Motivational Technologies: A Theoretical Framework for Designing Preventive Health Applications

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Abstract. Every day, millions of people seek health information online, but we still do not know how to create websites or mobile applications that could motivate them to change their health-related behaviors in a proactive manner. There is a big difference between learning about one's health status and doing something about it. In order to bridge this gap, we provide a theoretical framework for designing *Motivational Technologies*. We discuss how three affordances of modern media interfaces—*navigability*, *interactivity*, and *customization*—could be used to enhance individuals' intrinsic motivation for preventive health, based on self-determination theory. Empirical evidence and design guidelines discussed here could lead to significant advances in health information systems aimed at promoting preventive health behaviors.

Keywords: Motivational technology, preventive health, navigability, interactivity, customization, intrinsic motivation, self-determination.

1 Introduction

Internet-based interactive health technologies, whereby individuals interact with a communication medium to receive and share health information [41], have been credited with transforming healthcare [6, 8]. Websites, online widgets, smartphone and tablet applications make health information more accessible than ever. Recent reports by Mobi Health News [26, 27] identified a total of 5,820 medical, health and fitness apps for smartphones, with an estimated 3 million downloads.

However, despite widespread availability of health applications across several Internet-based media, surveys (e.g., [15]) have shown that most access them only sporadically for information about medication, nutrition and exercise. There is no evidence of sustained use of online health applications that promote and monitor one's preventive health actions. Recent national surveys have shown that very few adults in the United States follow a healthy lifestyle (e.g., [38]), with researchers calling for intensive preventive interventions that will help reduce risk factors for common diseases [22]. Therefore, it appears that, even with available information and tools, most individuals lack the self-determination for preventive health, despite being intrinsically motivated to avoid disease and ill-health. This presents a classic problem for the field of persuasion in general, and persuasive technologies in particular: How

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can we achieve wider, more consistent use of health technologies in order to reap their benefits for prevention and well-being?

A quick review of recent studies demonstrates several persuasive strategies employed in HCI research. Some have examined how social learning and teamwork principles can be applied to motivate young women to exercise and stay connected via mobile applications [51]. Cell phone applications that keep a count of daily physical activity [9] and caloric balance [52], as well as those that allow users to share health information with peers, friends and families [35], have been tested for personal awareness, competition and social influence. Other studies have explored the role of an embodied conversational agent that can take on the role of an exercise coach and motivate users toward regular physical activity, via goal negotiation and interactive coaching [5]. As we innovate with new tools for serving the cause of preventive health, there is a growing need for assessing the effectiveness of the tools [21]. As a case in point, while download data of mobile apps and evaluations of particular websites are quite promising in their potential to promote diet [33] and exercise [49], we do not yet have systematic knowledge about the efficacy of such tools for preventive health, and what can be done to (i) improve their continued use, and (ii) convert online use into offline health-related outcomes.

Studies have shown that users of Web applications and mobile tools discovered significant design shortcomings, expressing their need for real-time feedback as well as self-configuration and tailoring [2]. A recent study noted that usability issues are likely to frustrate users and lead them to abandon the self-monitoring tasks expected of them [10]. These findings suggest that more interactive, customizable tools and applications may indeed enhance individuals' self-determination to use these online resources for preventive health efforts. In order to meet these needs, we need to articulate and evaluate key guidelines for designing and optimizing such technologies, to introduce system characteristics that promote user engagement and translate into smarter management of a healthy lifestyle, operationalized by sustained performance of wellness routines. We identify key ingredients for internet-based systems that can motivate users to perform health behaviors offline. In this way, our investigation yields guidelines for development of psychologically meaningful interfaces for health websites and mobile applications.

2 Designing Technologies to Enhance Intrinsic Motivation

Intentionality plays a key role in persuasive technologies. Scholars have observed how computers do not have an intention of their own [14, 34]. Instead, intentions lie in the hands of those who design, create and adopt persuasive technologies. With this intentionality perspective in mind, our chief argument is that certain structural features of the technology can be leveraged to build intrinsic motivation among users. For example, scholars have found that the addition of digital photography capabilities to a glucometer changed the device from one that simply displays blood glucose levels to an enabler, encouraging users to visually capture, monitor and regulate their diet [43]. Studies have shown that interactivity in an otherwise static website serves to

profoundly alter user psychology [46]. Investigations into the psychological effects of interactivity and navigability have found that the ability to customize one's online experiences can imbue a profound sense of agency by shifting the locus of control from the system to the user [45].

Understanding oneself is an inherent human drive. Therefore, technologies that showcase one's own self are likely to be intrinsically motivating to users. We can draw upon self-determination theory (SDT) to explain some of the key psychological processes involved in the use of self-monitoring technologies [42]. Self-determination theory makes a distinction between autonomous and controlled regulation of individual behavior. When a goal is set by an individual and is self-driven, then the behavior is said to be autonomous; self-monitoring of one's health-related activities would fall in this category. In contrast, controlled behavior is a reflection of forced adherence to certain goals set by other people (extrinsic factors). Studies on weight-loss, weight-management and diabetes management have provided empirical support to the notion of self-determination and self-regulation by demonstrating that intrinsically motivated individuals are more successful in these programs than those whose behaviors are controlled by external factors. The key challenge therefore is to devise technologies for building self-determination among individuals without the need for repeated and expensive interventions.

2.1 Theoretical Model

Self-determination theory proposes that competence, autonomy and relatedness are essential for one to be intrinsically motivated toward a goal [42]. Autonomy refers to the degree to which individuals feel volitional, i.e., initiators or sources of their own behaviors. Competence is the degree to which one feels able to achieve set goals. The theory also argues that a felt relatedness with one's group, i.e., a warm feeling of connection and sharing, is imperative for enhanced motivation. Individuals who have a stable sense of relatedness with others and who are well integrated in social networks have been shown to possess superior mental and physical health [39]. Likewise, studies have found positive associations between encouraging the need for autonomy and competence in individuals and their health behaviors [28, 31].

Scholars argue that modern day technologies, whether online health-based social networks, bio-medical sensors (e.g., pedometers), personal health dashboards and other health data mining applications have the potential to provide "micro-motivation" by constantly seeking user input and providing continuous feedback that creates an ongoing awareness of their health situation [11]. In line with this, we advocate involving users in their own health behavior activities, letting them navigate, interact and customize their own health website or application. This should produce feelings of competence, relatedness and autonomy respectively, which in turn will positively affect intrinsic motivation to visit the site (or use the app) on a regular basis. Repeated access of health information, especially in such a proactive manner, is a critical determinant of advocated health behaviors, a well-established maxim in the health communication literature [1].

Our theoretical model (Figure 1) predicts not only that navigability (ability to explore the mediated environment), interactivity (ability to interact with others) and customization (ability to tailor the mediated environment) will influence intrinsic motivation to engage with the health tool, but also that this will in turn affect health attitudes (e.g., self-efficacy to learn about and perform preventive health behaviors) and actions (e.g., adoption and maintenance of healthy lifestyle), leading eventually to adoption of preventive health behaviors on a regular basis. Our argument is that specific aspects of health technologies enhance their stickiness, which in turn ensures that users engage these media on a regular basis. Over time, this engagement will translate into sustained exercise of preventive health behaviors. This model may be operationalized in the form of web-based tools or mobile apps for self-management of preventive regimens, such as the ability to monitor one's daily diet in the form of fruit and vegetable consumption, physical activity and exercise routines and allied factors involved in the management of health risk factors. The overarching propositions of the model (Figure 1) are as follows:

P1: Optimal levels of Navigability, Interactivity and Customization will lead to higher levels of Intrinsic Motivation (via psychological mechanisms of Competence, Relatedness and Autonomy, respectively).

P2: Higher levels of Intrinsic Motivation will lead to greater levels of Engagement with health content.

P3: Higher levels of Engagement with health content will lead to better Attitudes and adoption of continuous Health Behaviors.

Most research on health informatics focuses on design and delivery of specific messages for stimulating positive health outcomes. In contrast, our approach explores the role played by technology-related variables in creating an atmosphere conducive to enhancing users' sense of autonomy, competence and relatedness. Thus, our framework provides additional guidelines to build persuasive technologies, which can be easily translated into requirements specification process for software development [34]. In the sections that follow, we introduce the three key design characteristics (navigability, interactivity, and customization) and provide results from empirical studies of these user-interface design variables in a wide variety of content domains.

2.2 Navigability Builds Competence

Navigability refers to the extent to which users can explore a mediated environment, e.g., a health website, in a highly idiosyncratic manner. Online content is organized in a non-linear fashion, with a mix of hyperlinks and other information locatability tools such as search engines. Thus, when seeking information online, users must be able to navigate through large bodies of information. Navigability can be seen as the ability to access any part of an information space [13]. If the structure of a site is very complicated, users will feel lost in a maze of information and feel overwhelmed [17].

A common strategy for ensuring good navigability is to reduce complexity with the help of scaffolds (or help aids) that allow users to explore and manage the

environment. There are two ways in which scaffolding takes place. One is by providing familiar navigational tools such as sitemaps or alphabetical indices that list information in a logical, highly predictable fashion. Another technique is to provide psychologically prominent visual cues (or heuristics) that can help users in processing the information presented to them on health websites. As Balakrishnan and Sundar [3] point out, the primary role of navigability tools is to fulfill a "guidance" or "way-finding" function.

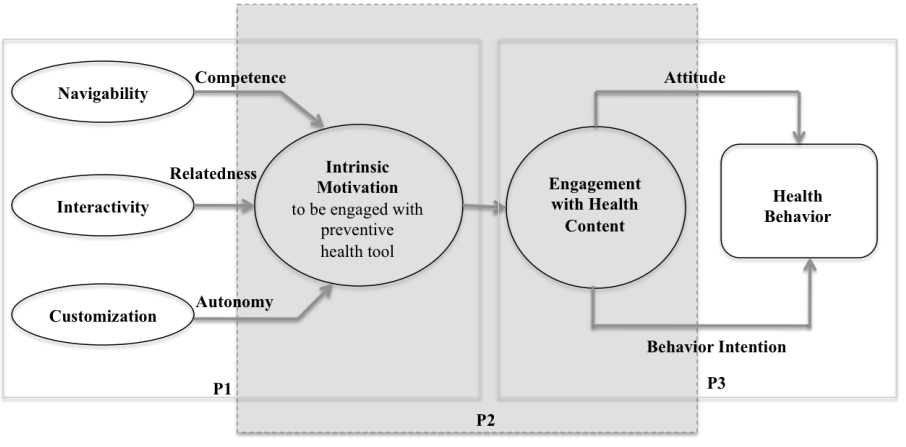

Fig. 1. Theoretical model of motivational technology to promote preventive health behaviors

In sum, effective interfaces should have navigational structures that show users how to reach their goals with ease. This is tied to Information Foraging theory, which suggests that online users are heavily influenced by the "information scent" transmitted by "proximal cues" in the immediate environment about "distal information" [36]. Literature on website usability identifies the following key features for enhancing navigability: search function, drop-down menus, A-Z index lists, breadcrumb navigation, sitemaps and a link to the Home page for user reorientation (see [7, 29, 30]). In addition to usability and user-friendliness, navigability gives the users a sense of control over the website. User control theory [12] suggests that in an online environment filled with clickable links, users will be able to feel in control of content if they are able to navigate through and process content in a manner that they think is personally appropriate. Users must be able to do so at their own pace, and thus any attempt to measure the effects of interface navigability must be based on users' personal needs and abilities. Power users are known to feel a sense of competence when they are able to effortlessly master the quirks of an interface while their lay counterparts end up feeling inadequate when faced with challenging interface features [25, 48]. Sundar [44] discusses the importance of navigability towards building competence and leading to positive cognitive, emotional, and behavioral outcomes by proposing that certain navigation cues on interfaces—cues such as

hyperlinks, site-maps, menus, tabs, and paths in games—serve to trigger distinct heuristics (or mental shortcuts) about the underlying content, leading to quick credibility judgments. Furthermore, navigational design for virtual environments serves the purpose of improving user comprehension of embedded information as well as relationships between different pieces of information [3]. These empirical findings suggest that users' willingness to consume content and be persuaded is significantly affected by the self-efficacy derived from their experience with highly navigable interfaces.

2.3 Interactivity Builds Relatedness

Interactivity, especially "person interactivity" [16], is said to occur if the user is able to connect and have a reciprocal exchange with other people. Good person-interactivity is said to occur when there is a great deal of contingency or threadedness in the interaction [37], i.e., any given message is based on multiple previous messages. This idea of message-based interactivity brings to the fore the notion of relatedness between messages. Studies (e.g., [47]) have shown that higher levels of interactivity will imbue a psychological feeling of relatedness among users and also facilitate greater communal participation in the interaction. When the user of a health site constantly receives messages from other users, it is likely to act as an online support group, providing not only information but also social and emotional comfort, thus building a sense of community. A good example is MoviPill [35], which is a cell-phone application that allows users to monitor not only their own but also their friends' and families' daily medication intake.

Scholars observe that there are two pathways of media influence for promoting changes in health behavior--a direct pathway and a socially mediated pathway--with the latter motivating individuals by connecting them to their social networks and communities [4]. In sum, interactivity features are essential for building relatedness among users as well as a deeper connection between users and the health content that they consume. Sharing options and other forms of interaction between users create a sense of community in online forums or among app user groups. Constructive competition, in workout applications for instance, motivates users in the same way that an offline gym buddy does. On the other hand, regardless of whether interactive features elicit actual interactions, simple interactivity cues, such as bandwagon cues, are likely to engage users by relating to similarly situated others [44], and thereby positively affect health behaviors.

2.4 Customization Builds Autonomy

Customization in health communication has typically taken the form of information tailored in such a way as to meet the needs of one specific individual, based on identification of distinctive attributes of that person [40]. A meta-analysis [32] of 57 studies found that tailoring does have a significant positive effect on health behavior changes. Other research suggests that tailoring may be even more effective when the user does it, especially if s/he is a power-user [48].

According to the agency model [45], customization serves to imbue users with a strong sense of personal agency, by allowing them to constantly specify highly individualistic preferences and requests. In an online environment, the sense of agency is best understood as the degree to which the self feels like s/he is a relevant actor in online interactions, or as a sense of involvement, identity and control, thereby enhancing their efficacy and self-determination in that domain. The fact that the user himself/herself specifies the customizable options makes the locus of causality to be perceived as internal, which brings about the true value of customization, i.e., a real sense of personal autonomy or self-determination [19].

To examine the influence of customization on people's sense of autonomy, we contrasted customization (user-tailoring) with the notion of personalization (where tailoring is performed by the computer system). While system-tailoring results in content that is relevant to the user, customization produces content that is not only relevant but also of utility to the user, thereby boosting user agency and self-determination. Prototypes of several customizable widgets were developed and tested in relation to long-term beneficial health behaviors such as exercise and diet. The findings from this study showed that when users were highly involved in their health, customizing their daily diet and exercise activities enhances their intention to perform preventive health behaviors whereas a control site diminishes their intention over time. Studies on customization features in the Netvibes Web portal [23, 24], avatar customization in Second LifeTM virtual world [20] and self-centered, as opposed to other-centered, customization in iGoogle [18] all show that regardless of the object that they customize, users feel a stronger sense of identity as well as control in their interactions through the interface, compared to users provided with system-tailoring.

3 Implications for Design of Persuasive Health Technologies

To promote sustainable, self-motivating health behaviors, it is not enough to make health information and data available and accessible. Nor is it sufficient to use persuasive messages to convince the user about practicing health behaviors. What we need are technologies that motivate and empower users, not simply inform or persuade them. The key therefore is to move beyond persuasive technologies to what we call *motivational technologies*. While the functional triad of persuasive technologies as tools, media and social actors suggests broad goals for health applications, it is time to drill down and identify specific variables that increase human ability, provide experiences and create relationships in order to persuade as well as motivate [14]. Design elements should be implemented to stimulate the psychology of self-determination for practicing health behaviors in a sustained manner. As discussed above, the technological affordances of navigability, interactivity, and customization have the psychological potential for increasing user's sense of competence, relatedness and autonomy respectively. Therefore, our design suggestions are as follows:

- Interfaces for preventive health applications ought to explicitly factor in competence-building tools. These could be temporary scaffolds and/or visual cues geared to make the user feel competent about his/her ability to navigate the

application and make full use of its features and functionalities. Power users and experienced users ought to be provided shortcuts for improving the efficiency of their actions on the interface.

- Relatedness can be enhanced by a variety of tools, ranging from those that feature message-interactivity (i.e., contingent message exchanges between and among users) to those that offer affordances related to sharing, competing, and otherwise socially exhibiting their preventive health behaviors. In addition, interfaces ought to build in metrics that produce interface cues displaying the degree of social support that users are receiving from their networks for their various health actions.
- For building a sense of autonomy among users, systems ought to offer customization features that actively involve the user in specifying their preferences. This may seem counter-intuitive given the easy availability of personalization technologies that require less user input (because they are able to unobtrusively collate user preferences automatically through their actions online). However, in the interest of building personal agency, it is important for tailoring tools to explicitly offer choices to users and provide them with avenues for creating highly idiosyncratic health regimens. Design should focus on making the user feel like they are the master of their actions, both with the interface and their own bodies. This can be achieved by way of affordances that allow users to exert volitional control (e.g., pursue health goals through an unorthodox patchwork of activities) as well as through interface cues, which highlight the fact that the user is the source of actions triggered by the interface.

For UX researchers evaluating interfaces of health sites and applications, this means

- Devising metrics for assessing perceived competence and related constructs unearthed by our review of studies—constructs such as user control, perceived quality of information scent, wayfinding ease, usefulness of guidance tools, and so on.
- Assessments should include measures of contingency in communications involving the tool (i.e., the degree of threadedness in interactions between the user and specific others), the perceived levels of social support and informational support felt by the user, the degree to which users feel the social presence of their networks, and the extent to which they feel like they can relate with others in making the tool work for them and produce the intended health benefits.
- User studies should factor in the degree of self-tailoring performed by the user, their degree of deviation from defaults and recommended actions, the psychological sense of agency felt by the user, and the extent to which the user sees the interface as reflecting their personal identity.

4 Conclusion

At a recent summit entitled “Putting the I in Health IT,” the U.S. Department of Health and Human Services encouraged health professionals and the general public to think of ways in which health consumers can be empowered and put in charge of their own healthcare [50]. In consonance with such macro-level policy directives, our work builds theoretical knowledge about effects of technological elements in motivating

preventive health behaviors at the individual level. It provides insights into developing and assessing health technologies for their usability and efficacy. Findings from studies employing the proposed model will provide guidelines for designing health technologies to meet the increasing need for visual, emotional and personal applications that utilize mobile and Web 2.0 technologies. Future preventive health technologies should incorporate all three factors discussed here--*navigability*, *interactivity*, and *customization*--in a theoretically meaningful manner so that we can build applications that are usable, social, self-determining, and therefore capable of promoting intrinsic motivation for preventive health actions.

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