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Treating Depression with a Behavior Change Support System without Face-to-Face Therapy

Special Issue: HCI in Health and Wellness

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Abstract:

In this paper, we present results from a randomized controlled trial (RCT) that examined the impact of persuasive reminders and virtual rehearsal on the effectiveness of a behavior-change support system (BCSS). We developed the Web-based BCSS to support people with mild to moderate depression without face-to-face therapy. We randomized eligible participants into two groups. Both groups rehearsed the target behavior virtually; however, only the first intervention group received email-based reminders. We applied a mixed-methods approach for the analysis. We collected data with semi-structured self-reported questionnaires and post-study interviews. Results indicate that the severity of depression was noticeably decreased and participants' self-confidence to manage depressive thoughts was generally improved. The influence of persuasive reminders on task completion was less than we anticipated, while the participants felt that virtual rehearsal was an effective technique for learning new behaviors. We discuss possible reasons for the results at the end of the paper.

Keywords: Behavior Change Support Systems, Persuasive Technology, Reminders, Virtual Rehearsal, Depression, Randomized Control Trial, RCT.

1 Introduction

Recently, human–computer interaction (HCI) researchers have shown growing interest in studying behavior-change technologies developed to promote healthy behaviors (Consolvo, Klasnja, McDonald, & Landay, 2009). Researchers have reported positive results in several areas where persuasive design features have been applied. The studies problem domains include but are not limited to smoking cessation, obesity, diabetes, stress, and depression (e.g., Hamari, Koivisto, & Pakkanen, 2014). However, there is still scope to improve the effectiveness and study the impact of specific persuasive software features (Oinas-Kukkonen, 2010).

Persuasive technologies are interactive systems designed to change attitudes and behaviors (Fogg, 2003). Persuasion through these technologies happens voluntarily without coercion or deception (Oinas-Kukkonen & Harjumaa, 2009). In persuasive systems, both computer-human and computer-mediated persuasion can be utilized (Oinas-Kukkonen & Harjumaa, 2008); thus, the process of persuasion may happen through persuasive software features, such as reminders, or by people interacting with each other through computers, such as via email or social chat rooms.

Behavior change support systems (BCSS) are a key concept of study in the persuasive technology research field (Oinas-Kukkonen, 2010, 2013). Oinas-Kukkonen (2013, p. 1225) defines BCSSs as “a socio-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behavior or an act of complying without using coercion or deception”.

Researchers have developed the persuasive system design (PSD) to provide a systematic design and evaluation method for developing BCSSs (Oinas-Kukkonen, 2013; Oinas-Kukkonen & Harjumaa, 2009). The model introduces, among other design and development issues, software features that can potentially increase a given system’s persuasive effect.

The PSD model (Oinas-Kukkonen & Harjumaa, 2009) proposes virtual rehearsal as one of the key software features that can assist users to complete primary tasks such as learning healthy behaviors. Psychology experts have acknowledged cognitive improvement through performance-based processes (Thorpe, Hecker, Cavallaro, & Kulberg, 1987). Thorpe et al. (1987) report the significance of rehearsal as a behavior-changing technique by arguing that it is a useful method for improving self-efficacy, which, in turn, has significant effects on, for example, expected performance (Bandura, 1977). However, rehearsal, as a software feature, has not received much attention in the HCI or persuasive systems research fields (Torning & Oinas-Kukkonen, 2009).

Another promising software feature proposed in the PSD model is reminders. By implementing computer-human dialogue support, such as reminders, a persuasive system’s users are more likely to keep moving toward achieving their goals (Oinas-Kukkonen & Harjumaa, 2009). In several cases, the effectiveness of the interventions was found to increase when users were reminded periodically (Fry & Neff, 2009). However, we need more research to thoroughly understand the effect of such software-based solutions (Clarke et al., 2005; Fry & Neff, 2009). Identifying this gap, we decided to study the software features of persuasive reminders and virtual rehearsal and their potential impact on the effectiveness of a Web-based BCSS for depressive symptoms.

2 Background

E-health) is about using information technology in delivering healthcare (Oh, Rizo, Enkin, & Jadad, 2005). It has enormous potential to deliver cost-effective innovative tools and practices to provide and promote sustainable healthcare solutions. The results from various studies that have focused on developing and evaluating health-based treatments and prevention programs delivered via the Internet show promise in being scalable, cost-effective, and efficacious (Ritterband & Tate, 2009).

Thus, it is no surprise that the Internet has become a focal point in health psychology research (Kraft & Yardley, 2009). Digital interventions can offer new methods for self-care and are potentially more accessible for those who either do not want to or cannot contact health professionals in person (Kraft & Yardley, 2009; Ritterband, 2009). Further, some evidence exists that computerized and Internet-based interventions can be helpful for people who suffer from depression (Andersson & Cuijpers, 2009). However, we need more research to determine usefulness of different types of interventions for different situations and the effect of various software features in them.

2.1 Persuasive Systems Design

Fogg (2003) was the first to conceptualize persuasive technology. He defines it as “interactive computing systems designed to change people’s attitudes and behaviors” (p. 1). Later, Oinas-Kukkonen and Harjumaa (2009) define persuasive systems as designed to “reinforce, change or shape attitudes or behaviors or both without using coercion or deception” (p. 486). Using such systems is based on voluntariness (Oinas-Kukkonen, 2013; Karppinen & Oinas-Kukkonen, 2013); if the system were to be effective, it would have to have enough persuasive power.

BCSS is an object of study in particular for persuasive technology research (Oinas-Kukkonen, 2010). A BCSS focuses more on psychological and behavioral outcomes, which is different from persuasive systems whose key-defining factor is in the persuader’s intent (Oinas-Kukkonen, 2013). One of a BCSS’s typical—but not obligatory—characteristics is that it helps people to change their behaviors and/or attitudes by building on their own motivation (Oinas-Kukkonen, 2013).

The technology dimension of Internet interventions such as BCSS enables researchers to study the specific factors in more depth (Kraft et al., 2009). By controlling the studied factor, it is possible to obtain deeper insights into the factor’s effectiveness. In addition, by using a protocol or framework to describe the design, implementation, and components in the intervention system, the characteristics making the intervention successful or unsuccessful can be expressed in a manner that allow one to redevelop the intervention (Kelders, Kok, Ossebaard, & van Gemert-Pijnen, 2012; Kraft, Drozd, & Olsen, 2009).

A leading framework in the persuasive systems’ field is the PSD model (Oinas-Kukkonen & Harjumaa, 2009), which builds on Fogg’s (2003) work and, to some extent, on theories such as the technology acceptance model (Davis, 1989) and the elaboration likelihood model (Petty & Cacioppo, 1986). Researchers have used the PSD model (Oinas-Kukkonen & Harjumaa, 2009) to design (see Derrick, Jenkins, & Nunamaker, 2011; Ghorai, Jahan, Ray, & Chylinski, 2014; Yap et al., 2011) and evaluate (see Drozd, Lehto, & Oinas-Kukkonen, 2012; Langrial, Lehto, Oinas-Kukkonen, Harjumaa, & Karppinen, 2012) persuasive systems. The PSD model comprises three phases: understanding the key issues behind persuasive systems, analyzing the persuasion context, and defining the persuasive software features (Oinas-Kukkonen, 2013; Oinas-Kukkonen & Harjumaa, 2009).

According to Oinas-Kukkonen and Harjumaa (2009), one needs to understand seven key issues—postulates—when designing or evaluating persuasive systems. Although all of the postulates are important and have been considered when designing the BCSS we use in this study, we emphasized certain postulates, which we describe below.

Direct and indirect routes are key persuasion strategies. This postulate states that there are two key routes for persuasion and attitude change: direct and indirect (Oinas-Kukkonen, 2013; Oinas-Kukkonen & Harjumaa, 2009). Those who are motivated and have the ability to elaborate persuasive messages carefully follow the central or direct route (Petty & Cacioppo, 1986). On the other hand, for those with low motivation, ability, or both to inspect the persuasive message, the indirect route is more influential (Petty & Cacioppo, 1986). These routes can affect simultaneously and be used in a BCSS by numerous software features (Oinas-Kukkonen & Harjumaa, 2009).

Persuasion is often incremental. Matthew (2005) observes that it is easier to persuade people to do a series of small actions through incremental suggestions than persuade them to make the whole behavior or attitude change at once.

Persuasive systems should be as unobtrusiveness as possible. Oinas-Kukkonen and Harjumaa (2009) state that the persuasive system should avoid disturbing the user; thus, the system should not, for example, send a message reminding the user to go for a short walk or drink a glass of water when the user is fully occupied with something else or otherwise unable to act as wanted. Trying to persuade users at inopportune moments may even lead to undesirable outcomes (cf. Oinas-Kukkonen & Harjumaa, 2009).

2.2 Research Hypotheses Regarding Reminders and Rehearsal

In this study, we emphasize two software features outlined in the PSD model (Oinas-Kukkonen & Harjumaa, 2009); namely, reminders from the computer-human dialogue category and rehearsal from the primary task-support category. Lehto and Oinas-Kukkonen (2015) found both of the mentioned categories

to have a significant impact on perceived effectiveness, but, interestingly, only the primary task support category had a direct impact on the continuance intention.

According to Fogg (2003), persuasive technology should prompt users to perform target behaviors when operating it. Persuasive reminders have the capacity to act as prompts and facilitate task completion. Reminders may vary in design and form (e.g., they could be incorporated as guileless messages or feedback) (Arroyo, Bonanni, & Selker, 2005), and they can be delivered via different means with varying frequencies. Researchers have studied the effectiveness of the reminders in, for example, the context of interventions for weight loss, physical activity, and promoting a healthier lifestyle (Fry & Neff, 2009). In several cases, the results were promising, and, together with personal contact with a counselor, the periodic reminders increased the effectiveness of the interventions (Fry & Neff, 2009). Griffiths and Christensen (2007) found that using an information system reduced depressive symptoms but that weekly reminders made no difference in its effectiveness. On the other hand, Schneider, de Vries, Candel, van de Kar, and van Osch (2013) found email prompts to be somewhat effective in boosting revisits to the program. In our study, we determine the effectiveness of reminders by how helpful the participants perceive the reminders to be in completing tasks. Thus, we hypothesize that:

H1: Persuasive reminders help users to complete tasks.

The system should remind the users of their target behavior to help them reach their goals (Oinas-Kukkonen & Harjumaa, 2009), but, in cases where the number or frequency of reminders is perceived as too high, the reminders might be perceived as “nagging” and even harassing (Dennison, Morrison, Conway, & Yardley, 2013). Reminders should encourage users to use the system and help them sustain their motivation; however, it is possible that reminding users happens in an unsuitable and/or obtrusive manner (e.g., at the wrong moment or too frequently). The content of the reminders should also be appropriate to have an effect. Thus, to explore the suitability of the frequency and content of reminders, we hypothesize that:

H2: Users will perceive persuasive reminders as a desirable software feature.

Virtual rehearsal is one of the key features in the PSD model's primary task-support category (Oinas-Kukkonen & Harjumaa, 2009). By rehearsing a behavior, the behavior or behavior change can be facilitated in the real world (Lehto & Oinas-Kukkonen, 2011). The primary task-support category supports enhancing user's self-efficacy by, for example, decreasing the cognitive burden (Drozd et al., 2012). Researchers have found perceived self-efficacy to have a great impact on one's behavior; it can be affected to increase, for example, performance and outcome expectations (Bandura, 1977, 2011). Self-efficacy has a great impact on mobilizing one's motivation toward behavior change and, once achieved, maintaining the new habit changes (Bandura, 2004). Cognitive improvements have been achieved through performance-based processes (e.g., Thorpe et al. (1987) state the significance of rehearsal as a behavior change technique and a helpful technique for improving self-efficacy). Virtual rehearsal has been studied surprisingly little, especially in the HCI and persuasive systems fields (Kelders et al., 2012; Langrial, Oinas-Kukkonen, Lappalainen, & Lappalainen, 2014) even though it is considered to be a very important persuasive feature in persuasive systems (Oinas-Kukkonen & Harjumaa, 2009). Langrial et al. (2014) and Peng (2009) found some preliminary positive results regarding virtual rehearsals' effectiveness. Langrial et al. (2014) found that most users accepted virtual rehearsal as being helpful in adopting new behavior, while Peng (2009) found the rehearsal to have a positive effect on self-efficacy in the context of healthy eating. Thus, we hypothesize that:

H3: Virtual rehearsal helps users achieve improved self-efficacy.

H4: Users with improved self-efficacy intend to continue to rehearse newly learned skills.

BCSS place emphasis on the final outcome of the intervention rather than on only the intent to persuade (Oinas-Kukkonen, 2013). Since the target group of the intervention in our study is people who suffer from depressive symptoms, we measure the overall effect by the possible change in depression. The fifth hypothesis is as follows:

H5: The BCSS's overall effect will significantly decrease depression.

3 Methodology

To analyze the impact of persuasive reminders and virtual rehearsal on the effectiveness of a Web-based BCSS for people suffering from depressive symptoms, we designed and implemented a BCSS by using

the PSD model (Oinas-Kukkonen & Harjumaa, 2009). For studying the effect of reminders, we created two intervention groups: one receiving reminders and one not, which created the opportunity to compare the effect of the BCSS between groups. We made the virtual rehearsal accessible to both groups since not giving any treatment for people voluntarily participating in the study and suffering from mild to moderate depression seemed unethical. We measured the degree of depressive symptoms before and after the participants used the BCSS for the designed six weeks. Figure 1 shows the timeline, which we explain further in this section.

3.1 Data Gathering

3.1.1 Recruitment

Depression is one of the most common mental illnesses in modern society (Kessler, 2012). Researchers have reported several hindrances that prevent people from using online and face-to-face treatments. For example, low motivation to reach experts, reluctance to discuss personal matters with strangers, lack of available professional services, distantly located health services, high treatment costs, and stigma are barriers that must be overcome (Aromaa, Tolvanen, Tuulari, & Wahlbeck, 2011; Cuijpers, 1997; Ebmeier, Donaghey, & Steele, 2006). Thus, depression remains a challenging area where BCSS may aid.

We conducted our study between September 2012 and January 2013. We recruited participants through newspaper advertisements stipulating that we were seeking individuals experiencing depressive symptoms for an eight-week university research project. In addition, the recruiting advertisement mentioned that we were investigating the efficacy of new psychotherapy methods provided via the Internet and that the treatment was free of charge. We published recruitment advertisements in two local Finnish newspapers on September 8, 2012. In response, 42 people contacted the university clinic via email or telephone. One participant dropped out before the initial screening phase.

Trained psychology student therapists performed the initial screening on September 10-12, 2012, by using structured interviews over the phone to verify that the participants met the inclusion criteria. The criteria included self-reported depressive symptoms, aged 18 or higher, at least basic computer skills, access to the Internet, an email address, and no other treatment for their depression at the time. We formulated the questions based on the Diagnostic and Statistical Manual of Mental Disorders' (DSM-IV) (American Psychiatric Association, 1994) criteria for a major depressive episode, in which the questions are planned to determine the participants' depressive symptoms. Participants had to report at least five of the DSM-IV depressive symptoms in order for us to include them in the study.

Two of the participants did not meet the eligibility criteria and were dropped from the study; therefore, the actual sample size comprised 39 participants. We sent the eligible participants a package via post on September 12, 2012, that included information about the study, a basic background demographic information questionnaire, a psychological measurement package to measure their symptoms of depression, and an informed consent form. Because the study included actual patients with depressive symptoms, the study followed the Declaration of Helsinki and was approved by the Ethics Committee of the Central Finland Healthcare District (Diary no: 15U/2012).

3.1.2 Randomization

We performed randomization on September 17, 2012, and conducted pre-study interviews afterwards. A person who was not connected to the research conducted the randomization. We used stratification on two levels: gender and the amount of self-reported depressive symptoms identified during the first screening. We randomized participants into two groups: 1) intervention group 1 ($n = 19$), which received automated weekly reminders via email and had access to weekly rehearsal exercises, and 2) intervention group 2 ($n = 20$), which first served as a waiting list control group and had to wait a period of six weeks before members could access the BCSS. The BCSS for intervention group 2 included the weekly rehearsal exercises (similar to those used in intervention group 1), but there were no reminders.

The intervention for group 1 started on September 28, 2012, and concluded on November 9, 2012, followed by final interviews on November 12-16, 2012. Treatment for intervention group 2 started November 17 and concluded January 4, 2013. We took post-measurements on January 7-11, 2013. A total of 28 (71.8%) females and 11 (28.2%) males with an average age of 51 years comprised the sample. One participant from intervention group 1 and three from intervention group 2 dropped out before the post-measurement; thus, the sample size comprised 35 participants. In addition, one participant from

intervention group 2 filled out the questionnaire about reminders, rehearsal, and the overall effect of the BCSS but not about depressive symptoms and self-confidence. The results reported in this paper are based on responses from both groups' participants.

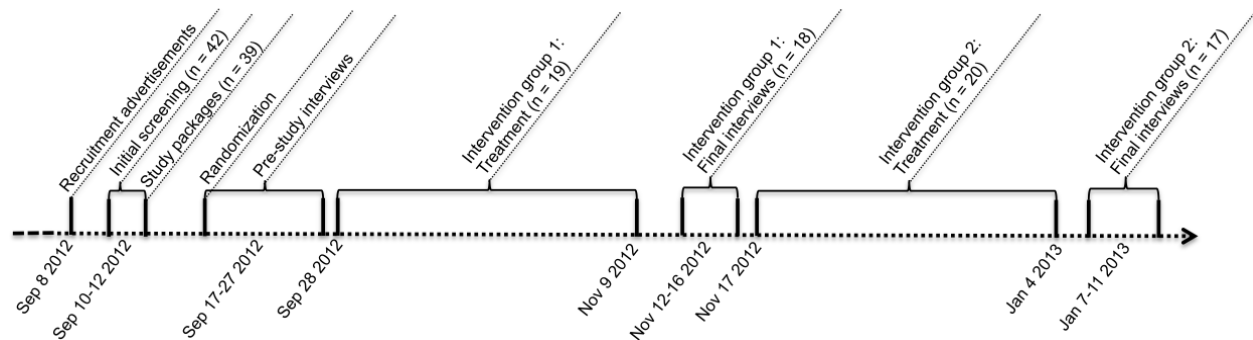


Figure 1. Research Timeline

3.1.3 BCSS Development and Content

The research team at the Department of Psychology, University of Jyväskylä, Finland, developed the BCSS, and the research team from the Department of Information Processing Science, University of Oulu, Finland, integrated the persuasive software features based on the PSD model into the system. We based the BCSS's content on acceptance and commitment therapy (ACT), and it included text, picture, and audio self-help material. The BCSS comprises six modules, which each focused on one of the six ACT processes: values, committed action, being present, cognitive defusion, self as context, and acceptance (Hayes et al., 2006). We used virtual rehearsal as a software feature to enhance mindfulness, acceptance skills, and commitment to value-based actions among participants by using a variety of metaphors, experiential exercises for mindfulness, and behavioral activation (Hayes, Luoma, Bond, Masuda, & Lilles, 2006).

3.1.4 Reminders and Virtual Rehearsal

We required participants to complete one rehearsal module per week before moving on to the subsequent week. The rehearsal exercises were in audio format and provided depression-management skills. The reminders encouraged the participants to practice the skills that they had learned, including mindfulness and acceptance skills, and to complete value-based actions through email-based reminders (see Appendix 1). Everyone in the intervention group 1 automatically received one reminder in the beginning of each week. We sent the reminders by email so that the participants could read them in appropriate time and the reminders would not disturb the users. Each Thursday during the study, trained student therapists monitored whether the participants completed weekly modules. Those who did not complete weekly modules in time were sent an additional reminder by SMS. In the event that a participant did not complete the task (module) after receiving two reminders, the assigned therapist contacted the individual via telephone¹.

3.1.5 Therapists

Master's level psychology students performed the psychological intervention. They went through 21 hours of intensive training about ACT, including lectures on the general principles of ACT and core processes. During the training sessions, third and fourth author provided students with an ACT handbook (Lappalainen et al., 2007) with a detailed description of the therapy, its core processes, 32 metaphors, 18 exercises, and practical forms that are commonly used in such therapies. The therapists received two hours of supervision during the first three and last weeks of the program. The author is an experienced clinician, licensed psychologist, and psychotherapist and has nearly 30 years of experience in clinical work and supervision and 12 years' experience in ACT clinical practice.

¹ Only one client was approached via telephone and that this occurred only one time.

3.1.6 Data Collection

We employed both qualitative and quantitative approaches, Likert-type scale questionnaires (see Appendix 2), and structured interviews. We chose the mixed-methods approach for developing rich insight into the phenomenon (Venkatesh, Brown, & Bala, 2013). On completing the study, we asked the participants questions about their experiences with the BCSS. The questionnaire comprised two parts. The first part included demographic questions devised to collect information about the participants, their computing skills, and their familiarity with the Internet. The second part included questions about participants' opinions on the system's usefulness, ease of use, the impact of reminders on task completion, the impact of virtual rehearsal on self-confidence, and their intention to rehearse newly learned behaviors. The questions used a five-point Likert-type scale (1 = "strongly agree"; 5 = "strongly disagree"). Finally, we interviewed them in a post-study satisfaction survey in which we recorded, coded, and analyzed their experiences with the intervention.

In total, 35 participants (intervention group 1, $n = 18$; intervention group 2, $n = 17$) agreed to fill out the questionnaires (see the Table 1 for demographics). In intervention group 1, approximately 28 percent of the participants were male; in intervention group 2, approximately 18 percent of the participants were male. All of the participants were aged 22 or older. The majority of the participants in both groups were aged 51 or over (intervention group 1, $n = 8$, 53%; intervention group 2, $n = 10$, 59%). As Table 2 shows, participants' background variables were comparable.

Table 1. Participants' Demographic Description

Demographics	Value	Intervention group 1	Intervention group 2
Age	< 22	0	0
	22-31	3 (16.7%)	1 (5.9%)
	32-41	1 (5.6%)	3 (17.6%)
	42-51	4 (22.2%)	3 (17.6%)
	51>	10 (55.6%)	10 (58.9%)
Gender	Male	5 (27.8%)	3 (17.6%)
	Female	13 (72.2%)	14 (82.4%)

At the end of their intervention periods, we asked participants in both groups questions related to their perceptions about the impact of reminders. Because intervention group 2 did not receive persuasive reminders, we asked them whether they thought that reminders could have helped them in completing the required tasks.

3.1.7 Psychological Measures

We assessed symptoms of depression and self-reported confidence at the beginning and end of the study. For measuring depressive symptoms, we used the Beck Depression Inventory-II (BDI-II) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and self-confidence (Ojanen, 2001) as primary measures. The BDI-II includes 21 questions about depressive symptoms and their severity. The scale ranges from 0-63 (where 0-13 indicates no or very few depressive symptoms, 14-19 indicates mild depression, 20-28 indicates moderate depression, and 29-63 indicates severe depression). The BDI-II has been recognized as being reliable and valid in both nonclinical and clinical populations (Segal, Coolidge, Cahill, & O'Riley, 2008; Beck, 2011). To measure the self-confidence of the participants, we used the Finnish descriptive visual rating scale (0-100). The scale has shown good test and retest reliability (Sjögren-Rönkä, Ojanen, Leskinen, Mustalampi, & Mälkiä, 2002).

4 Results

In the study, we sent reminders to only intervention group 1. To study how the participants perceived the effectiveness of the reminders, we asked them after the study if they felt that persuasive reminders helped them in completing their weekly exercises. We asked the participants in intervention group 2 whether they thought that reminders would have helped them in completing the weekly exercises and to state their willingness to receive reminders. They provided answers using a five-point Likert-type scale ranging from

strongly agree to strongly disagree. To test hypotheses H1–H4 by t-tests, we used the midpoint (3) as a population estimate.

For H1, a slight majority (55.6%) of intervention group 1 reported that the persuasive reminders helped them complete the tasks; however, the one-sample t-test showed no statistically significant support for the reminders to be effective in helping complete the tasks ($M = 2.39$; $SD = 1.378$; $p = 0.077$). Thus, H1 was not supported.

For H2, Oinas-Kukkonen and Harjuma (2009) emphasize that persuasive systems should avoid disturbing the user in the wrong moment. The majority of the participants (77.8%) receiving the reminders felt that the reminders did not interrupt them. The unobtrusiveness could also be shown from the one-sample t-test since the mean (1.94) was statistically significantly ($p < 0.05$) different from the null hypothesis ($M = 3$). In addition, the intervention group 2 participants' answers to the question of whether the reminders would have helped them in completing the weekly task confirmed H2 further ($M = 2.24$, $SD = 1.2$; $p < 0.05$). Interestingly, only 70.6 percent of intervention group 2 participants stated that reminders should not disturb users, the rest being unsure (11.8%) or stating that the reminders should be more or less obtrusive (17.7%).

For H3, independent sample tests showed that there was no statistically significant difference between the two intervention groups ($p = 0.181$); thus, we combined the results from both intervention groups and ran the one-sample t-test to test H3. The results ($M = 1.77$; $SD = 1.031$, $p < 0.05$) confirm H3.

For H4, a high majority of participants from intervention group 1 (72.2%) and group 2 (88.2%) indicated their intention to rehearse newly learned skills in the future. Again, there was no statistically significant difference between the two intervention groups (independent samples test $p = 0.194$), so we combined the data. The results ($M = 1.86$; $SD = 1.192$; $p < 0.001$) showed a statistical significance: the participants intended to carry on rehearsing. Thus, H4 was supported.

For H5, we analyzed pre- and post-measurements of BDI and self-confidence from both intervention groups by using mixed model ANOVA. The test showed no significant differences between intervention groups (BDI: $F = 0.132$, $p = 0.719$; self-confidence: $F = 0.054$, $p = 0.817$). The mean score of BDI dropped from 21.94 ($SD = 7.426$) to 12.71 ($SD = 9.402$). Pearson correlation was large ($r = 0.640$) and statistically significant ($p < 0.01$). Similarly, we obtained statistically significant ($p < 0.001$) results from analyzing Pearson correlation of self-confidence, the effect size being large ($r = 0.630$). Participants' self-confidence increased from mean 46.97 ($SD = 18.469$) to 60.97 ($SD = 20.297$). The psychological measurements provide strong evidence for the BCSS's overall effectiveness, which supports H5. However, reminders applied in intervention group 1 did not seem to have additional effect of depression and self-confidence. Table 2 summarizes the results.

Participants generally approved of the persuasive reminders, with the majority giving positive feedback, which acknowledges that, in today's overwhelmingly busy lifestyle, it is easy to overlook important tasks. Below are some representative comments:

"Reminders ensured me to remember doing the assignments; I use email very often." (P1)

"They reminded me of doing my homework and I found the (hyper)link (to be) very handy." (P2)

"Reminders give (gave) you the feeling that you are not alone. They encouraged and gave a boost for replying to the assignments. It felt personal." (P3)

"In addition to email-based reminders, SMS could be beneficial." (P4)

"Add supportive criticism; enveloping criticism in a way that it won't depress (discourage) the person." (P5)

Participants in intervention group 2 received the same intervention except that we did not send them reminders. A high majority (70.6%) stated that reminders would have been desirable. Some representative comments follow:

"Yes, if one has a tendency towards forgetting things that need to be done [reminders would have helped]." (P6)

"Yes, because I forgot, since there were no reminders; the due dates were hard to remember." (P7)

Table 2. Summary of Results

Construct		Intervention group 1	Intervention group 2	Hypothesis
Reminders helped in task completion		2.39 (1.378) p = 0.077 95% CI -1.3 to 0.07		H1 not supported
Reminders would have helped me complete weekly tasks			2.24 (1.200) p = 0.018 95% confidence interval -1.38 to -0.15	H2 supported
Reminders were unobtrusive		1.94 (1.514) p = 0.009 95% CI -1.81 to -0.3		
Rehearsal improved my self-efficacy		1.77 (1.031) p < 0.01 95% CI -0.58 to -0.87		H3 supported
Intent to continue to rehearse		1.86 (1.192) p < 0.001 95% CI -1.55 to -0.73		H4 supported
BDI	Pre	21.94 (7.426)		H5 supported
	Post	12.71 (9.402)		
		r = 0.640 (p < 0.01)		
Self-confidence	Pre	46.97 (18.469)		
	Post	60.97 (20.297)		
		r = 0.630 (p < 0.01)		

CI = confidence interval

We also note some mixed remarks. P8 commented: "I did not need to be reminded. I was already committed to the program."

A great majority of the participants acknowledged the rehearsal feature as a good technique to learn new skills. Some of the representative comments include:

"Exercises [rehearsals] were good. All in all, the interaction was excellent." (P9)

"Weekly themes [rehearsals] were very good. They [rehearsal exercises] brought me in touch with my [core] values and I learned to be consciously present in the moment." (P10)

"I found [the] rehearsal content to be supportive. It kept me on track." (P11)

5 Discussion

In this study, we analyzed the impact of reminders and virtual rehearsal on the effectiveness of a Web-based BCSS for people suffering from depressive symptoms. Participants' reflections about reminders, virtual rehearsal, and the BCSS reveal that the system was generally well received. Most importantly, we observed significant improvements in post-study psychological measurements where depressive symptoms decreased distinctively, while, in parallel, participants' self-confidence improved considerably.

Reminders, or a software feature, supporting computer-human dialogue (Oinas-Kukkonen & Harjumaa, 2009), seem to have less impact on the overall effectiveness of the BCSS in terms of decreasing depression and increasing self-confidence scores. This finding is interesting because Lehto and Oinas-Kukkonen (2015) found that the wider computer-human dialogue support category had a direct impact on the perceived effectiveness of a BCSS. Thus, it would be interesting to further study whether this discrepancy is because of studying one computer-human dialogue feature (reminder) rather than the

category of features or because their study was about perceived persuasiveness and our study was about actual change in self-reported measures of depression and self-confidence².

One reason for the lack of effect of reminders in our study could be that the content of the ACT-based rehearsals was highly effective and engaging and, as a result, the participants were intrinsically motivated to perform required tasks (weekly exercises) with an obvious need of reminders. The participants were also fairly motivated to change their behavior at beginning of the study because they were recruited through newspaper advertisements. Their willingness to participate in the research project indicates their intrinsic motivation to try technology-assisted treatments. Some of the participants did not find the reminders to be necessary because they were highly self-motivated to use the BCSS and the treatment program. In addition, the intervention might have been too short to bring up the need for such reminders. Kelders et al. (2012) found that adherence is influenced by user engagement. Also, the research setting and urge to please researchers may influence participants' willingness to complete weekly tasks; however, a majority of the participants considered reminders to be a useful software feature.

According to some participants, reminders made them feel as though they were being treated on a personal level and that they were not alone. This seems to be an important observation, especially in the context of treating depression.

In our study, we sent only email-based reminders to the participants of intervention group 1 and no reminders to intervention group 2. Some of the participants expressed that they would have benefitted more had there been mobile phone-based reminders as well. The method of delivering the reminders can be seen as part of the technology context from the PSD model (Oinas-Kukkonen & Harjumaa, 2009). There are different means for delivering reminders, and, as technology develops rapidly, there are even more means to choose from. Thus, finding the most suitable one for the target group of the intervention demands understanding of the use and user context.

Interestingly, some of the participants who did not receive reminders suggested that they would have preferred obtrusive (assertive) reminders. Perhaps users who need to build up their motivation to perform the given tasks need stronger reminders. This may also be the case with depressed people because depressive symptoms generally lead to lower motivation and reduced productivity.

The findings show that the effectiveness of virtual rehearsal was significant. A high majority of the participants stated that the BCSS was useful and influenced their behavior by increasing their self-confidence. We can verify this observation from participants' decreased severity of depressive symptoms and increased self-confidence to manage depressive thoughts. It seems possible that, for treating depression, increased use of technology and reduced face-to-face contact may still produce a desirable outcome. Technology-driven treatments are cost-effective and, thus, a research area growing in importance as Ritterband and Tate (2009) have already outlined.

Responses from the participants indicate that they learned new skills to manage depression, which is a key measure in a behavior change process. In addition, a high majority of participants felt confident that they could fight depressive thoughts and indicated their intention to continue practicing the skills that they had learned from the treatment program. These findings are in line with Bandura's (1977) theory of self-efficacy.

The qualitative feedback from the participants helped us identify two additional themes for designing better computer-human dialogue in BCSS:

- Provision of positive feedback: users have a desire for meaningful and positive feedback (Arroyo et al., 2005), and BCSSs have the capacity to enhance such desired interactivity and improve computer-human dialogue (cf. Oinas-Kukkonen & Harjumaa, 2009). The language and tone used in the reminders should be carefully developed because it could have unintended consequences. Personal sensation might enhance the effect of the reminders. It is also essential that people suffering from depressive symptoms are not left in situations where they feel unaided. Reminders could and should be designed in such a way that they make users feel "important". Therefore, we propose that adding empathetic content to reminders could have a positive influence when treating depression.

² The finding here is in line with Lehto and Oinas-Kukkonen (2015), who found that dialogue support did not have a direct impact on continuance intention; instead, the effect passed through multiple constructs.

- Helping users reflect on their values: the content of rehearsals could be made even more effective if it helps people to reflect on their values (cf. Ploderer, Reitberger, Oinas-Kukkonen, & van Gemer-Pijnen, 2014). This would mean that the content is developed in a way that reminds people of their values and goals, which, thereby, supports them to commit to actions that reduce disparity between their values/beliefs and actual actions. Such content could help people in overcoming different situations (e.g., unpredictable changes in everyday situations). We did not tailor the reminders in our study for each individual; however, some of the participants felt that they were.

5.1 Limitations

Like most research projects, our work has limitations. First, the sample size was fairly low; therefore, it would be hard to generalize the results. However, recruiting people with depressive symptoms or depression is a challenging task for various reasons, including social isolation, lack of motivation, hopelessness, and stigma. Second, the intervention lasted only six weeks and did not include a follow-up study. The period of six weeks may have been too short to find any significant effect of the reminders. Third, we developed the treatment for a Finnish audience, which limits the scope of generalizability for depressed people from other cultures or with non-Finnish backgrounds. In future studies, the above limitations should be considered when designing the research setting. Further, we highly advise a post-intervention follow-up.

6 Conclusion

In this paper, we present a mixed-methods study of a Web-based BCSS with rehearsal techniques and persuasive reminders. The system used a well-known therapy approach for treating depression without face-to-face meetings. First, we studied reminders and their effect on task completion. Second, we evaluated virtual rehearsal in terms of learning new behaviors leading to a potentially higher state of self-efficacy. Lastly, we investigated overall usefulness of the BCSS and its potential benefits as experienced by participants.

This research contributes to the existing body of knowledge relating to behavior change interventions and, more generally, to exploring the role of technology in healthcare. The overall findings are especially promising because we performed the entire intervention without face-to-face therapy. The participants received the virtual rehearsal as a persuasive software feature well. Although half of the participants considered the reminders to be helpful in completing tasks, they did not have as large of an impact on the effectiveness of the BCSS in this study context as we originally assumed, which calls for further research. In sum, the presented results provide a solid basis to continue research on reminder and rehearsal technologies and on services for people with depression and other mental disorders.

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Appendix A

Table A1. Reminders

Week	Reminder text
1	<p>“Believe in yourself! Have faith in your abilities! Without a humble but reasonable confidence in your own powers you cannot be successful or happy.” -Norman Vincent Peale</p> <p>Dear User, Welcome to Kompassi!</p> <p>We hope that you are having a good day. This is a gentle reminder for you to complete the first exercise tomorrow. In case you have already done that, please ignore this message. If you wish to log into the Kompassi system, please click on the link below and you will be redirected to the Kompassi website: Kompassi system (hyperlink)</p> <p>Good luck with the exercise, and we look forward to being in touch with you next week.</p>
2	<p>“Always continue the climb. It is possible for you to do whatever you choose, if you first get to know who you are and are willing to work with a power that is greater than ourselves to do it.” -Ella Wheeler Wilcox</p> <p>Dear User, We hope to have reached you at a convenient time. Congratulations on completing the exercise for Week 1. This is a reminder for you to complete your exercise for Week 2. In case you have already completed the exercise, please ignore this message.</p> <p>We would further like to advise you to keep checking your email on a regular basis, as we might wish to contact you.</p> <p>For your convenience, we have added the link to the Kompassi system below. Simply click on the link below and you will be redirected to the web site: Kompassi system (hyperlink)</p> <p>Good luck with the exercise, and we look forward to being in touch with you next week.</p>
3	<p>“Act as if what you do makes a difference. It does.” -William James</p> <p>Dear User, Hoping that you are having a good day, we wish to congratulate you upon successfully completing the exercise for Week 2. You are making great progress, and we truly hope that you are happy with your performance!</p> <p>We hope that you will complete the upcoming exercise for Week 3 in time. When it feels convenient, please click on the link provided below and you will be redirected to the Kompassi website: Kompassi system (hyperlink)</p> <p>Good luck with the exercise, and we look forward to being in touch with you next week.</p>
4	<p>“Do you want to know who you are? Don't ask. Act! Action will delineate and define you.” -Thomas Jefferson</p> <p>Dear User, We wish you a good day.</p> <p>We are now in week 4 and are delighted to inform you that you are making great progress by completing your weekly exercises. We further hope that you find the exercises to be of great use.</p> <p>This is a gentle reminder that the exercise for week 4 is due tomorrow. Please keep up the good work and complete your weekly exercise on time. If you have already completed it, please ignore this message. For your convenience, clicking on the link below will access Kompassi system: Kompassi system (hyperlink)</p> <p>Good luck with the exercise, and we look forward to being in touch with you next week.</p>
5	<p>“Follow your dreams, work hard, practice and persevere. Make sure you eat a variety of foods, get plenty of exercise and maintain a healthy lifestyle.” -Sasha Cohen</p> <p>Dear User, Greetings from Kompassi! You have now completed four exercises. This shows your commitment and resilience. Well done. We are sure that you are finding the exercises to be of great use.</p> <p>We are now in week 5 of the program, and this is a reminder for you to complete this week's exercise. At your convenience, simply click on the link provided and you shall be redirected to the website. In case you have already completed this week's exercise, please ignore this message. Kompassi system (hyperlink)</p> <p>Keep up the good work and we shall be in touch with you next week. Have a wonderful day!</p>

Table A1. Reminders

6	<p>"The will to win, the desire to succeed, the urge to reach your full potential . . . these are the keys that will unlock the door to personal excellence." –Confucius</p> <p>Dear User, Greetings from Kompassi!</p> <p>Let us congratulate you for completing 5 exercises over the past weeks. We hope that you have found the exercises to be useful!</p> <p>You also deserve special applause for your commitment and persistence with the program! This is a reminder for you to complete the last exercise, due tomorrow. If it feels convenient and you wish to complete the exercise right now, simply click on the link provided below and you shall be redirected to the website: Kompassi system (hyperlink)</p> <p>In case you have already completed this week's exercise, please ignore this message. Let us take this opportunity to thank you for being part of the study, and one more time, congratulations on completing the program!</p>
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Appendix B

Table B1. Questionnaire for Intervention Group 1

	No	Question	Measurement tool/options
Part 1	A	Gender	Male Female
	B	Age	Under 22 22-31 32-41 42-51 51 and over
	C	How many hours do you spend on computer daily?	1. Less than 30 minutes a day 2. 30 min-2 hours a day 3. 2-4 hours a day 4. Over 4 hours a day
	D	My expertise in using a computer is . . .	1-5 (1 = beginner, 5 = skillful and experienced user)
Part 2	1	I found the BCSS to be useful.	1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly disagree
	2	The BCSS was easy to interact with.	"
	3	Weekly reminders helped me complete the weekly exercises.	"
	4	The reminders did not interrupt my routine.	"
	5	Varying content of the reminders was effective.	"
	6	Weekly exercises and rehearsals affected my behavior, and I feel that I can manage my depression better.	"
	7	I intend to continue to exercise to better manage my depression.	"
	8	The information presented in the BCSS affected my behavior.	"
	9	The weekly rehearsals influenced my confidence to better manage my depressive symptoms.	"
	10	I would have liked to share my progress with fellow users.	"
	11	How would you evaluate the usefulness of the BCSS?	1-5 (1 = totally useless, 5 = very useful)
	12	How would you evaluate the usefulness of the reminders?	"
	13	How would you evaluate the BCSS' ease of use?	1-5 (1 = very difficult to use, 5 = very easy to use)
	14	Did you miss any exercise?	Yes / no
15	Why did you miss an exercise/exercises (e.g., obvious low motivation, or other reason)?	(Open-ended question)	
16	How could the reminders could be used in the treatment of mental disorders?	"	
17	Describe your experiences with the BCSS in your own words. (e.g., Which features were useful, which were useless? Were some exercises more effective than others?)	"	

Appendix C

Table C1. Questionnaire for Intervention Group 2

	No	Question	Measurement tool/options
Part 1	A	Gender	Male Female
	B	Age	Under 22 22-31 32-41 42-51 51 and over
	C	How many hours do you spend on computer daily?	1. Less than 30 minutes a day 2. 30 min-2 hours a day 3. 2-4 hours a day 4. Over 4 hours a day
	D	My expertise in using a computer is . . .	1-5 (1 = beginner, 5 = skillful and experienced user)
Part 2	1	I found the BCSS to be useful.	1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly disagree
	2	The BCSS was easy to interact with.	"
	3	If I had received weekly reminders, they would have helped me in completing my exercises on time.	"
	4	Reminders should have been a part of the system in such a way that they did not interrupt my routine.	"
	5	I would have liked to receive reminders with content that was different each time.	"
	6	Weekly exercises and rehearsals affected my behavior and I feel that I can manage my depression better.	"
	7	I intend to continue doing exercises to better manage my depression.	"
	8	The information presented in the BCSS affected my behavior.	"
	9	The weekly rehearsals influenced my confidence to better manage my depressive symptoms.	"
	10	I would have liked to share my progress with fellow users.	"
	11	How would you evaluate the usefulness of the BCSS?	1-5 (1 = totally useless, 5 = very useful)
	12	How would you evaluate the usefulness of the reminders?	"
	13	How would you evaluate the BCSS' ease of use?	1-5 (1 = very difficult to use, 5 = very easy to use)
	14	Did you miss any exercise?	Yes / no
	15	Why did you miss an exercise/exercises (e.g., oblivious low motivation, or other reason)?	(Open-ended question)
	16	How could the reminders be used in the treatment of mental disorders?	"
	17	Describe your experiences with the BCSS in your own words. (e.g., which features were useful? Which were useless? Were some of the exercises more effective than others?)	"

About the Authors

Liisa Kuonanoja, MSc, is a doctoral student at the Faculty of Information Technology and Electrical Engineering in the University of Oulu, Finland. Her main research interest lies in persuasive information systems and specifically their unintended consequences. She has been working at Professor Harri Oinas-Kukkonen's OASIS research group since 2013, first as a research assistant and later as a doctoral student.

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