FACTORS AFFECTING PERCEIVED PERSUAIVENESS OF A BEHAVIOR CHANGE SUPPORT SYSTEM

Completed Research Paper

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Abstract

Despite the popularity of the technology acceptance and adoption studies, adoption of persuasive systems has not been investigated from a theoretical perspective. In the present study, we put forward a novel approach for investigating behavior change support systems (BCSS) through a theoretical model. We constructed and tested (two measurement points; 172 subjects) a model predicting perceived persuasiveness and actual usage of a behavior change support system. Results from a rigorous PLS-SEM analysis support most of our hypotheses about factors affecting persuasiveness and actual usage. The proffered model can be considered as a meta-model, i.e. it may be utilized in a multitude of domains, such as health behaviors (as in the present study), safety and education. The present study extends the extant (rather limited) body of knowledge regarding the factors contributing to engagement with behavior change support systems.

Keywords: behavior change support systems, persuasive systems, structural model
Introduction

According to Benbasat (2010, p.18), HCI research has mainly focused on “interface designs for information systems implemented for improving the effectiveness or efficiency of users during tasks ranging from decision-making to purchasing on the Internet”. Benbasat (2010) calls these types of systems neutral, i.e. the systems have no agenda on their own. Another class of system is one that attempts to persuade the user to choose a particular course of action (Benbasat 2010; Chatterjee and Price 2009; Fogg 2003; Oinas-Kukkonen and Harjumaa 2009). This type of persuasive system is designed with a specific agenda or intent. The design implications for these systems are “interesting in that the designs should differ based on whether the goal is assisting in an objective way, to persuade or to deceive” (Benbasat 2010). Recent essays (Benbasat 2010; Hevner and Zhang 2011; Lyysinen 2010) call for a greater design focus in IS HCI research. Moreover, there is a need to broaden the scope from managerial and organizational systems to individual information systems (Baskerville 2011). In this study, we are interested in persuasive information systems designed for individual behavior change.

For such systems, Oinas-Kukkonen (2010; 2012) has conceptualized an umbrella term behavior change support systems. A behavior change support system is defined as follows (Oinas-Kukkonen 2012): “A behavior change support system (BCSS) is a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception.” Behavior change support systems are in essence persuasive, producing either computer-mediated persuasion or computer–human persuasion. Computer-mediated persuasion means that people are persuading others through computers, e.g., discussion forums, e-mail, instant messages, blogs, or social network systems. In the case of BCSSs, there must exist other stakeholders who have the intention of influencing someone’s attitudes or behavior. 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. Moreover, BCSSs emphasize the autogenous approaches in which people use information technologies 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. Chatterjee and Price (2009) have discussed the challenges and critical issues regarding persuasive technologies. In their view, one of the pivotal issues is how persuasive technologies can engage its users. The objective of the present study is to examine factors affecting perceived persuasiveness and use continuance of a particular BCSS (a web-based information system to support individuals’ weight loss). A research model (see Figure 1) is developed, and empirically tested through partial least squares structural equation modeling (PLS-SEM) analysis.

The remainder of the paper is organized as follows. First, we present the related research, theoretical background and formulate the research model with hypotheses. Second, we discuss the research methodology. Third, results from the data analysis are presented. Fourth, we give the discussion of the results with implications and limitations, and finally, we conclude the paper.

Related Research

Persuasive technologies have been studied rather extensively during the past ten years. Persuasive technologies influence users’ behavior and perceptions, and various tactics may be applied by these technologies to support different outcomes and behavior change strategies (Berkovskyy et al. 2012). Persuasive technologies are employed in a multitude of domains, for instance, within the domains of e-commerce (Kaptein 2011), education (Forget et al. 2008), health (Chatterjee and Price 2009; Parmar et al. 2009), safety (Chittaro 2012), and sustainability (Loock et al. 2012). According to Oinas-Kukkonen (2012), behavior change support systems are at the core of persuasive technologies, and behavior change support systems are, in essence, persuasive systems. To clarify, the basic assumption behind persuasive systems is that the persuadee (recipient) adopts a persuasive system and its contents whereas the persuader (source) designs and embeds the persuasive mechanisms into the respective system. Persuasive systems may utilize either computer-mediated or computer–human persuasion.

In spite of the growing interest towards the field, there is a limited amount of rigorous theoretical and
empirical studies studying persuasive systems. Decision support systems for managers/professionals (see a review by Arnott and Pervan 2008) and consumers (e.g. Al-Natour et al. 2008; Wang and Benbasat 2009), and persuasive recommendation agents (e.g. Komiak and Benbasat 2006; Xiao and Benbasat 2007) have been studied widely in the information systems discipline. Even though these types of studies relate to the nature of persuasive systems, there is certainly a need for gaining more knowledge on how people engage and interact with persuasive systems. Moreover, despite the popularity of the technology acceptance and adoption studies, adoption of persuasive systems has not been investigated from a theoretical perspective. In the present study, we put forward a theoretical approach for investigating behavior change support systems.

**Theoretical Background, Research Model and Hypotheses**

The Persuasive Systems Design Model (PSD) (Oinas-Kukkonen and Harjumaa 2009) serves as the theoretical framework for this research. PSD model is a recent conceptualization mainly for designing and developing persuasive systems. The PSD model consists of a set of persuasive design principles under four categories: (i) primary task support; (ii) dialogue support; (iii) credibility support; and (iv) social support. The design principles in the primary task category focus on supporting the user's primary activities and goals. Design principles related to human-computer dialogue aid in achieving the goal set for using the system. The credibility support principles relate to how to design a system so that it is more credible and thereby more persuasive. The design principles in the social support category describe how to design the system so that it motivates users by leveraging different aspects of social influence (Oinas-Kukkonen and Harjumaa 2009). Social support is not included in the research model in this paper, since the BCSS under investigation currently does not directly facilitate observing other users and communicating with them.

![Research Model](image)

**Primary Task Support**

The central category of persuasive design that can enhance the persuasiveness of systems is primary task support. Primary task support refers to the means to aid the user in performing his or her primary task (Oinas-Kukkonen and Harjumaa 2009). Gefen and Straub (2000) have made a distinction between intrinsic and extrinsic IT tasks. They argue that intrinsic IT tasks are those where the IT itself provides the primary “ends,” i.e., the product or service for which the IT is ultimately being used. In extrinsic IT tasks, IT is not the central component of the process or the goal but is instrumental in achieving it (e.g. IT acts...
as the interface through which one accomplishes a goal) (Gefen and Straub 2000). Arguably, within the context of primary task support, extrinsic tasks are more crucial than intrinsic tasks. Primary task support increases positive affect (Derrick et al. 2011). In turn, positive affect augments the persuasiveness of the source (Angst and Agarwal 2009; Derrick et al. 2011). Moreover, Angst and Agarwal have found that (2009, p.344): "Elaboration on information is greater when people can relate the information to themselves and to their own experience". Thus, we put forward the following hypotheses:

H1: Primary task support positively affects perceived persuasiveness.

**Dialogue Support**

IT artifacts are social actors and people consider their interactions with IT artifacts as interpersonal in nature (Al-Natour and Benbasat 2009; Fogg, 2003; Fogg and Nass 1997). Moreover, people tend to react to IT artifacts as if they were interacting in social situations (Al-Natour and Benbasat 2009; Fogg and Nass 1997). Evidently, supporting the dialogue between the IT artifact and the individual users is essential. In dialogue support, providing appropriate argumentation and feedback to the users is important. This occurs via various prompts, suggestions, and reminders (Oinas-Kukkonen and Harjumaa 2009). Through dialogue support the users are encouraged in using the system and consecutively motivated to perform their primary task (intended behavior). This originates from the cognitive fit theory (Vessey and Galletta 1991). Thus, we hypothesize the following:

H2a: Dialogue support has a positive impact on primary task support.

In dialogue support, compelling arguments lead to more persuasion, but to less persuasion when the arguments are specious (Briñol et al. 2007). As a result, we offer the following hypothesis:

H2b: Dialogue support positively affects perceived persuasiveness.

Ideally, dialogue support promotes users’ positive affect, which will likely influence users’ confidence in the source (credibility) (Kahn and Isen 1993). Hence, we put forward the following hypothesis:

H2c: Dialogue support positively influences perceived credibility.

**Perceived Credibility**

Credibility and trust are important, related constructs. According to Everard and Galletta (2005) the apparent difference between trust and credibility is that “trust is an attribute of an observer (to have trust), whereas credibility is an attribute of another person or an object of interest (to be credible)” (p.60). Moreover, trust is a manifestation of credibility, which could be considered to be trustworthiness (Everard and Galletta 2005). Prior research on (online) trust has favored dividing the trust component into various subcomponents. These subcomponents include, for example, knowledge-based trust, institution-based trust, and cognition-based trust (Gefen et al. 2003; McKnight et al. 2002; Vance et al. 2008). According to Sillence et al. (2006) various factors are likely to govern the extent to which individuals feel they can trust (health) advice online: (i) credible and aesthetic visual design, (ii) branding of the site or presence of familiar images or trusted logos; (iii) quality of information (perceived expertise); and (iv) personalization. Since the present research objective does not involve a detailed understanding or analysis of trust signals, trust issues are integrated under the perceived credibility construct. A highly credible source is typically found more persuasive than a low-credibility one (Pornpitakpan 2004). Consequently, we offer the following hypothesis:

H3: Perceived credibility positively affects perceived persuasiveness.

**Design Aesthetics**

Prior research has recognized that visual aesthetics of computer interfaces is a strong predictor of users’ satisfaction and pleasure (Lavie and Tractinsky 2004). In a study by Cyr and colleagues (2008), visual design aesthetics significantly impacted ease of use, perceived usefulness and enjoyment. Van Vugt and colleagues (2006) suggest that an encounter with a (new) system is generally a visual one, and during system interaction, constant visual information immediately elicits aesthetic judgments. Moreover, people
make initial assessments of the system credibility based on a firsthand visual inspection. This principle is
called surface credibility (Oinas-Kukkonen and Harjumaa 2009).

Since attractiveness of the source has been often found to influence how people react and process upon
information (e.g. Wathen and Burkell 2002), we hypothesize the following:

H4a: Design aesthetics positively affects dialogue support.

Robins and Holmes (2008) found out that when the same content is displayed using varying levels of
aesthetic treatment, the content with a higher aesthetic treatment was assessed as being more credible.
This is called the amelioration effect of visual design and aesthetics on content credibility (Robin and
Holmes 2008). Therefore, we hypothesize the following:

H4b: Design aesthetics positively affects perceived credibility.

Unobtrusiveness

Technology may provide the means to aid the individual users in their tasks but the key to successful
implementation and continued use may depend on whether users have the opportunity to use the system
as a seamless part of their daily routines. Unobtrusiveness is one of the key postulates behind persuasive
systems design as discussed in the paper by Oinas-Kukkonen and Harjumaa (2009). Hensel et al. (2006)
have conceptualized a framework regarding user perception of obtrusiveness in the context of consumer
health informatics applications. They propose eight different dimensions of perceived obtrusiveness:
physical, usability, privacy, function, human interaction, self-concept, routine, and sustainability. In the
present study, unobtrusiveness is operationalized as a contextual construct that reflects whether the
system fits with the user’s environment in which he or she uses the system. Prior research has shown the
importance of fit between technology and its users on individual performance (Goodhue and Thompson
1995). Thus, we offer the following hypothesis:

H5a: Unobtrusiveness has a positive relationship to primary task support.

It is logical to predict that in order for a behavior change support system to be perceived as persuasive, it
has to be unobtrusive. Thus, we propose the following:

H5b: Unobtrusiveness has a positive relationship to perceived persuasiveness.

On the other hand, intrusive technology characteristics are found to have negative consequences such as
"technostress" (Ayygari et al. 2010). Consequently, we hypothesize the following:

H5c: Unobtrusiveness has a positive relationship to intention to use.
H5d: Unobtrusiveness has a positive relationship to actual usage.

Perceived Persuasiveness

In extant models of attitude change, messages are presented, received, processed, and if successful,
recipients’ attitudes shift towards the advocated position (Crano and Prislin 2006; Petty and Cacioppo
1986; Wood 2000). The altered attitude may lead to subsequent behavior change under appropriate
conditions (Crano and Prislin 2006). Crano and Prislin (2006) argue that a central aspect that must be
taken into account when reflecting on persuasion involves the fundamental construct of attitude. They
state the following (p. 347): “Today, most accept the view that an attitude represents an evaluative
integration of cognitions and affects experienced in relation to an object.” In the present study, perceived
persuasiveness is operationally defined as the integration of the individual’s subjective evaluation of the
system and its impact on the self. Hence, the following hypotheses are rendered:

H6a: Perceived persuasiveness has a positive impact on intention to use the system.
H6b: Perceived persuasiveness has a positive impact on actual usage.
Intention to Continue Using the System

H7: Intention to continue using the system at 2 weeks (T1) predicts usage at 6 weeks (T2).

Research Methodology

Participant Recruitment and Inclusion Criteria

Subjects were recruited through online advertisements and banners over a period of two weeks during October 2011. Upon clicking on a banner, prospective subjects were redirected to an external website containing study information and an informed consent. Subjects had to confirm to have read the study information before they could proceed to fill in the online survey. Data were collected online at baseline (T0), two weeks (T1), and six weeks (T2) post-intervention. The surveys consisted of questions related to 1) demographics, 2) primary task support, 3) dialogue support, 4) perceived credibility, 5) perceived persuasiveness, 6) design aesthetics, 7) unobtrusiveness, and 8) intention to continue the program. All of the survey items were derived from existing theories and literature. The items were reviewed and refined by IS researchers and psychologists prior to data collection. A seven-point Likert scale was applied for all continuous items (ranging from strongly disagree to strongly agree). Usage was collected by means of log file data six weeks post-intervention, about the time as users would have finished the program with optimal program compliance. Subjects at least 18 years old with a verified e-mail address, and less than two missing values per measurement point (T1; T2), were included in the data analysis. With these criteria, 172 responses were included in the data analysis. We tested the data set for nonresponse bias following Gefen et al. (2011); the results indicated that nonresponse bias should not be a concern for this study. Nevertheless, females are overrepresented in the sample. The gender bias is probably due to the nature of the system under investigation. Females may be more active within web-based programs for health behaviors (cf. Mo et al. 2009). Descriptive statistics for the sample are presented in Table 2.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Female 77.3%</th>
<th>Male 22.7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Range 18–67 years</td>
<td>Mean 37.8 years (S.D. 12.1)</td>
</tr>
<tr>
<td>Education</td>
<td>Elementary 1.2%</td>
<td>High School 26.7%</td>
</tr>
<tr>
<td>Occupational status</td>
<td>Employed 66.3%</td>
<td>Student 19.8%</td>
</tr>
</tbody>
</table>

Overview of the Behavior Change Support System Under Investigation

Ned i Vekt (NIV) is a fully automated web-based behavior change support system developed by Changetech AS. The system has been designed with three primary aims in mind: (i) to assist users in changing their eating habits, (ii) to upregulate users positive emotions and mood, and (iii) to aid users in losing their body weight. NIV is a tunneled program consisting of 11 program days for six weeks. Every program day is unique and consists of psycho-educative information, online exercises, and home assignments. The program content has been devised by psychologists and is mainly based on consumer psychology, positive psychology, and the basic premises of the non-dieting paradigm (Polivy and Harman 1992).

Data Analysis and Results

We analyzed our research model(s) using partial least squares structural equation modeling (PLS-SEM) by utilizing WarpPLS 3.0 software (Scriptwarp Systems; www.scriptwarp.com/warppl/) software for data analysis. PLS-SEM is appropriate when the purpose of the model is to predict, rather than to test.
established theory (Hair et al. 2011). According to Gefen et al. (2011) PLS-SEM suits well for exploratory research. Moreover, PLS-SEM is reasonably robust to deviations from a multivariate distribution. According to Hair et al. (2011) PLS-SEM minimum sample size should be equal to the larger of ten times the largest number of structural paths directed at a particular latent construct in the structural model. Our sample size exceeds this requirement.

As most of our variables were measured using the same instrument, common method variance (CMV) poses a potential threat to the validity of the results. In order to minimize CMV *ex ante*, we randomized the order of the survey items. Moreover, respondents were assured of the anonymity and confidentiality of the study, and that they should answer as honestly as possible. No incentives were used to drive participation. Actual usage was measured with log file data that was captured independent of the surveys. Several measures were also taken *ex post* to test and possibly control for CMV. Podsakoff and colleagues (2003) argue that if there is a harmful level of common method bias, "(a) a single factor will emerge from exploratory factor analysis (unrotated) or (b) one general factor will account for the majority of the covariance among the measures" (p. 889). Regarding the former criterion, more than one factor (five) emerged to explain the variance in our analysis. With respect to the latter criterion, no general factor was observed. We also conducted a PLS common method bias test introduced by Liang et al. (2007). In this test, of the 24 paths from common latent variable to single-indicator constructs, only five were significant. Moreover, the indicators’ substantive variances were substantially greater than their method. Finally, WarpPLS 3.0 software calculates Full Collinearity VIFs (Variance Inflation Factors). Full Collinearity VIFs (Table 3) further indicate (all VIFs < 5) that common method variance should not cause a detrimental effect. Construct means for both measurement points are presented in Table 3.

We ran Wilcoxon Signed Rank Test in order to observe potential differences between the measurement points. Interestingly, unobtrusiveness was the only construct that diminished significantly over time. In other words, obtrusiveness increased over time. Design aesthetics and perceived persuasiveness remained nearly the same, whereas primary task support and dialogue support, and perceived credibility increased over the short time period.

<table>
<thead>
<tr>
<th>Table 3. Construct Means, Wilcoxon Signed Ranks Test, and Full Collinearity VIF</th>
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<tbody>
<tr>
<td>Mean (S.D.) (T₁)</td>
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<td>PRIM</td>
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<td>DIAL</td>
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<td>CRED</td>
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<td>DESA</td>
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<td>UNOB</td>
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<td>INTE</td>
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<td>USE</td>
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</table>

*aWilcoxon signed ranks test: {PRIM; DIAL; CRED; DESA; PERS} based on negative ranks; {UNOB} based on positive ranks | **p<.001  "p<.01  ’p<.05  n.s.-non-significant

Measurement Model

The properties of the scales are assessed in terms of item loadings, discriminant validity, and internal consistency. Item loadings and internal consistencies greater than .70 are considered acceptable (Fornell and Larcker, 1981). The constructs in the model display good internal consistency, as evidenced by their composite reliability scores, which range from .89 to .99. Item loadings ranged from .72 to .99 (Table 5). Inspection of the latent variable correlations and square root of the average variance extracted (AVE) in Table 4 demonstrates that all constructs share more variance with their own indicators than with other constructs. In addition, AVE values of all the constructs were well above the suggested minimum of .50 (Fornell and Larcker, 1981), thus demonstrating adequate internal consistency.
### Table 4. Reliabilities, Square Roots of AVEs and Inter-Construct Correlations (Model T₁)

<table>
<thead>
<tr>
<th>Construct</th>
<th>CA</th>
<th>CR</th>
<th>1</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<td>.68</td>
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<td>2. DIAL</td>
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<td>5. PERS</td>
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<td>.32</td>
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</table>

CA = Cronbach’s alpha; CR = Composite reliability; Shaded cells = Square root of AVE

### Table 5. Item Loadings and Cross-Loadings (Model T₁)

<table>
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<tr>
<th></th>
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<td>.91</td>
<td>.51</td>
<td>.49</td>
<td>.27</td>
</tr>
<tr>
<td>PERS3</td>
<td>.67</td>
<td>.67</td>
<td>.67</td>
<td>.38</td>
<td>.91</td>
<td>.47</td>
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<td>.15</td>
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<tr>
<td>UNOB1</td>
<td>.11</td>
<td>.16</td>
<td>.11</td>
<td>.22</td>
<td>.23</td>
<td>.72</td>
<td>.39</td>
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<tr>
<td>UNOB2</td>
<td>.56</td>
<td>.50</td>
<td>.49</td>
<td>.48</td>
<td>.60</td>
<td>.84</td>
<td></td>
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</tr>
<tr>
<td>UNOB3</td>
<td>.21</td>
<td>.22</td>
<td>.19</td>
<td>.30</td>
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<td>.80</td>
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<td>UNOB4</td>
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<td>.51</td>
<td>.46</td>
<td>.46</td>
<td>.61</td>
<td>.91</td>
<td>.58</td>
<td>.36</td>
</tr>
<tr>
<td>INTE1</td>
<td>.43</td>
<td>.40</td>
<td>.37</td>
<td>.26</td>
<td>.54</td>
<td>.53</td>
<td>.99</td>
<td>.35</td>
</tr>
<tr>
<td>INTE2</td>
<td>.42</td>
<td>.38</td>
<td>.37</td>
<td>.27</td>
<td>.55</td>
<td>.55</td>
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<td>.37</td>
</tr>
<tr>
<td>USE</td>
<td>.21</td>
<td>.26</td>
<td>.17</td>
<td>.11</td>
<td>.22</td>
<td>.32</td>
<td>.36</td>
<td>1.00</td>
</tr>
</tbody>
</table>

CA = Cronbach’s alpha; CR = Composite reliability; Shaded cells = Square root of AVE
**Structural Model**

For the evaluation of the structural model, the bootstrapping resampling (100 resamples) procedure was applied to test the significance of the paths’ coefficients. Bootstrapping is recommended for sample sizes greater than 100 (Kock, 2011). We used Warp3 PLS regression algorithm in the analysis.

As can be observed from Figures 2 and 3, the results of the PLS analysis provide substantial support for the proposed model. All but one of the hypotheses were supported. Control variables (age; gender; education) did not yield significant effects on the model.

![Diagram](image)

**Figure 2. PLS Results (Model T₁)**

In Model T₁ (Figure 2), design aesthetics (DESA) explains roughly a quarter of the variance in dialogue support (DIAL). In turn, together with design aesthetics, dialogue support explains 61 percent variance in perceived credibility (CRED). Moreover, dialogue support explains 60 percent of the variance in primary task support (PRIM). In conjunction, primary task support, dialogue support, perceived credibility, and unobtrusiveness (UNO) explain a substantial amount, three quarters, of the variance in perceived persuasiveness (PERS). In addition, unobtrusiveness contributes to the variance in perceived persuasiveness, intention to use (INTE) and actual use (USE). Perceived persuasiveness and unobtrusiveness account for 43 percent of the variance in intention to use. Consecutively, intention to use and unobtrusiveness explain 26 percent of the variance in use. Contrary to our expectations, perceived persuasiveness (T₁) did not predict use.

We also examined the temporal stability of the constructs. In Model T₂ (Figure 3) we are able to discern a similar pattern as previously. Intention to use has been omitted from this model, since it is redundant at T₂. Primary task support, dialogue support, perceived credibility, and unobtrusiveness account for 76 percent of the variance in perceived persuasiveness. In T₃, design aesthetics explains substantially more of the variance in dialogue support in T₁ (40% vs. 26%). Interestingly, in contrast to T₁, perceived persuasiveness had a hypothesized impact on actual use. This finding lends support to the postulate of incremental persuasion presented in Oinas-Kukkonen and Harjumaa (2009).
We examined the total effects and effect sizes for total effects (Table 6). Effect sizes ($f^2$) determine whether the effects indicated by path coefficients are small (.02), medium (.15), or large (.35) (Cohen, 1988). Effect sizes below .02 are considered to be too weak to be relevant. Nearly all effect sizes for total effects are above the .02 level, thus lending support for their practical relevance. We also provide the Stone-Geisser Q-squared coefficients for the endogenous latent variables. Adequate predictive validity in connection with an endogenous latent variable is demonstrated by a Q-squared larger than zero. Q-squared, usually obtained through blindfolding, is similar to R-squared, but is generally regarded as a more reliable measure.

Table 6. Total Effects with Effect Sizes, Stone-Geisser Q-squared coefficients (Model T2)

<table>
<thead>
<tr>
<th>Construct</th>
<th>PRIM</th>
<th>DIAL</th>
<th>CRED</th>
<th>DESA</th>
<th>PERS</th>
<th>UNOB</th>
<th>USE</th>
<th>$Q^2$</th>
</tr>
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<tbody>
<tr>
<td>PRIM</td>
<td></td>
<td>.63***</td>
<td></td>
<td>.40***</td>
<td>.27***</td>
<td>.68</td>
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<td></td>
</tr>
<tr>
<td>DIAL</td>
<td></td>
<td>.63***</td>
<td></td>
<td>.40</td>
<td></td>
<td>.40</td>
<td>.40</td>
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</tr>
<tr>
<td>CRED</td>
<td></td>
<td>.59***</td>
<td></td>
<td>.68***</td>
<td></td>
<td>.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DESA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERS</td>
<td>.31***</td>
<td>.62***</td>
<td>.12*</td>
<td>.43***</td>
<td>.28***</td>
<td>.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNOB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USE</td>
<td>.08*</td>
<td>.16*</td>
<td>.03n.s.</td>
<td>.11*</td>
<td>.26*</td>
<td>.27**</td>
<td>.16</td>
<td></td>
</tr>
</tbody>
</table>

***$p<.001$  **$p<.01$  *$p<.05$  n.s.-Non-significant

Notes: **Bolded** numbers represent total effects; **underlined** numbers are effect sizes (Cohen’s $f^2$) for total effects
Discussion

In the present study, we constructed and tested a theoretical research model predicting perceived persuasiveness of a behavior change support system. Results from rigorous PLS-SEM analysis support most of our hypotheses about factors affecting perceived persuasiveness and use continuance. Indeed, the persuasive system categories presented in the PSD model (Oinas-Kukkonen and Harjumaa 2009) appear to have a significant impact on perceived persuasiveness.

Primary task support refers to whether the BCSS provides the means to aid the user in performing his or her primary task. We found out that primary task support has a significant effect on perceived persuasiveness. Through dialogue support the system users receive appropriate feedback, which keeps them motivated in their endeavors. The results show that dialogue support has significant connections to primary task support, perceived credibility, and perceived persuasiveness. As Lyytinen (2010) noted, computers are no longer merely reactive devices that are optimized to respond to user requests but more proactive devices. Current technological advances allow novel solutions for dialogue support, such as embodied conversational agents (Derrick et al. 2011) establishing and maintaining long-term human-computer relationships (Bickmore and Picard 2005), or even persuasive robotic assistants (Looije et al. 2010).

Perceived credibility encompasses trust, believability, reliability, and credibility. It is clear, that if the users do not perceive the system credible, especially in the eHealth or similar highly sensitive domain, they are more likely to abandon it (or not adopt it at all) (Sillence et al. 2006). As expected, perceived credibility has a significant relationship to the perceived persuasiveness.

A rather interesting finding is that the effect of design aesthetics on other constructs is substantial. Prior research has identified that visual aesthetics of computer interfaces is a strong predictor of users' satisfaction and pleasure. In this study, design aesthetics contributes to primary task support, dialogue support, perceived credibility, and perceived persuasiveness.

One of the key contributions of this study is the introduction of the unobtrusiveness construct. It is described as one of the seven key issues behind successful persuasive systems (Oinas-Kukkonen and Harjumaa 2009). In the present study, unobtrusiveness is operationalized as a contextual construct that reflects whether the system fits within the user’s daily domain. It plays an essential part in the model, as it has direct and statistically significant connections to primary task support, perceived persuasiveness, intention to continue using, and actual usage.

In general, this study paves the way for further theory development regarding factors contributing to perceived persuasiveness and adoption of behavior change support systems (Oinas-Kukkonen 2012). The next step to augment the proposed theoretical model would be to incorporate the construct of social influence and examine its interplay with the other constructs. Moreover, it will be important to look beyond perceptions and intentions, and investigate whether a persuasive system is actually successful in changing the intended behaviors of its users. From a practical perspective, it is beneficial to recognize the most influential constructs leading to perceived persuasiveness, and in turn, adoption and prolonged use of the system. This type of knowledge will aid in guiding the design and development processes of behavior change support systems.

There are limitations to this study. The research participants were mostly female from one country (Norway), so the results may not be generalizable to other settings and contexts. As a consequence, the proffered theoretical model should be subjected to further testing with various participants and settings. For instance, cultural aspects might play an important role in the model. Lastly, it has to be noted that persuadees do not necessarily adopt systems based upon their persuasiveness (cf. Friestad and Wright 1994).

Conclusion

This study has proposed a theoretical research model predicting factors contributing to perceived persuasiveness of behavior change support systems. The proposed model can be considered as a meta-model, i.e. it may be utilized in a multitude of domains, such as health behaviors (as in the present study), safety and education. The present study extends the current rather limited body of knowledge regarding
the factors contributing to engagement with BCSSs. Some might consider our stance technologically deterministic. However, we do not wish to imply that the use of technology, or BCSSs, no matter how persuasive, is necessarily enough in matters related to behavior change. Even so, scaffolding the knowledge base of BCSSs may prove to be valuable in such efforts. Regarding future research, it is necessary to further develop and test constructs applicable to individuals’ intention to adopt behavior change support systems. A rigorous mixed-method approach would be advantageous in related study designs. To conclude, results from these types of studies are helpful in identifying the most influential adoption factors and proposing solutions that are able to engage and captivate the individuals using the behavior change support systems for a prolonged time for intrinsic rewards.

Conflicts of Interest

The third author (FD) is working for Changetech AS which has developed the behavior change support system under investigation.

Acknowledgments

The authors would like to thank the referees for their helpful comments and suggestions while reviewing this paper. The authors extend their thanks to Changetech AS for enabling this study. The study was partially supported by the SalWe Research Program for Mind and Body (Tekes – The Finnish Funding Agency for Technology and Innovation grant 1104/10).

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## Appendix A. Measurement Items for Principal Constructs

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Items</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary task support</strong></td>
<td>1. NIV provides me with means to lose weight.</td>
<td>Self-developed based on (Oinas-Kukkonen and Harjumaa 2009)</td>
</tr>
<tr>
<td></td>
<td>2. NIV helps me lose weight.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. NIV helps me change my eating habits.</td>
<td></td>
</tr>
<tr>
<td><strong>Dialogue support</strong></td>
<td>1. NIV provides me with appropriate feedback.</td>
<td>Self-developed based on (Fogg and Nass 1997; Klein et al. 2002; Oinas-Kukkonen and Harjumaa 2009)</td>
</tr>
<tr>
<td></td>
<td>2. NIV provides me with appropriate counselling.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. NIV encourages me.</td>
<td></td>
</tr>
<tr>
<td><strong>Perceived credibility</strong></td>
<td>1. NIV is trustworthy.</td>
<td>Self-developed based on (Corritore et al. 2003; Oinas-Kukkonen and Harjumaa 2009; Wathen and Burkell 2002)</td>
</tr>
<tr>
<td></td>
<td>2. NIV is reliable.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. NIV shows expertise.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. NIV instills confidence.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. NIV is made by health professionals.</td>
<td></td>
</tr>
<tr>
<td><strong>Design aesthetics</strong></td>
<td>1. The screen in NIV (i.e. colours, layout, presenters, etc.) is attractive.</td>
<td>Adapted from (Cyr and Head 2006)</td>
</tr>
<tr>
<td></td>
<td>2. The general appearance of NIV is appealing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. NIV provides a nice visual experience.</td>
<td></td>
</tr>
<tr>
<td><strong>Perceived persuasiveness</strong></td>
<td>1. NIV has an influence on me.</td>
<td>Self-developed based on (Crano and Prislin 2006; Petty and Cacioppo 1986; Wood 2000)</td>
</tr>
<tr>
<td></td>
<td>2. NIV is personally relevant for me.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. NIV makes me reconsider my eating habits.</td>
<td></td>
</tr>
<tr>
<td><strong>Unobtrusiveness</strong></td>
<td>1. Using NIV fits into my daily life.</td>
<td>Self-developed based on (Ayygari et al. 2011; Hensel et al. 2006; Karahanna et al. 2006; Oinas-Kukkonen and Harjumaa, 2009)</td>
</tr>
<tr>
<td></td>
<td>2. Using NIV disrupts my daily routines.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Reversed item)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Using NIV, is practical / convenient for me.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Finding the time to use NIV is not a problem for me</td>
<td></td>
</tr>
<tr>
<td><strong>Intention to continue using the system</strong></td>
<td>During the next few weeks...</td>
<td>Adapted from (Bhattacherjee 2001)</td>
</tr>
<tr>
<td></td>
<td>1. I plan to use NIV.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. I expect to use NIV.</td>
<td></td>
</tr>
<tr>
<td><strong>Usage</strong></td>
<td>Measured with log file data: number of completed program days 6 weeks post-intervention</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** All constructs were modeled as reflective.