Given that QS users' continuance intention plays a key role in this reuse, understanding how the users' entrenched cognitions and emotional factors affect their continuance behavior becomes important.

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