Chapter 11
Designing Persuasive Health Behavior Change Interventions

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Abstract In the past decade, the utilization of various technologies to change individuals' health behaviors has been a rapidly expanding field of interest. Examples of persuasive technologies can be found rather easily as there are a variety of Internet-, Web- and mobile-based systems and applications promoting healthier lifestyles. Still, the use of persuasive technology in the E-health arena is in its infancy. While the field is expanding, it is evident that more research is needed to better determine how the systems affect users' intended behaviors. This book chapter outlines several important perspectives in designing and developing persuasive health behavior change interventions. Furthermore, this chapter offers novel viewpoints, both theoretical and practical, in designing and developing health behavior change interventions. In addition, useful underlying theories and design models are identified and discussed. This type of knowledge may assist in building, deploying and evaluating behavior change support systems that are able to engage and retain large amounts of individuals, potentially enhancing population health and well-being.

Keywords Health • Behavior change • Persuasive technology • Design

11.1 Introduction

Changing people's behavior is at the heart of health promotion. In the past decade, the use of technologies to persuade, motivate and activate individuals' for health behavior change has been a quickly expanding field of research. The

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use of the Internet for delivering health behavior change interventions has been especially relevant. Applications and systems for preventing, assessing, and treating conditions such as alcohol problems (cf. Bewick et al. 2008), depression (van Straten et al. 2008), diabetes (Tate et al. 2003), obesity (Harvey-Berino et al. 2010), physical inactivity (Hurling et al. 2007), and smoking (cf. Shahab and McEwen 2009) have been tested in numerous controlled trials. These automated health behavior change interventions have the potential of high reach and low cost. Recent comprehensive meta-analyses provide support for their effectiveness in changing knowledge, attitudes, and behavior in the health promotion area (Portnoy et al. 2008; Webb et al. 2010).

Various terms have emerged in order to describe technology-based interventions for mental and physical health purposes: cybertherapy, digital therapy, e-therapy, Web-based therapy, eHealth, e-Interventions, digital interventions, internet interventions, computer-mediated interventions, and online therapy (or counseling), among others (Barak et al. 2009). Thus far, there is no consensus of the terminology. Barak et al. (2009, p. 5) have defined a Web-based intervention as:

> A primarily self-guided intervention program that is executed by means of a prescriptive online program operated through a website and used by consumers seeking health- and mental-health related assistance. The intervention program itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive web-based components.

The abovementioned definition is a fine endeavor to capture the essence of *Web-based* health behavior change interventions. However, in this book chapter we will discuss Behavior Change Support Systems (Oinas-Kukkonen 2010). The definition of behavior change support systems may be more flexible than the definition presented by Barak et al. and serves the purpose of this chapter better. In addition, BCSSs are not limited to the Web, and they might run on various operating systems, platforms and devices.

On a par with health behavior change, persuasive technology has the potential for significant breakthroughs on many areas of human well-being, such as education, and environmental conservation. Examples of persuasive technology can be found rather easily as there are a variety of websites promoting healthier lifestyles. Unsurprisingly, one of the strongest domains of innovation for persuasive technology in the immediate future will be preventive health care. Still, the use of persuasive technology in the health arena is in its infancy. While the field is expanding, it is evident that more research is needed to better determine how the systems affect users' intended behaviors. Resnicow et al. (2010) point out that the first generation of patient-centered eHealth studies have concentrated mainly on answering the question of whether such programs are efficacious. They propose that the next generation of eHealth research starts to better address the questions of why, how, and for whom they work (Resnicow et al. 2010).

11.2 Behavior Change Support Systems

Oinas-Kukkonen (2010, p. 6) has defined a behavior change support system as follows:

> A behavior change support system (BCSS) is an information system designed to form, alter or reinforce attitudes, behaviors or an act of complying without using deception, coercion or inducements.

Behavior change support systems (Oinas-Kukkonen 2010) are persuasive, producing either computer-mediated[1] persuasion or computer-human persuasion BCSSs emphasize – but are not limited to – autogenous approaches in which people use information technology to change their own attitudes or behaviors through building upon their own motivation or goal. They also request a positive user experience and encourage the user engagement regularly over an extended period of time (Oinas-Kukkonen 2010).

Evidently, the design and development of BCSSs is a multifaceted issue. It links to technological services, applications, platforms, and functionality, the quality and content of information, personal goal-setting (Locke and Latham 2002) by the end-users, and social networks/environments, among other issues. In many cases, the BCSSs must be always available, they have to address global and cultural issues with a multitude of standards, habits, and beliefs. Furthermore, they have to be adaptable into a variety of domains (e.g. healthcare, education) and business models (Oinas-Kukkonen 2010).

When building BCSSs, psychological insight is needed. According to Oinas-Kukkonen (2010) several important lessons can be learned from psychological theories, including: (1) people like their views about the world to be organized and consistent (Festinger 1957); (2) persuasion is often incremental; (3) direct and indirect routes are key persuasion strategies (cf. central and peripheral route, Petty and Cacioppo 1986).

The primary research interests in BCSSs include not only human-computer interaction and computer-mediated communication, but also topics such as approaches, methodologies, processes and tools to design and develop such systems and means for examining the individual, social, and organizational impacts of them. The research underlines software qualities and characteristics, (information) systems analysis and design, and individual behavior and perceptions. Technologically, the research may address socio-technical platforms, systems, services or applications, or the software features in them, developed for persuasive purposes (Oinas-Kukkonen 2010).

Research on *persuasive technology* has been introduced relatively recently. Briñol and Petty (2009, p. 71) outline persuasion as follows: “In the typical situation

[1] We use the term computer for the sake of simplicity; it also includes e.g. mo-bile/smart/tracking/monitoring/wearable devices.

Table 11.1 Evolution of persuasive technologies (Adapted from Chatterjee and Price 2009)

Type (generation)	Example technology
Prescriptive systems (G1)	Phone call, brochures, CD-ROM
Descriptive systems (G2)	Web/Internet, mobile devices, sensor devices
Environmental systems (G3)	Body area networks, Context-aware real-time sensing
Automated systems (Future)	Pervasive sensing, genetic integration

Table 11.2 Outcome design matrix (Oinas-Kukkonen 2010)

	Compliance	Behavior	Attitude
Formation	Forming an act of complying	Forming a behavior	Forming an attitude
Alteration	Altering an act of complying	Altering a behavior	Altering an attitude
Reinforcement	Reinforcing an act of complying	Reinforcing a behavior	Reinforcing an attitude

in which persuasion is possible, a person or a group of people (i.e., the recipient) receives an intervention (e.g., a persuasive message) from another individual or group (i.e., the source) in a particular setting (i.e., the context)." Successful persuasion takes place when the target of change (e.g., attitudes, beliefs) is modified into the desired direction (Briñol and Petty 2009) (Table 11.1).

Webb et al. (2010) suggest that the effectiveness of Internet-based interventions is associated with (1) more extensive use of theory; (2) inclusion of more behavior change techniques; and (3) use of additional delivery modes.

Kaptein et al. (2010) argue that in order to develop beneficial programs capable of persuading individuals to change their health-related attitudes and behaviors, more insight of how different individuals respond to the persuasive strategies utilized is required. Kreps and Neuhauser (2010) call for interventions that appeal to the distinctive interests and emotions of targeted audiences to capture attention and influence behaviors (cf. 'Affective Computing', Picard 2003).

11.2.1 Types of Change

Oinas-Kukkonen (2010) categorizes behavioral changes as follows: (1) a change in an act of complying; (2) a behavior change; and (3) an attitude change. Respectively, these are called C-, B-, and A-Change, in ascending order of complexity. Different persuasive goals and strategies may be needed for applications supporting different types of changes. A design matrix can be constructed from the intended outcomes and the types of change (Oinas-Kukkonen 2010). See Table 11.2.

The designers of BCSSs should carefully consider which of these nine different goals the application will be built for as the *persuasion context* may change dramatically when moving from one slot to another (Oinas-Kukkonen 2010). Dey (2001) states that context is all about the entire situation relevant to an application and its group of users, and he defines context as any information that can be used to characterize the state of an entity. An entity may be a person, place, or object that is

regarded germane to the interaction between a user and the application (including the user and applications themselves).

In our view, the ultimate goal of a behavior change support system lies within the outcome matrix. Obviously, the outcome matrix is a simplification of the matter as the intended behavior change might occur on multiple levels.

11.2.2 Examples of Health Behavior Change Interventions

In this section, we will discuss recent research endeavors of behavior change support systems in the health domain.

We have selected three very important areas for a closer view: (1) physical activity and dietary behavior change; (2) weight loss and weight management; and (3) substance abuse. Based on our experience, these are amongst the most studied areas in individual health behavior change during the past decade (cf. Lustria et al. 2009).

11.2.2.1 Physical Activity and Dietary Behavior Change

In their review, Norman et al. (2007) conclude that published studies of eHealth interventions for physical activity and dietary behavior change are in their infancy. Their results indicated mixed findings related to the effectiveness of eHealth interventions. According to these researchers, interventions that feature interactive technologies need to be refined and more rigorously evaluated to fully determine their potential as tools to facilitate health behavior change (Norman et al. 2007).

In a review conducted by Vandelanotte et al. (2007) 8 out of 15 of the trials of Web-based physical activity interventions reported positive behavioral outcomes. However, they conclude that intervention effects were momentary, and there was slight evidence of maintenance of physical activity changes (Vandelanotte et al. 2007). Neville and colleagues (2009) reviewed 12 computer-tailored interventions for dietary behavior outcomes, and reported significant positive effects on seven of the interventions. Kroeze et al. (2006) systematically reviewed the scientific literature on computer-tailored physical activity and nutrition education. They reported significant effects on 3 of 11 of the physical activity studies and 20 of 26 of the nutrition studies.

In spite of these promising results, most of the researchers advice caution in generalizing the results. For instance, Neville et al. (2009) argue that even though the evidence of short-term efficacy for computer-tailored dietary behavior change interventions is relatively strong, there is uncertainty whether the reported effects are generalizable and sustained long term. According to Vandelanotte et al. (2007) more research is required to pinpoint elements that can enhance behavioral outcomes, the maintenance of change and the engagement and retention of participants. Van den Berg et al. (2007) point out that the importance of specific components of Internet-based physical activity interventions, such as increased supervisor contact, tailored information, or theoretical fidelity remains to be determined.

Consolvo and colleagues' study of 'Houston' (2006) was one of the first attempts at developing a persuasive technology to encourage physical activity. In the study, three groups of women from pre-existing social networks shared their step counts and progress toward a daily goal with each other via their mobile phones. The prototype consisted of three elements: a pedometer, mobile phone and custom software, Houston, that was ran on the phone. Based on their analysis of the qualitative data, Consolvo et al. (2006) present "key design requirements of technologies that encourage physical activity": (1) give users proper credit for activities (cf. 'rewards', Oinas-Kukkonen and Harjumaa 2009); (2) provide personal awareness of activity level (cf. 'self-monitoring', Oinas-Kukkonen and Harjumaa 2009); (3) support social influence (cf. 'social support' category, Oinas-Kukkonen and Harjumaa 2009); and (4) consider the practical constraints of users' lifestyles (cf. 'the event', Oinas-Kukkonen and Harjumaa 2009). A more advanced mobile, persuasive technology system 'UbiFit' is presented in Consolvo et al. (2009).

'Fish'n'Steps', a social computer game (Lin et al. 2006), was designed to persuade users to take more steps each day. Each participant was assigned a weekly step count goal, which became progressively more challenging over the six weeks of the participation in the game. The user's daily step count was measured by simple pedometers. The data was linked to the different states and activity of a fish displayed in a virtual fish tank. The game utilized *competition, recognition, and cooperation* (cf. Oinas-Kukkonen and Harjumaa 2009) as an additional leverage towards the goals. The game increased participants' awareness of their physical activity status and provided motivation to increase the activity level in an engaging way (Lin et al. 2006).

Harjumaa et al. (2009) explored a prototype of a heart rate monitor (Polar FT60) that included a persuasive training program. The aim of their study was to investigate how different persuasive strategies function with different people and in relation to each other in the context of exercise behavior. The authors of the study suggest that leveraging goal setting, tracking performance, adopting social roles, along with a high overall perceived credibility influences user behavior. Short-term verbal system feedback via praise and rewards may provide additional persuasive effect. They also emphasize that even if the product is designed for a homogenous target group, small individual differences between users may weigh in persuasion. It may be wise to select a set of persuasion principles and use them together rather than rely on one principle only. In turn, persuasion principles are interlinked. Thus, the effect of persuasion principles may be "more than the sum of its parts" (Harjumaa et al. 2009).

11.2.2.2 Weight Loss and Weight Management

One of the most vibrant areas within health behavior change research has been Web-based software systems promoting weight loss and weight management. These Web-based services are illustrative examples of BCSSs in the eHealth space.

Recent research suggests that the Web may be a highly viable channel for delivering weight loss and obesity interventions across diverse populations. Web-based weight control applications have the potential to achieve outcomes similar to other

lifestyle treatment options. Several randomized trials have demonstrated Web-based weight-loss interventions to be efficacious for short-term weight loss. However, online programs have not accomplished weight losses of the magnitude typically produced by traditional individual and or group treatment approaches. These findings should be interpreted with caution, however. According to Bennett and Glasgow (2009) most randomized controlled trials in this particular domain have been relatively small and underpowered, suffering from high levels of attrition and occasionally reporting change in only secondary outcomes, e.g., knowledge and self-efficacy, rather than primary outcomes, e.g., behavior change. Tsai and Wadden (2005) argue that minimal evidence still exists for recommending the use of commercial Internet-based interventions. Also, Womble and colleagues (2004) found in their study that a commercial Internet-based weight loss program produced only minimal weight loss and was not as effective as a traditional manual-based approach. Harvey-Berino et al. (2004) reported that participants assigned to an online weight maintenance program sustained similar levels of weight loss over 18 months compared to individuals who continued to meet face-to-face.

Bennett and Glasgow (2009) summarize that greater results in weight loss are typically observed with such Web-based weight-loss interventions that are highly structured, provide support from a human counselor, utilize tailored materials, and promote a high frequency of website logins. Krukowski and colleagues (2008) share this view by concluding that structured interventions comprising behavior therapy components, interactive and dynamic website features, and synchronous communication produce the most significant weight losses.

The current generation of online weight loss interventions takes advantage of a set of varying software components, such as self-monitoring functionality, food diaries, body mass index calculators, support forums, and coach messaging (Lehto and Oinas-Kukkonen 2010). See Table 11.3. Yet, it is unclear which of these features, either in isolation or collectively, are associated with the greatest magnitude of weight loss.

Lehto and Oinas-Kukkonen (2010) investigated the utilization of various persuasive features on six weight loss websites. The Persuasive Systems Design Model (Oinas-Kukkonen and Harjumaa 2009) was applied to extract and analyze persuasive

Table 11.3 Typical content in weight loss websites

Content	Example
Health-related advice	Nutrition, diet, physical activity, exercise, weight loss, and weight management advice
Self-monitoring tools	Food/activity/weight logs and trackers, body mass index and calorie counters, diaries, reminders, feedback
Social/peer influence components	Blogs, forums, groups, instant messaging, chat rooms, e-mail/inbox, competitions/challenges, social media connectivity, public recognition
Expert components	"Ask an expert", expert blogs, expert moderation on forums/chat rooms
Rehearsal and simulation	Workout builders, video workouts, exercise planners

system features found in the sites. The evaluated sites provided relatively good primary task support and strong social support. However, there were weaknesses in both dialogue and credibility support.

The results of their study indicate that there is room for improvement in both designing and implementing Web-based interventions for weight loss.

11.2.2.3 Substance Abuse

A digital therapy intervention for smoking cessation, 'Happy Ending', has been shown to be efficacious in previous randomized controlled trials (Brendryen et al. 2008; Brendryen and Kraft 2008). Happy Ending is a fully automated system and delivered by using the Internet and mobile phone. The intervention builds on multiple theories: self-regulation theory, social cognitive theory, cognitive–behavior therapy, motivational interviewing and relapse prevention. The arrangement of the content matches to psychological processes that people undergo at specific points of time in a process of therapy-supported self-regulation. The design of the intervention is novel in that it combines four delivery modes (SMS, Interactive Voice Response, e-mail, and Web). Happy Ending blends "just-in-time therapy" and a tunneling strategy. The two forms of just-in-time therapy are a craving helpline, and the relapse prevention system based on a daily assessment of the target behavior (Brendryen et al. 2010).

Lehto and Oinas-Kukkonen (2009) studied persuasive features (Oinas-Kukkonen and Harjumaa 2009) in Web-based alcohol interventions. They suggest that the evaluated websites were not very persuasive. Nevertheless, all evaluated sites successfully demonstrated trustworthiness, expertise, and surface credibility. Primary task support principles were utilized relatively poorly in many of the sites. Interestingly, and perhaps rather worryingly, tailoring was applied in only one of the sites. There were also notable differences between the evaluated sites. For instance, some sites placed more emphasis on online social support than others. Many of the sites did not offer any online social support. The authors believe that providing (expert-moderated) support groups as a part of a technology-based intervention is a very important aspect of such interventions. There are several techniques (e.g. instant messaging, chat rooms, discussion forums, social networks) readily available to facilitate communication between peers. In anonymous online support groups, the participants may overcome the feeling of being stigmatized, and time and location are no longer obstacles for participation.

11.2.2.4 Summarizing the Examples

Thus far there is limited evidence on the effectiveness of behavior change support systems. Researchers have been cautious about the generalizability of the results. Finding e.g. optimal theories, strategies, and delivery modes require further research. Both rigorous evaluations of existing health-related behavior change systems, and experimental/pilot studies with creative approaches are called for.

Atienza and colleagues (2010 p. 86) make an excellent remark that "health information technology does not occur in a vacuum, but rather technologies exist within social systems." In order to widespread adoption, dissemination, and extended use of technology-based health interventions to take place, it is incumbent on researchers to investigate not only how the interventions affect individuals, but also how individuals interact with technology and each other (Atienza et al. 2010).

11.3 Design and Theory Issues

> A large number of health information system projects fail. Most of these failures are not due to flawed technology, but rather due to the lack of systematic considerations of human and other non-technology issues in the design and implementation processes (Zhang 2005, p. 1)

Attempts to create persuasive systems often fail, because many projects are too ambitious being set up for failure. For example, a design team might select a difficult behavior as the target, e.g. smoking cessation, but without having ever before created such a persuasive system the success rate might be low (Fogg 2009b). Thus, designing systems that aim at behavior change requires thorough understanding of the problem domain, the underpinning theories and strategies of persuasive systems design. Usually an interdisciplinary team of professionals is called for. According to Kuziemsky et al. (2007) the primary challenge for information system design in healthcare is to interconnect the medical, technical and social contexts.

Consolvo et al. (2009, p. 414) emphasize that "lifestyle behavior change is a long-term endeavor that pervades everyday life, including the social world. If done poorly, the technology is likely to be abandoned; therefore a principled approach for its design is needed".

Kreps and Neuhauser (2010) have identified four main directions for designing eHealth interventions to attain their full promise for promoting health. According to them, eHealth interventions must be (1) interactive, encouraging and involving; (2) effective, transparent, and interoperable; (3) dynamic, personally engaging; and have (4) high reach, and adaptability. Glanz and Bishop (2010) warrant for creativity. In their view, interventions should be "as entertaining and engaging as the other activities with which they compete".

Pagliari (2007) argues that designing effective eHealth systems involves applying expertise from diverse fields. Such advantageous interdisciplinary collaboration, with the ultimate goal of achieving transdisciplinary working, may be alleviated by increasing familiarity with each others' terminologies, theories and methods. Moreover, "mutual trust and respect for each others' aims, epistemologies, and contextual drivers, as well as a willingness to step outside traditional working boundaries" is required (Pagliari 2007).

Some might argue that behavior change technologies should be designed for action, not persuasion. In our view, however, persuasive behavior change support systems ultimately aim at both, motivating and facilitating (and maintaining) change.

According to Oinas-Kukkonen (2010), many BCSS design issues are general software design issues rather than specific to BCSSs only. These include, but are not limited to, usefulness, ease of use, ease of access, high information quality, simplicity, convenience, attractiveness, lack of errors, responsiveness, high overall positive user experience, and user loyalty.

11.3.1 Examples of Persuasive Design and Analysis Tools

In *Fogg Behavior Model* (FBM), behavior is a product of three factors: motivation, ability, and triggers, each of which has subcomponents (Fogg 2009a). The FBM asserts that for an individual to perform a target behavior, she must (1) be sufficiently motivated; (2) have the ability to perform the behavior; and (3) be triggered to perform the behavior (Fogg 2009a). Fogg underscores that these three factors must take place at the same moment, otherwise the behavior will not happen. According to Fogg (2009a), the FBM is useful in analysis and design of persuasive technologies. The FBM may also helps teams work together efficiently since the model gives enables people to share thoughts about behavior change (Fogg 2009a). See also Fogg's eight steps in early-stage persuasive design (Fogg 2009b).

Persuasive Systems Design Model (PSD Model) is a recent conceptualization (Oinas-Kukkonen and Harjumaa 2009) mainly for designing and developing persuasive systems. Thorough analysis of the persuasion context (the intent, event, and strategy of persuasion) is needed to discern (in)opportune moments for delivering the messages (Oinas-Kukkonen and Harjumaa 2009). The PSD model consists of a set of design principles under four categories: (1) primary task; (2) human-computer dialogue; (3) perceived system credibility; and (4) social influence. The design principles in the primary task category focus on supporting the user's primary activities. Design principles related to human-computer dialogue aid in achieving the goal set for using the system. The perceived system credibility design principles relate to how to design a system so that it is more credible and thereby more persuasive. The design principles in the social influence category describe how to design the system so that it motivates users by leveraging social influence (Oinas-Kukkonen and Harjumaa 2009). The greatest benefit of the PSD model may be achieved when it is applied together with a sound behavior change theory or a model, such as the *Elaboration Likelihood Model* (Petty and Cacioppo 1986).

Design with Intent (DwI) means design that is intended to influence or result in certain user behavior – it is an attempt to describe many types of systems (products, services, interfaces, environments) that have been strategically designed with the intent to influence how people use them (Lockton et al. 2008; Lockton et al. 2009). The Design with Intent Toolkit[2] consists of a wiki and 101 design patterns (cards),

[2] http://www.danlockton.com/dwi/. Accessed Aug 25, 2010.

which are grouped according to eight 'lenses' bringing divergent disciplinary perspectives on behavior change.

There are also a number of other examples of design strategies. Consolvo et al. (2009) have proposed a set of design strategies for technologies motivating lifestyle behavior change. They propose eight design strategies: (1) abstract and reflective; (2) unobtrusive; (3) public; (4) aesthetic; (5) positive; (6) controllable; (7) trending/historical; and (8) comprehensive. The authors state using theory and findings from recent persuasive technology research to extend existing design goals.

Based on their systematic review, Lustria et al. (2009) has presented strategies used in computer-tailored online behavioral interventions. The organizing heuristic includes two main categories: implementation strategies and message tailoring strategies. The first category hosts three subcategories: (1) general implementation strategies; (2) modalities; and (3) tools for building self-regulatory skills. The latter category includes (4) tailoring criteria and (5) tailoring mechanisms.

Ritterband et al. (2009) has conceptualized *A Behavior Change Model for Internet Interventions*. The model has two main objectives: informing future development; of Internet interventions and helping to predict and explain behavior changes produced by those (Ritterband et al. 2009).

RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) is used to report results or compare interventions, it is also a design/planning tool and as a method to review intervention studies (Glasgow et al. 1999).

11.3.2 Design Science Approach

According to Hevner et al. (2004) two paradigms command much of the research in the Information Systems discipline: *behavioral science* and *design science*. The first attempts to develop and verify theories that explain or predict human or organizational behavior. The latter is aiming for enhancing the boundaries of human and organizational capabilities by devising novel artifacts. Both paradigms are "foundational to the IS discipline, positioned as it is at the confluence of people, organizations, and technology" (Hevner et al. 2004, p. 75).

Design science is a discipline oriented to the creation of successful artifacts, which may be, for instance, constructs, models, methods, or instantiations. Peffers and colleagues (2007) have proposed the design science research methodology (DSRM). The DSRM process model is presented in Table 11.4.

The process is structured in a nominally sequential order. It is not assumed that one would always proceed from step 1 through activity 6. The process may actually be initiated at virtually any step. *A problem-centered approach* might be feasible if the idea resulted from observation of the problem or from suggested future research (e.g. in a paper from a prior project). *An objective-centered solution* could be prompted by an industry or research need that can be addressed by developing an artifact. *A design- and development-centered* approach would arise from the existence of an artifact that has not yet been formally supported as a solution for

Table 11.4 DSRM process model (Adapted from Peffers et al. 2007)

Activity	Explanation	Resources required (e.g.)	Possible research entry points
1. Problem identification and motivation	Define problem Show importance	Knowledge of the state of the problem and the importance of its solution	Problem-centered initiation
2. Define the objectives for a solution	What would a better artifact accomplish?	Knowledge of the state of problems and current solutions, if any, and their efficacy	Objective-centered solution
3. Design and development	Determining the artifact's desired functionality and its architecture and then creating the actual artifact. Artifacts may be constructs, models, methods, or instantiations	Knowledge of theory that can be brought to bear in a solution	Design and development centered initiation
4. Demonstration	Find suitable context. Use artifact to solve the problem (this could involve its use in experimentation, simulation, case study, proof, or other appropriate activity)	Knowledge of how to use the artifact to solve the problem	Client/context initiated
5. Evaluation	Observe how effective, efficient Iterate back to design	Knowledge of relevant metrics and analysis techniques	
6. Communication	Scholarly and professional publications	Knowledge of the disciplinary culture	

the explicit problem domain in which it will be applied. Such an artifact might have come from another research domain, it might have already been used to solve a different problem, or it might have appeared as an analogical idea. Lastly, a *client-/context-initiated* solution may be derived from observing a practical solution that worked, resulting in a design science solution if researchers (designers) work backward to exercise rigor to the process retrospectively (Peffers et al. 2007).

We believe that researchers and designers of eHealth interventions, or BCSSs, may benefit from this type of novel, yet formal, approach. The DSRM is intended as a methodology for research, even so, there would appear to be no reason it could not be used in practice (Peffers et al. 2007).

11.3.3 Underpinning Theories

There is no unified theory or model to inform eHealth development to promote behavior change (Neuhauser and Kreps 2003; Pingree et al. 2010). Nevertheless, a

number of prominent health behavior theories and models have informed the design of health behavior change interventions (Tufano and Karras 2005). These theories and models have their origins in the disciplines of psychology, sociology, communication, and medicine, and they call on research in persuasion, social marketing, and relational communication (Neuhauser and Kreps 2003).

According to Glanz and Bishop (2010) the most often used theories of health behavior are *Social Cognitive Theory* (Bandura 1991, 1998), the *Transtheoretical Model* (Prochaska et al. 1997), the *Health Belief Model* (cf. Janz and Becker 1984; Rosenstock et al. 1988), and the *Theory of Planned Behavior* (Ajzen 1991). This notion is supported by many researchers (e.g. Neuhauser and Kreps 2003; Norman et al. 2007; Webb et al. 2010). For instance, in a recent extensive systematic review (85 studies) conducted by Webb and colleagues (2010) only three theories were used by three or more studies to develop the intervention; social cognitive theory, the transtheoretical model, and the theory of reasoned action/planned behavior. In a review by Norman et al. (2007) the majority of studies explicated the theoretical underpinnings of the intervention designs, and transtheoretical model and social cognitive theory were the most common theories used.

Glanz and Bishop (2010) argue that reviews of studies on an array of health behaviors have indicated that theory-based interventions are more effective than those not using theory. In Webb and colleagues' (2010) review and meta-analysis, interventions differed considerably in their use of theory, but more comprehensive use of theory was associated with larger effect sizes. They suggest that "this finding is consistent with assertions that interventions can benefit from using behavior change theory and extends the evidence base to interventions delivered on the Internet".

According to Fishbein and Cappella (2006), theories of (predicting) behavior change are valuable since they aid in identifying the determinants of any given behavior, which is a crucial first phase in the development of successful interventions to change behavior. Atienza et al. (2010) stress the need for identifying, clearly delineating and explicitly testing of which theories and constructs are most pertinent for a specific research topic or area (e.g., smoking cessation, obesity prevention), under what circumstances (e.g., environments, locations, time periods), and for which individuals or groups.

Pingree and colleagues (2010, p. 103) hypothesize that "given the wide variety of purposes and techniques of e-health, there will probably never be a single general theory of e-health". Nevertheless, they point out that this should not lead to the opposite extreme of applying a set of lower-level theories to explain different facets of a single intervention. They suggest that researchers should strive to apply or develop comprehensive theories to cover the complexity of their interventions. They maintain that "Ideally, this work should be a starting point for e-health development: identify the outcome(s) to target, then some mechanisms known to causally affect them, and work backwards to design the e-health intervention to activate at least some of those mechanisms (Pingree et al. 2010, p. 103)". We suggest that this type of approach is closely related to design science (see Sect. 3.2).

Glanz and Bishop (2010, p. 412) offer a contrasting view: "The strongest interventions may be built from multiple theories. When combining theories, it is important

to think through clearly the unique contribution of different theories to the combined model."

Cappella (2006) maintains that behavior change and information processing theories are not two distinct traditions of theorizing about attitude processes, but are complementary. Thus, these theories not plainly answer different questions, rather answer complementary questions (Cappella 2006).

O'Keefe (2001) posits that there are three general kinds of theories have informed work on persuasion: (1) theories of attitude; (2) theories of voluntary action; (3) and theories of persuasion proper. The first two are not directly connected to persuasion, but have proved influential in shaping understandings of persuasion processes (O'Keefe 2001).

O'Keefe (2001) proposes reasons why there has not been more rigorous integration of the variable-analytic and applied-research findings within the different theoretical frameworks. He argues that one possible explanation is the width of academic fields in which persuasion-relevant research is conducted. He also points out that researchers are not encouraged to look abroad for relevant work, and that the research literature is scattered. He criticizes extant theoretical frameworks for failing to address a wide range of relevant issues. For instance, although emotional and visual aspects of persuasion are clearly important, theoretical models so far have not been designed to focus on such aspects. O'Keefe (2001) calls for more expansive frameworks, taking up a broader range of matters and engaging relevant work across disciplinary boundaries.

Fishbein has proposed an integrative model of behavior (see Fishbein and Yzer 2003; Fishbein and Cappella 2006) that attempts to bring together a number of theoretical perspectives.

Brewer and Rimer (2008) note that disappointing outcomes for some health behavior change interventions should urge us to consider the use of persuasion strategies. We share their view, that several established persuasion theories, including the *Elaboration Likelihood Model* (Petty and Cacioppo 1986), *Heuristic Systematic Model* (Chen and Chaiken 1999), and the *Unimodel* (Kruglanski and Thompson 1999) merit more attention.

11.4 Conclusion

This chapter has discussed several important perspectives in designing and developing persuasive health behavior change interventions. Clearly, designing such interventions is a demanding task. Based on the current state of related research, we suggest that several challenges (even obstacles) in designing persuasive health behavior change interventions are remaining. These include, but are not limited to: (1) lack of unified theory; (2) lack of interdisciplinary awareness, communication and efforts; (3) lack of accepted design models; (4) lack of common terminology; and (5) lack of evidence of individual contributing factors/components. We concur with Resnicow and colleagues (2010, p. 101) who state that "a better understanding

of what is inside the black box of e-health interventions will lead to more empirically informed and ultimately more effective programs."

The chapter makes contribution at several levels. First, it introduces persuasive technology and behavior change support systems to the eHealth research community. Second, it offers several novel viewpoints, both theoretical and practical, in designing and developing health behavior change interventions. Third, it presents many theories and design models by other researchers, thus being a useful starting point for researchers and designers. Finally, the chapter addresses, though briefly, an important aspect of information systems research that has not yet gained attention in the eHealth community, that is design science research. As mentioned previously, we believe that researchers and designers in the eHealth domain may benefit from this type of approach. Some might consider our stance technologically deterministic. However, we do not simply claim that the use of technology, no matter how persuasive, is enough in health behavior change endeavors. Even so, understanding and using persuasive technology may prove to be valuable in such efforts.

Obviously, there are some limitations to the study. The amount of different facets and groups of interest in the eHealth space is overwhelming. For instance, cultural, economic, emotional, ethical, and privacy considerations were beyond the scope of this single chapter. Additionally, issues concerning evaluation, integration (e.g. into existing healthcare systems) and dissemination of eHealth interventions were excluded.

To conclude, this chapter was motivated by the need to explore the current state of persuasive health behavior change interventions, in research and practice. The chapter has merely scratched the surface of a large umbrella called eHealth. As demonstrated, there is a lot of future work to be done. Future research needs to address a multitude of open questions beginning with 'what', 'how' and 'why'. As persuasion should be incremental, we believe that this diverse and highly fascinating research area benefits the most when building on small successes.

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