

Involvement as a Working Mechanism for Persuasive Technology

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Abstract. Internet interventions have been shown to be effective for treatment of mental health complaints. Although non-adherence poses a problem, persuasive technology might be a solution. However, there is limited insight in how and why technology may lead to more adherence and effectiveness. This study explores the role of involvement in a Behavior Change Support System (BCSS) for treatment of depression. Involvement is seen as an important factor in the success of treatment, but has received little research attention. This study expands on an earlier study and uses self-reported data to explore differences between versions of the BCSS on involvement. The results show that involvement and adherence are related, but involvement outperforms adherence as predictor for effectiveness. This underlines the importance of involvement: it may be a working mechanism of persuasive technology and may be used as an early measure to assess whether the intervention is likely to reach its goals.

Keywords: Persuasive technology · Behavior change support system · Health · Adherence · Involvement

1 Introduction

Internet interventions have been shown to be effective for treatment and management of a range of (mental) health complaints [1, 2]. However, substantial non-adherence (participants not using the Internet intervention as intended, for example by not completing all modules) is often observed, especially when interventions are not part of a strict research protocol and when there is no counselor involved [3]. This non-adherence poses a problem for the effectiveness of Internet interventions because of the ‘dose-response’ relationship: the more the intervention is used, the more positive effects participants experience [4].

To overcome this problem, persuasive technology can be employed to increase both adherence and effectiveness. Internet interventions for mental health can be seen as Behavior Change Support Systems (BCSSs). A BCSS is defined as ‘a sociotechnical 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’ [5]. In these systems, different features can be used to increase the persuasiveness. The Persuasive System Design-model (PSD-model) describes four

categories of features: primary task support, dialogue support, credibility support and social support [6]. Although many of these features have been used in health BCSSs, most research focusses on the effects of the system as a whole, instead of focusing on the added value of features or categories of features [5]. This ‘black-box’-approach has resulted in limited insight into the role of these persuasive system design features. Besides limited insight in *what* persuasive technology can do in health BCSSs, there is limited insight in *how* and *why* technology may lead to more adherence and effectiveness. These working mechanisms may be important in understanding why persuasive technology leads to positive results in some cases (e.g. in certain context and for certain people) and not in other cases.

Involvement may be such a working mechanism. In ‘offline’ therapeutic interventions, the importance of involvement is well known. Studies have shown that more involvement of clients in therapy is beneficial for a better therapeutic relationship [7], which in turn is an important predictor of the effectiveness of therapy [8]. Moreover, it seems that involvement may even be a prerequisite for an intervention to be effective [9]. In many of the theories that are the foundation of BCSSs [5], personal involvement is seen as closely related to the motivation to change behavior, although this has received little research attention. In BCSSs for mental health, it may well be that the way technology is persuasive, e.g. making working with the intervention easier, more fun, more interesting or more relevant, may well be captured by measuring how involved participants are.

In this study, we investigate the role of involvement in a BCSS for the treatment of depression. Different versions of this intervention were created to investigate the influence of persuasive technology on adherence and effectiveness. These results are presented in a different paper [10] and show that persuasive technology did not directly result in increased adherence and effectiveness. However, there were significant differences between variations of the intervention and involvement. This paper builds on these earlier results and uses new analysis of the existing data to further explore these differences and their role in explaining adherence and effectiveness.

2 Methods

2.1 Experimental Design

This paper presents further analyses of data collected within a fractional factorial randomized controlled trial on a web-based intervention for the treatment of people with mild to moderate depressive symptomatology. For the study, different versions of the intervention were created. Five components were chosen (support, text messages, experience through technology, tailoring of success stories, and personalization) of which two levels were created (automated support and human support; text messages and no text messages; high and low experience through technology; high and low tailoring of success stories; high and low personalization). These components were chosen based on research into the design of this intervention (these were the features that deemed to be important to the target group to keep using the intervention [11]). Moreover, these components have been shown to be important for the effectiveness or

adherence of online interventions [6, 12-15]. For the fractional factorial design, eight intervention arms were created where each level of each component was present in half of the intervention arms. A more detailed description of this study design is presented in [10].

2.2 Intervention

The web-based intervention ‘Living to the full’ included nine chronological lessons and is based on Acceptance and Commitment Therapy. Each module included text, online and offline exercises, and metaphors. Participants were instructed to complete one lesson per week, but had twelve weeks in total to complete the nine lessons. The intervention was developed using a human centered design [11]. The intervention was proven effective compared to a waiting list and active control group [16]. Following is the description of the five components of which two levels were created.

Support. Participants randomized in the human support condition, received their weekly feedback from a human counselor. Participants randomized in the automated support condition, received weekly automatically generated feedback. The human counselors were psychology Masters students of the University of Twente, supervised by a clinical psychologist. The counselors were instructed to write a weekly feedback message containing the key learning points and goal of the completed lesson; the key exercises and feedback on at least the core exercise; feedback on the mindfulness exercise; and a preview of the following lesson. The automatically generated feedback contained the same elements, where the feedback on the core exercise and the mindfulness exercise was tailored based on the multiple choice responses of the participants to the question which was added to both exercises. An example question that was added after a core exercise was: ‘Was writing down your ‘bag of sorrow’ confronting to you?’. Feedback messages in both conditions were presented in the same manner: under ‘feedback’ in the personal home screen, accompanied by a picture of the counselor. In the automated support condition, a picture of a clinical psychologist was placed who was not directly involved in the study. We have chosen to include a picture in both conditions to ensure comparability, but also as an effort to humanize our system [17] and to increase the persuasiveness. Participants were aware of whether their counselor was human or automated to ensure that the system complies to the openness postulate of the PSD-model [6]. Apart from the source of the feedback message, there were two differences between the conditions. Participants in the human support condition had the opportunity to ask questions to their counselor. Questions were elicited when participants completed a lesson, but could also be asked at any time. Participants in the automated support condition, received one additional instant feedback message per lesson. This was an automatically generated message tailored to the multiple choice response of the participant on a different exercise than the core-exercise and was presented as a pop-up accompanied by the picture of the counselor.

Text messages. Participants in the condition that included text messages, had the opportunity to turn the SMS-coach on. This SMS-coach sent three pre-designed text

messages each week to a mobile phone number provided by the participant. The timing of the text messages was different each week, but all messages were sent between 9AM and 9PM. Each week one message contained a motivational message (e.g. “Do you realize you have taken the first step to learn to ‘live to the full’? Congratulations and keep going!”), one message contained a mindfulness trigger (e.g. “How mindful are you today?”) and one message reflected on the content of that week (e.g. “Avoidance is like scratching an itch. It only works for a short time.”). This way, the text messages served both as reminders and as suggestion [6]. The timing and content of the messages were based upon the results of the development study [11], to make the system as unobtrusive as possible. All text messages were presented in the ‘text message’ tab of the application, independent of whether the SMS-coach was turned on or off, but only for the participants in the condition that included text messages.

Experience Through Technology. This component is about the persuasive experience participants have when using the intervention. The high experience condition offers a more immersive and interactive experience than the low experience condition due to two differences. In eight of the nine lessons, a short movie was added to the high experience condition, in which the writer of the course or an experienced clinical psychologist explains the key points of the lesson. The movie does not contain other information than the text, but the information is presented in a different, more immersive way. The second difference was that the high experience condition contained an interactive exercise or multimedia presentation of an exercise or metaphor in seven of the nine lessons, whereas in the low experience condition the exercises and metaphors were presented as text.

Tailoring of Success Stories. The intervention contained a success story for each of the lessons of the intervention that became available at the same time as the lessons. The participants accessed these stories from the personal home screen, under ‘experiences of others’. The stories were fictional, but based on experiences of participants in an earlier study on the self-help book version of the intervention and served as the persuasive principle recognition [6]. For the high tailored condition, each success story was tailored on four of the following aspects: gender, age, marital status, daily activity, most prominent symptom and the reason for participating in the web-based intervention. In the low tailored condition a standard success story was presented each week. Attention was paid to vary these stories on the aspects that were used for tailoring in the high tailored condition.

Personalization. Personalization was implemented according to the definition of Knutov et al. 2009 [18], where it is seen as consisting of adaptation (automatic, implicit personalization) and adaptability (the system provides the opportunity to the user for personalization) of the content, presentation, navigation and user input. However, we were only able to personalize a small part of the intervention. Independent of condition, all respondents were addressed with their (reported) first name when logging on to the intervention in a welcome message (e.g. Welcome Saskia, you are at part 1

of lesson 4). Additionally, the high personalization condition showed the self-chosen picture and motto of the participant on the personal home screen as soon as this was chosen in lesson one; and showed the self-chosen most important values on the personal home screen (from lesson seven onwards). Furthermore, in this condition, participants had the opportunity to create their own 'top 5' of things from the course that they found most important. This top 5 was also shown on the personal home screen. The low personalization condition did not provide these options.

2.3 Procedure

Participants were recruited through advertisements in Dutch newspapers. Interested people visited the study website and could register for the study and intervention on this website after reading online information and giving informed consent. A total of 239 respondents fulfilled the inclusion criteria, completed the online baseline questionnaire and were automatically randomized to one of eight intervention arms. Participants received an emailed link to the online post-intervention questionnaire three months after the start of the intervention period. Six months after the start of the intervention period, participants received an emailed link to the online follow-up questionnaire. Up to two automated email reminders were sent to the participants when not filling out a questionnaire.

2.4 Participants

Participants in this intervention were people aged 18 years or older with self-reported mild to moderate depressive symptomatology (>9 and <39 on the Center of Epidemiological Studies – depression scale; CES-D)[19]. Exclusion criteria were receiving psychological or psycho-pharmacological treatment within the last three months, having less than three hours per week time to spend on the web-based intervention and poor Dutch language skills. For this paper, only data was used of participants that have actually started using the intervention, because only then can the participants form an opinion on the intervention and the included persuasive technology. Additionally, only the data from participants that also filled out the post-intervention questionnaire was used, because involvement was assessed at this post-intervention questionnaire. We have chosen not to impute missing data on involvement, because we have no theoretical basis on which to impute these values. Table 1 presents the characteristics of the 134 participants that were included in this study. Significant differences show that within the included participants, there is a higher percentage of females and people with a higher education. Furthermore, participants included in this analysis are more often adherers and have reached a higher lesson in the intervention. These differences in adherence and lesson reached are inherent to our inclusion criteria: a large group of non-adherers was excluded because they did not start using the intervention ($n = 33$), and drop-out (e.g. participants not filling out questionnaires) and adherence are interrelated [20].

Table 1. Participant characteristics

	All participants	Included	Test value	<i>p</i>
Age Mean (s.d.)	44.9 (12.3)	46.1 (12.0)	$F_{1,237} = 2.912$	.089
Gender % (no.)			$\chi^2_1 = 7.013$	.008
Male	29.3 (70)	22.4 (30)		
Female	70.7 (169)	77.6 (104)		
Education level % (no.)			$\chi^2_2 = 11.771$	.003
High	66.1 (158)	74.6 (100)		
Middle	26.4 (63)	21.6 (29)		
Low	7.5 (18)	3.7 (5)		
CES-D Mean (s.d.)	25.0 (7.0)	24.4 (7.1)	$F_{1,237} = 2.088$	.150
Adherence % (no.)			$\chi^2_1 = 97.310$	<.001
Yes	49.4 (118)	77.6 (104)		
No	50.6 (121)	22.4 (30)		
Lesson reached Mean (s.d.)	5.92 (3.59)	8.25 (1.75)	$F_{1,237} = 278.605$	<.001

2.5 Measurements

Depressive symptoms were measured at baseline, post intervention and follow-up with the CES-D (a self-report questionnaire with 20 items, score 0-60; higher scores mean more depressive symptoms) [19, 21]. Involvement was measured at post intervention with the short version of the Personal Involvement Inventory (10 items, mean score 1-7, higher score means more involvement) [22]. This is a self-report questionnaire formulated as “To me the online course ‘Living tot the full’ is ...”, with a bipolar adjective scale (i.e. for each item participants were asked to rate whether the intervention was e.g. unimportant – important, or boring – interesting). Adherence was measured objective through system log files. The log files contained a record of actions taken by each participant. One of the actions that was logged was starting a new lesson. Each lesson could only be started when the previous lesson was finished and feedback was received. Adherence was defined as a participant starting lesson 9, because the intervention is intended to be used during the nine lessons. Furthermore, the highest lesson reached was recorded (1 to 9) to measure the degree of adherence.

2.6 Data Analysis

Statistical analyses were done using SPSS 20 (IBM, USA). All tests were two-tailed. First, differences on involvement and lesson reached between variations of the technology were investigated using oneway Anova's. Second, the relationship between involvement and adherence was investigated using a oneway Anova to assess whether there were differences on involvement between adherers and non-adherers. The relationship between adherence and involvement was also studied by using a linear regression to investigate the predictive value of lesson reached (i.e. the degree of adherence) on involvement. Third, to investigate the influence of involvement on outcome measures, blockwise regression analyses were used with the clinical outcomes (CES-D on post intervention and follow-up) as dependent variables. Clinical baseline values and

adherence or lesson reached were entered in the first block, because of their expected influence on outcome measures. Involvement was entered second in the model, to assess the added value of involvement as predictor.

3 Results

3.1 Involvement and Adherence

There were differences between how the participants who received the different variations scored on involvement and lesson reached (Table 2). On support and on text messages, the variations show significant differences on involvement, where human support and the inclusion of text messages lead to higher scores on involvement. On interaction, the high interaction variant shows higher involvement, although this difference is not significant ($p = .08$). On tailoring and personalization, no difference between the variations is discernible. On lesson reached, there are no significant differences between the variations of the intervention. Moreover, adherers score significantly higher on involvement than non-adherers, and lesson reached is a significant predictor for involvement. The model including the constant and lesson reached explains 15.5% of the variance in involvement (Table 3).

Table 2. Mean values and differences on involvement and lesson reached

	Mean (s.d.) involvement*	Test value, p	Mean (s.d.) lesson reached	Test value, p
Support		$F_{1, 132} =$		$F_{1, 132} = 2.955,$
Automated (n = 62)	5.50 (1.16)	4.411,	7.97 (2.14)	$p = .088$
Human (n = 72)	5.90 (1.00)	$p = .038$	8.49 (1.31)	
Text messages		$F_{1, 132} =$		$F_{1, 132} = 0.001,$
No (n = 64)	5.51 (1.12)	4.415,	8.25 (1.65)	$p = .981$
Yes (n = 70)	5.90 (1.04)	$p = .038$	8.24 (1.85)	
Experience through tech.		$F_{1, 132} =$		$F_{1, 132} = 0.185,$
Low (n = 54)	5.51 (1.27)	3.116,	8.17 (2.04)	$p = .668$
High (n = 80)	5.85 (0.94)	$p = .080$	8.30 (1.55)	
Tailoring success stories		$F_{1, 132} =$		$F_{1, 132} = 0.621,$
Low (n = 82)	5.79 (1.04)	1.024,	8.34 (1.58)	$p = .432$
High (n = 52)	5.59 (1.17)	$p = .313$	8.10 (2.00)	
Personalisation		$F_{1, 132} =$		$F_{1, 132} = 2.770,$
Low (n = 72)	5.65 (1.09)	0.468,	8.01 (1.87)	$p = .098$
High (n = 62)	5.78 (1.10)	$p = .495$	8.52 (1.58)	
Adherence		$F_{1, 132} =$		—**
Adherers (n = 104)	5.88 (0.96)	10.946,	9.00 (0.00)	
Non-adherers (n = 30)	5.15 (1.34)	$p = .001$	5.63 (2.24)	

* These results are also presented in [10].

** Difference not tested because the categories are different by definition.

Table 3. Linear regression lesson reached and involvement

Variable	<i>B</i> (<i>SE</i>)	<i>Beta</i>	<i>p</i>
Constant	3.69 (0.42)		<.001
Lesson reached	0.25 (0.05)	0.39	<.001

Note $R^2 = 0.155$, adjusted $R^2 = 0.149$. Model $F_{1, 132} = 24.223$, $P < .001$

3.2 Predictive Value of Involvement

Table 4 and 5 present the results of linear regressions to predict clinical outcomes, i.e. CES-D on post-intervention (Table 4) and on follow-up (Table 5). The signs of the *B*-values show that increased baseline CES-D predicts higher CES-D scores on post-intervention and follow-up, whereas increased adherence and involvement predict lower CES-D scores on post-intervention and follow-up. Both analysis show that including the variable involvement in step 2 increases the explanatory value of the model (on post-intervention the explained variance increases from 10% to 16% and on follow-up the explained variance increases from 6% to 9% when including involvement). Furthermore, adherence is only a significant predictor in the first step of predicting clinical outcomes on post-intervention. Both analysis show that when including involvement as a predictor, the predictive value of adherence disappears. Lastly, the predictive value of involvement is comparable to that of CES-D on baseline (Beta CES-D 0.28 and 0.22 and Beta involvement -0.29 and -0.23 on post-intervention and follow-up, respectively). Analyses using lesson reached as predictor instead of adherence show similar results (data not shown).

4 Conclusions and Discussion

The results of this study show that differences in the intervention can lead to differences in how involved participants are with the intervention. Significant differences were found between automated and human support, where human support led to more involvement. This may not be a surprising finding, because literature shows that increased counselor interaction leads to increased adherence [3]. It may be more surprising that the difference between automated and human support is similar as the difference between the in- or exclusion of text messages and not larger than that difference. It may be that the way automated support was implemented (e.g. employing virtual presence [23], a social role [6], and a more humanized version of the system [17]) accounts for this relative small difference. It may also be that some of the participants were not complete aware that their counselor was virtual. The picture may have made the counselor too real, although participants were told that their counselor was virtual. This may have made the virtual counselor more effective, but thereby violated the openness postulate of the PSD-model [6]. However, due to the design of the study, this hypothesis cannot be tested. The other significant difference on involvement was seen between the in- and exclusion of text messages, where the inclusion of these messages led to more involvement. The positive effects of reminders are well documented

Table 4. Linear regression predicting CES-D on post-intervention

Step	Variable	<i>B</i> (<i>SE</i>)	<i>Beta</i>	<i>p</i>
1	Constant	12.30 (2.99)		<.001
	CES-D baseline	0.35 (0.11)	0.28	.001
	Adherence	-3.69 (1.81)	-0.17	.044
2	Constant	24.52 (4.54)		<.001
	CES-D baseline	0.36 (0.10)	0.28	<.001
	Adherence	-1.95 (1.81)	-0.09	.283
	Involvement	-2.42 (0.69)	-0.29	.001

Note Model step 1: $R^2 = 0.10$, adjusted $R^2 = 0.09$. Model $F_{2, 131} = 7.337$, $P = .001$; Model step 2: $R^2 = 0.18$, adjusted $R^2 = 0.16$. Model $F_{3, 130} = 9.378$, $P < .001$

Table 5. Linear regression predicting CES-D on follow-up

Step	Variable	<i>B</i> (<i>SE</i>)	<i>Beta</i>	<i>p</i>
1	Constant	11.56 (3.10)		<.001
	CES-D baseline	0.27 (0.11)	0.21	.014
	Adherence	-3.03 (1.88)	-0.14	.109
2	Constant	21.22 (4.78)		<.001
	CES-D baseline	0.28 (0.11)	0.22	.010
	Adherence	-1.65 (1.91)	-0.08	.389
	Involvement	-1.91 (0.73)	-0.23	0.10

Note Model step 1: $R^2 = 0.06$, adjusted $R^2 = 0.05$. Model $F_{2, 131} = 4.212$, $P = .017$; Model step 2: $R^2 = 0.11$, adjusted $R^2 = 0.09$. Model $F_{3, 130} = 5.208$, $P = .002$

(e.g. [24]). However, in this study, reminders did not lead to increased adherence or effectiveness, but only to increased involvement. A reason for not finding an effect on adherence or effectiveness may be the optional nature of the SMS coach: the default state of the coach was off and participants had to change this to turn it on. Analysis of the log-data of the intervention showed that only few participants turned the SMS coach on [25]. On experience through technology, a non-significant difference was seen where high experience led to slightly higher involvement. Although this is not a significant difference, it resonates with literature on the positive effects of increased interaction and on Fogg's functional triad of persuasive technology where creating an experience through technology is one of the ways to increase the persuasiveness of technology [26]. There were no differences on involvement between the levels of tailoring of success stories and personalization, which is contrary to what was expected based on literature of the positive effects of tailoring and personalization. However, this may be explained through the implementation of these variations: the success stories were only a small part of the intervention and a study of the usage of the intervention showed that these success stories were hardly read [25]; the differences on personalization were small and the 'top 5' was implemented in a way that was hard to use for participants. Moreover, the difference between the implementation of tailoring and personalization in this study was small, which may have caused the lack of

difference. Nonetheless, the results show that, although there was no difference on adherence and lesson reached between the variations in technology, there were differences on involvement. This shows that involvement may be a more proximal outcome of changes within the technology which is more sensitive to change.

Moreover, scores on involvement were different between participants who adhered to the intervention and participants who did not adhere, where adherers showed the higher involvement scores. Additionally, the more lessons participants complete, the higher their involvement. However, due to the timing of the involvement measure (post-intervention) we cannot say that higher involvement leads to a higher reached lesson, only that the two variables are related. These results were expected and confirm the importance of involvement [7, 9].

The results do show the predictive value of involvement on clinical outcomes. Although this may be expected, it is striking that the predictive value of involvement is on par with the predictive value of clinical baseline scores. However, interpretation of these results should be done with caution, because it may also be that because participants experience more positive results, they are more involved with the intervention. Nonetheless, this cannot account for the differences observed between the variations of technology, because these did not lead to differences in effectiveness [10].

Additionally, the results show that when including involvement as a predictor for clinical outcomes, adherence disappeared as a predictor. The earlier mentioned results about the relationship between involvement and adherence show that these two concepts are related, but they are not the same. A difference is that involvement seems to outperform adherence as a predictor for effectiveness. Other studies have showed that adherence or increased usage of an intervention may not always be a good predictor of effectiveness [27]. It may be that participants have different reasons to adhere, and some reasons (e.g. intrinsic motivation) are more beneficial for the effectiveness of interventions than other reasons (e.g. the feeling that you 'have to' finish the intervention to please someone else) [28]. This study is novel in that it suggests that adherence as a measure does not make a distinction between the different reasons, whereas involvement seems to be closely related to intrinsic motivation, which may be a reason to adhere that is predictive for the success of an intervention for an individual. Therefore, involvement may be a more valuable measure for the working mechanism of an intervention than adherence per se.

A limitation of this study is that only the data of a specific sup-group of participants are used, i.e. participants who started using the intervention and who filled out the post-intervention questionnaire. These participants were more likely to be female and higher educated than participants not included in this study, so the results should be interpreted with caution. Additionally, the included participants were more often adherers and reached a higher lesson, which makes the difference in lesson reached between adherers and non-adherers smaller. A second limitation is that involvement was measured post-intervention and was self-reported. Because of this, the involvement scores may be influenced by the experienced effectiveness of the intervention. However, the predictive value of involvement on effectiveness in this study warrants further research into this area. In future studies, it may be beneficial to measure involvement at different time-points, e.g. early, halfway through and at the end of the

intervention period, to see whether involvement changes over time. Furthermore, more implicit ways to measure involvement (e.g. using an Implicit Association Test [29]), may be beneficial because it is seen as more objective.

Future research could benefit from this earlier measure of involvement: it can be used to find out for whom the intervention may not be suitable (as indicated by low involvement scores) and redirect these participants to a different (kind of) intervention. It could also be used as an early assessment of the added value of persuasive technology: if the technology does not lead to higher involvement scores, it may be a good idea to reassess whether the technology is persuasive in the way that it is supposed to be. Lastly, the importance of involvement could be used as a starting point for design: what persuasive elements and techniques can be used to create a behavior change support system that leads to higher involvement.

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