

Behavior Change Support Systems: A Research Model and Agenda

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Abstract. This article introduces the concept of a behavior change support system and suggests it as a key construct for research on persuasive systems design, technologies, and applications. Key concepts for behavior change support systems are defined and a research agenda for them is outlined. The article suggests that a change in complying, a behavior change, and an attitude change (C-, B- or A-Change) constitute the archetypes of a behavioral change. Change in itself is either of a forming, altering or reinforcing outcome (F-, A- or R-Outcome). This research model will become helpful in researching and designing persuasive technology.

Keywords: Socio-technical system, behavioral outcomes, psychological outcomes, behavioral change, persuasive technology.

1 Introduction

The emergence of web 2.0 concepts and technologies to create, access, and share information in new ways has opened up opportunities for also developing new kinds of information systems for influencing users. For instance, one of the most prominent areas for future healthcare improvement is the role of the web in fostering improved health and healthier lifestyles [1]. Researchers have reported positive results in areas such as the management of smoking cessation, hazardous drinking, obesity, diabetes, asthma, tinnitus, stress, anxiety and depression, complicated grief, and insomnia [2]. Other application areas include directing users towards proper exercise behaviors [3], better sitting habits [4], healthier eating [5], and greener energy behaviors [6], among others. All these target behavioral changes in the end-users.

Both software developers and the general audience should be aware of the various ways of and approaches to how people may be, are being, and will be influenced through the information technology (IT) designs. Moreover, the contemporary and future web will keep opening up a myriad of opportunities for building various kinds of software applications and benefiting from them. In this article, we define *behavior change support systems (BCSS)* as a key construct for research in persuasive

technology [7].¹ For achieving better outcomes from BCSSs, they should be designed by using persuasive systems design frameworks and models [8].

This article is conceptual and theory-creating by its nature. The article is structured as follows: Section 2 will discuss the related research. Section 3 will define and discuss the concept of a behavior change support system. Section 4 will discuss the research implications and future research directions. Finally, section 5 will draw conclusions based on the earlier sections. In general, the article lays ground for future research in this new frontier of research on BCSSs.

2 Related Research

The study of users' attitudes and behavior has a long history in information systems (IS) research [9]. Lessons have been drawn from social psychology [10, 11] and cognitive psychology [12], and new models and frameworks have been developed, such as the Technology Acceptance Model [13] and the Unified Theory of Use and Acceptance of Technology [14]. These theories are useful for understanding attitudes and behaviors related to information systems and their use, and some of them are well-known among IS researchers. Besides these general attitude and behavior-related theories, there are also useful attitude and/or behavior change related theories such as the Elaboration Likelihood Model [15]. These change-related theories are not very well-known among IS researchers, however.

A key element in behavior and attitude change is persuasion. Persuasive design and technology has received growing interest among researchers for a little over a decade now [cf. 16].² Fogg's seminal book [18] was the first conceptualization suggested for software designers, stating that information technology may play the role of a tool, a medium, or a social actor for its users.³ Bogost [20] proposed an approach to developing persuasive games. More elaborate conceptual and design frameworks for on and off-the-Web information systems have been suggested, such as the Persuasive Systems Design model [21, 22]. Recently, one of the major development trends has been the persuasion patterns of social network based information systems, in particular in conjunction with Facebook.

A wide variety of BCSSs have been developed, such as an easy-to-use password creation mechanism to help create stronger passwords [23], an interactive picture frame for adopting better sitting habits while working at the computer [4], a ubiquitous sensor-based kitchen application for improving home cooking by providing calorie awareness regarding the food ingredients used in the meals prepared [5], and a personal health information system to influence the health behaviors of rural women in India through offering them information for increasing their awareness about menses and maternal health [24].

¹ Persuasive technology is the field of research, whereas a BCSS is an object of study within the field.

² Affective computing [17] may be recognized as a sister-field of persuasive technology, or perhaps from the persuasive viewpoint as a sub-field of it, which directly focuses on the emotions information technologies evoke.

³ Sharp criticism of persuasive technology and Fogg's book has been offered by Atkinson [19].

3 Behavior Change Support Systems

Even if the web and other information technologies are often considered as just tools to accomplish goals, they are never neutral. Rather, they are ‘always on.’ This means that people are constantly being persuaded in a similar manner to how teachers persuade students in schools, and there is nothing bad in this in itself, of course. To put it simply, information technology always influences people’s attitudes and behaviors in one way or another. In some cases, the influence may even be an unintentional side effect of the design. Thus, software designers but also the general audience should be well aware of the various ways and approaches how people may be, are being, and will be influenced through IT design. Moreover, there is a plethora of applications that can be developed with the purpose of behavioral change.⁴ For these reasons, it is important to define and adopt into use the concept of a behavior change support system.

In our definition, persuasive technology is the field of research, whereas a BCSS is an object of study within the field. The main 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 develop such systems and ways for studying the organizational, social, and end-user impacts of them. The research emphasizes software qualities and characteristics, systems analysis and design, and end-user behavior and perceptions. Technologically, the research may tackle socio-technical platforms, systems, services or applications, or the software features in them, developed for persuasive purposes.

A BCSS is defined here 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.

Persuasion relies on the user’s voluntary participation in the persuasion process. Naturally, in addition to persuasion, other forms of attempts at influence do also exist. For instance, a pop-up window or a hyperlink may be purposefully deceitful; coercion implies force and the possibly economic sanctions; inducements are exchanges of money, goods, or services for actions by the person being influenced. By definition, these are not persuasive elements.

3.1 Types of Change

In this article, we divide behavioral changes into three categories, namely a change in an act of complying, a behavior change or an attitude change.⁵ Respectively, these may be called C-, B-, and A-Change, in ascending order of difficulty. Different persuasive goals and strategies may be needed for applications supporting different types of changes.

⁴ It should be noted that even if we speak about behavioral changes, we do not posit a behaviorist or any mechanistic psychological view towards human beings. End-users may use these applications to support achieving their goals, maintaining a constructivist view (cf., the field of education) towards human behavior.

⁵ For the sake of simplicity, we use the term “behavior” change rather than “behavioral” change even if the BCSS covers all three behavioral change types.

3.1.1 C-Change

With a *C-Change*, the goal of the behavioral change is simply to make sure that the end-user complies with the requests of the system. For instance, the goal of a healthcare application may be to guarantee that its users take their daily blood pressure medication. The users may or may not have the proper motivation for doing so, but, nevertheless, the key in this approach is to provide triggers for the user to take action and to comply with the requests of the application. First achieving a C-Change may help achieve a B-Change later.

It should also be noted that a myriad of software applications that have been created for purposes other than a behavioral change *per se* utilize, in the micro scale, the same design principles and techniques as systems supporting behavior changes.

3.1.2 B-Change

The goal of systems supporting a *B-Change* is to elicit a more enduring change than simple compliance once or a few times. A one-time behavior change may be achieved more easily, whereas long-term behavior change (not to even speak about a permanent behavior change) is much more difficult to achieve.

3.1.3 A-Change

The goal of systems supporting an *A-Change* is to influence the end-users' attitudes rather than behavior only. An attitude change that directs behavior may be the most difficult type of change to achieve but we maintain that persuasion-in-full occurs only when attitude change takes place, and that a sustainable B-Change happens only through an A-Change. In some cases, behavior change support systems should aim bolstering both an A-Change and a B-Change simultaneously. This is particularly important in areas such as providing support for overcoming addictive behaviors, where users in spite of high motivation and proper attitudes may lack the skills to put their knowledge and attitudes into practice (a B-Change is needed), but at the same time their motivation and self-efficacy may need further strengthening (an A-Change is needed).

3.2 Outcome/Change Design Matrix

In the abovementioned definition, three potential, successful voluntary outcomes are the formation, alteration or reinforcement of attitudes, behaviors or complying. A forming outcome (*F-Outcome*) means the formulation of a pattern for a situation where one did not exist beforehand, e.g., abstaining from substance abuse. An altering outcome (*A-Outcome*) means changes in a person's response to an issue, e.g., increasing the level of exercise, decreasing the amount of drinking, or stopping smoking. A reinforcing outcome (*R-Outcome*) means the reinforcement of current attitudes or behaviors, making them more resistant to change.

A design matrix can be constructed from the intended outcomes and the types of change. See Table 1. When designing a BCSS, the developers should carefully think about which of these nine different goals the application will be built for. The persuasion context may change dramatically when moving from one slot to another.

Table 1. Outcome/Change Design Matrix

| | <i>C-Change</i> | <i>B-Change</i> | <i>A-Change</i> |
|------------------|---------------------------------------|------------------------------|-------------------------------|
| <i>F-Outcome</i> | Forming an act of complying (F/C) | Forming a behavior (F/B) | Forming an attitude (F/A) |
| <i>A-Outcome</i> | Altering an act of complying (A/C) | Altering a behavior (A/B) | Altering an attitude (A/A) |
| <i>R-Outcome</i> | Reinforcing an act of complying (R/C) | Reinforcing a behavior (R/B) | Reinforcing an attitude (R/A) |

3.3 Design of Software System Qualities

Behavior change support systems utilize either computer-mediated or computer-human persuasion. Computer-mediated persuasion means that people are persuading others through computers, e.g., e-mail, instant messages, or social network systems. Even if the web cannot communicate in the same way as humans do, some patterns of interaction similar to social communication may be utilized also in computer-human persuasion. In the case of BCSSs, there must exist other stakeholders who have the intention of influencing someone's attitudes or behavior, as computers do not have intentions of their own. These stakeholders are those who create or produce BCSSs, those who give access to or distribute them to others, or the very person adopting or using such a system [18]. 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 stickiness, which encourage the user to engage with them regularly over an extended period of time.

Building BCSSs requires insight from software and information systems design as well as psychology. Lessons learned from psychology include: (1) the fact that people like their views about the world to be organized and consistent, (2) that persuasion is often incremental, and (3) that the direct and indirect routes are key persuasion strategies [22]. Important software design requirements to be always kept in mind when developing BCSSs are that: (1) behavior change support systems should be both useful and easy to use, and (2) persuasion through behavior change support systems should always be transparent. Quite understandably, if a system is useless or difficult to use, it is unlikely that it could be very persuasive. The transparency requirement emphasizes the need for revealing the designer bias behind a BCSS.

The Persuasive Systems Design model [21, 22] is the state of the art conceptualization for designing and developing BCSSs. According to the PSD model, careful analysis of the persuasion context (the intent, event, and strategy of persuasion) is needed to discern opportune and/or inopportune moments for delivering the message(s). Many design aspects in developing BCSSs are general software design issues rather than specific to BCSSs only. These include, for instance, 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.

The PSD model suggests a set of design principles under four categories, namely primary task, human-computer dialogue, perceived system credibility, and social influence. See Figure 1. The design principles of the primary task category focus on supporting the carrying out of the user's primary activities. Design principles related

to human-computer dialogue help move towards achieving the goal set for using the BCSS. The perceived system credibility design principles relate to how to design a system so that it is more believable 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.

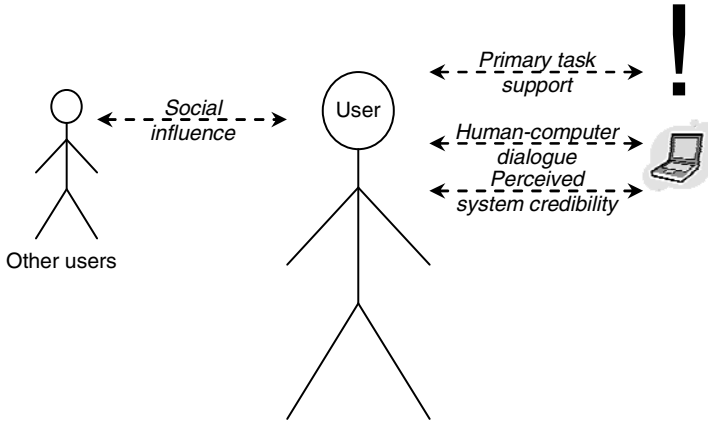


Fig. 1. Four categories of design principles for BCSSs

Tørning and Oinas-Kukkonen [25] have analyzed the scientific research publications in the PERSUASIVE conferences during 2006-2008 as regards the software system features and the abovementioned categories. According to their study, the most utilized features have been tailoring, tunneling, reduction, and self-monitoring (representing the primary task category), suggestion (for supporting human-computer dialogue), surface credibility (in support of perceived system credibility), and social comparison, normative influence, and social learning (relating to social influence).

Many types of research on software system features have been conducted. For instance, Harper et al. [26] studied the roles that social influence and social comparison may play in online communities for motivating members rather than editors to contribute and moderate content. Andrew et al. [27] studied the challenges in implementing suggestion and how it differs from and overlaps with other techniques, in particular tunneling, reduction, and self-monitoring. Räsänen et al. [28] studied the right-time suggestions of messages. Cugelman et al. [29] demonstrated that system credibility, in particular the system's trustworthiness, affects a user's behavioral intent. Gamberini et al. [30] showed that in some situations a persuasive strategy based on reciprocity is more effective than one based on reward, as well as that the presence of social proof features seems counterproductive when using a reciprocity strategy, whereas it seems to improve compliance with a request when using a reward strategy. At a more general level, Zhu [8] conducted a meta-study of persuasive techniques in BCSSs motivating for regular physical activity. The results of this study suggest that very few previous studies resulted in achieving the intended goal. Only a few studies took advantage of any persuasive techniques, and

none of these interventions were conceptually designed through persuasive design frameworks. The conclusion of this study was that designing a new generation of BCSSs should be based on such frameworks.

4 Research Agenda for BCSS

Tørning and Oinas-Kukkonen [25] report some interesting findings regarding the current state of research on BCSSs:

Thus far there has been much more research on C- and B-Change than on A-Change. Only about 16% of the research has addressed A-Change. This may be due to the fact that C- and B-Change are in most cases easier to study than A-Change. Nevertheless, in the future more emphasis should be placed on A-Change.

In the current research literature, there seems to be a tendency of describing the software systems and the persuasion context (use, user, and technology contexts) at too general a level. Black-box thinking of the software systems – with no actual description of what was implemented and how – may make the research results obsolete. The differences between problem domains are so huge that very general claims can be seldom argued for. For instance, in most of the experimental research students are regarded as a homogenous mass. More specific information is often limited to gender and age. Yet, a deep understanding of the user segments is highly important for designing successful persuasive systems. Specific target audiences may request very different kinds of software features. Just consider the differences between small schoolchildren, tweens, teens, and perhaps even young adults in comparison to lumping them all together as students.

When describing a persuasive system, a very clear description of the technology context is needed. After all, much of the success or failure of an application can be attributed in many cases to the fluent navigation and smooth interaction arising from the technological infrastructure rather than to the design of the system. Relying on black-box thinking is a symptom of a severe misunderstanding of conducting BCSS research.

The message and route for persuasion are also often not described at such a level of detail that it would be possible to determine whether a direct or indirect approach actually has been applied and whether that has played a role in the success or failure of the system. Moreover, it should be clearly defined whether one or multiple arguments were presented, and what kinds of arguments were presented.

Often, the empirical and experimental research does not reveal much about the motives behind the system under study. The designer bias should necessarily be revealed much more clearly.

Admittedly, space is often too limited in scientific papers to provide many details about the system. For this reason, the actual system descriptions easily become radically shortened or are even cut out from the papers. Moreover, the field would benefit from a shift in research emphasis from proof of concept approaches into theorizing for persuasive systems design.

Quite surprisingly, ethical considerations have remained largely unaddressed in persuasive technology research. Many important issues need to be recognized, such as the actual voluntariness for change in using the application and potential ways for

abusing the system. There may also be situations where computer-mediated persuasion takes place without the user being aware of it. These 'grey areas' should be carefully considered.

Open research questions to be tackled in future research include the following:

- How can "change" be measured? Are there differences in measuring C-, B- and A-Changes?
- What challenges do A-, B- and C-Change pose for BCSS research? What are the connections between C-, B- and A-Change?
- How can we conduct experiments in such a manner that it will be really possible to pinpoint a change to have been caused by a BCSS, or even more precisely, by a specific software feature in it?
- How do the BCSSs developed for R-, A- and F-Outcomes differ from each other?
- How can we build BCSSs in such a manner that they will be unobtrusive with users' primary tasks?
- What are the roles of cognition and emotion in BCSSs?
- What is the relationship between convincing and persuasion in BCSSs?
- What is the role of goal setting in different kinds of BCSSs? How can the change in the user's goals be supported?
- When should a BCSS use a direct/indirect persuasion strategy?
- Which software features have the greatest impact in different settings? Which combinations of software features have the greatest impact?
- Which modes of interaction are more persuasive than others? How can the fit between these interaction modes and catering for certain types of behaviors be recognized and measured?
- What are the differences between problem domains (e.g., increased exercising vs. weight management, or reduced energy consumption vs. overcoming addictions)?
- What are the challenges in the development of persuasive platforms/systems/services/applications/features?
- What is the difference between developing a BCSS as a software system vs. as a software service (e.g., a mash-up)?
- What challenges result from the requirement for a service to be available 24/7?
- How can we cope with it when the technological platform which the BCSS has been built upon changes dramatically?
- What is the difference between persuasiveness and perceived persuasiveness? How should perceived persuasiveness be studied?
- How and to what extent should the bias behind a BCSS be explicated?
- How can we map psychological and behavioral theories within BCSS research?
- What research issues (other than ones relating to the user interface) need to be tackled?
- What are viable business models for BCSSs?

- What are the cultural and gender differences in BCSSs?
- How can we recognize and analyze the unintended side-effects of using a BCSS? What kind of abuses of a BCSS can be recognized and how?

As can be seen above, many questions remain to be addressed. Indeed, even if many research efforts have already been conducted thus far, we are still in the very early steps of research into persuasive technology and behavior change support systems.

In sum, what distinguishes research into BCSSs from research into other information systems and technologies is that BCSSs are inherently transformative, deliberately attempting to cause a cognitive and/or an emotional change in the mental state of a user to transform the user's current state into another planned state. Empirical BCSS research provides a unique opportunity for quantifying measures for system success. This requires explicitly stating the aim of the system, how the success was to be measured, and the extent to which the system succeeded in achieving this measure. It has to be explicitly defined what really takes place through the software system to be able to demonstrate to what extent an outcome/change is really due to the system, or a feature or a set of features in it. Thus, sound ways of defining the systems and their goals clearly are needed. Otherwise, it will be difficult or perhaps even impossible to translate lessons learned from the results into related problem and application domains.

5 Conclusions

Human-computer interaction and social interaction through information systems can be used to influence people's behavior. Yet, even the relatively well-known persuasion techniques need to be adapted to match computing specificities. Moreover, the development of BCSSs is much more than just a user interface issue. It relates to technological services, applications, platforms, and functionality, the quality and content of information, personal goals set by the end-users, and social environments, among other issues. In many cases, the BCSSs must be available 24/7, they have to address global and cultural issues with a multitude of standards, habits, and beliefs, and they have to be adaptable into a variety of business models.

Persuasive technology as a field has the responsibility of educating the general audience about the pros and cons of people's behaviors being influenced by information systems, whereas web and other software developers must realize that they exercise enormous power over the users because their designs always influence them in one way or another, whether they intend them to or not. Moreover, the contemporary and future web will keep opening up a myriad of opportunities for building various kinds of behavior change support systems and benefiting from them.

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