Using personal characteristics and usage patterns for the prediction of adherence and effectiveness in a web-based intervention for the treatment of depression.

Master Thesis

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Abstract

Background: Web-based interventions have been shown to be effective and efficient means of providing eHealth. It has been established, however, that high rates of non-adherence (ie. users not following the intervention protocol) have a detrimental effect on their success. At this point there are numerous theories surrounding the various factors that determine effectiveness and adherence in web-based interventions, but none that have been able to do so satisfactorily. Personal factors as well as use of the intervention seem to play an important role.

Objective: The aims of this study were to (1) find out to what degree a combination of adherence, personal factors and usage patterns of the intervention could determine its effectiveness, (2) examine to what degree personal factors and usage patterns can predict adherence, (3) determine if there is any added value in using data from the first two weeks as opposed to the first week alone and (4) evaluate, whether there is any advantage to using usage patterns instead of separate intervention features for predicting effectiveness and adherence.

Methods: Data were used from 195 participants that used the Web-based intervention Living to the full, a Web-based intervention for the prevention of depression, that had previously been shown to be effective. Log data of the original study were analyzed in quantitative analyses. Outcome measures were mean improvement scores on the Center for Epidemiologic Studies Depression Scale (CES-D) and Hospital Anxiety and Depression Scale (HADS-A), as well as the lesson a participant reached.

Results: There were two variables that proved significant for predicting improvement scores for depression: adherence and being divorced. Use of certain intervention features was also significant. Regarding anxiety, no consistent significant predictors could be found. The most predictive power was found in determining adherence with R^2 –values of up to .30. The only personal factor of significance was the average time spent online per day, but a number of intervention features were also indicated as predictors for adherence when used together.

Conclusions: Valuable lessons for future research were learned by including usage patterns as well as personal characteristics in the research model for predicting effectiveness and adherence. Although the predictive value for effectiveness was small, results regarding adherence are more promising. In future, this may help in taking preventative action to keep users engaged with web-based interventions so they can derive as much effect from them as possible.

Table of Contents

Introduction

Over the last several years, more and more (mental) health interventions have been designed as web-based programs, outside the realm of face-to-face interaction. Barak, Klein and Proudfoot (2009, p.5) define a web-based intervention as "a primarily self-guided intervention program that is executed by means of a prescriptive online program operated through a website and used by consumers seeking health- and mental-health related assistance. The intervention program itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive web-based components." This is a very inclusive definition that attempts to incorporate not only programs aimed at treatment and therapy, but also those that are designed for prevention, promotion and education interventions (Barak et al, 2009).

The variety among different kinds of web-based interventions is immense: Fully automated, partially automated with personal feedback, exercises for download, online diaries, online support groups and message boards are but a few of the features currently in use (e.g. Barak, Hen, Boniel-Nissim & Shapira, 2008; Freyne, Saunders, Brindal, Berkovsky & Smith, 2012; 'From somber to super', Menzis, 2013). All of these interventions share the advantage of being able to reach a great number of people in urban as well as rural areas around the clock and, because of their anonymity, the stigma associated with seeking psychological help can be avoided (Postel, de Haan, ter Huurne, Becker & de Jong, 2011; Griffiths, Lindenmeyer, Powell, Lowe, Thorogood, 2006). Additionally, the use of web-based interventions can significantly reduce the average time a client spends with an actual therapist, thereby increasing the number of clients per therapist. This eliminates waiting time as well as treatment costs without significant decreases in effectiveness (Proudfoot, 2004), thereby achieving an overall increase of cost-effectiveness.

Effectiveness and Adherence

In systematic reviews (Barak et al., 2008; Webb, Joseph, Yardley and Michie, 2010), the average effect of web-based interventions on behavior has been shown to be small, due to the diverse nature of the interventions included. They ranged from mental health and lifestyle interventions to programs designed for the support of patients with chronic illnesses. According to Barak et al. (2008), it appears that psychological problems are more suited for treatment via web-based interventions than other problems. Of those interventions that have been found to have a significant effect on behavior and from these programs a range of factors have been derived that are critical in influencing an intervention's effectiveness.

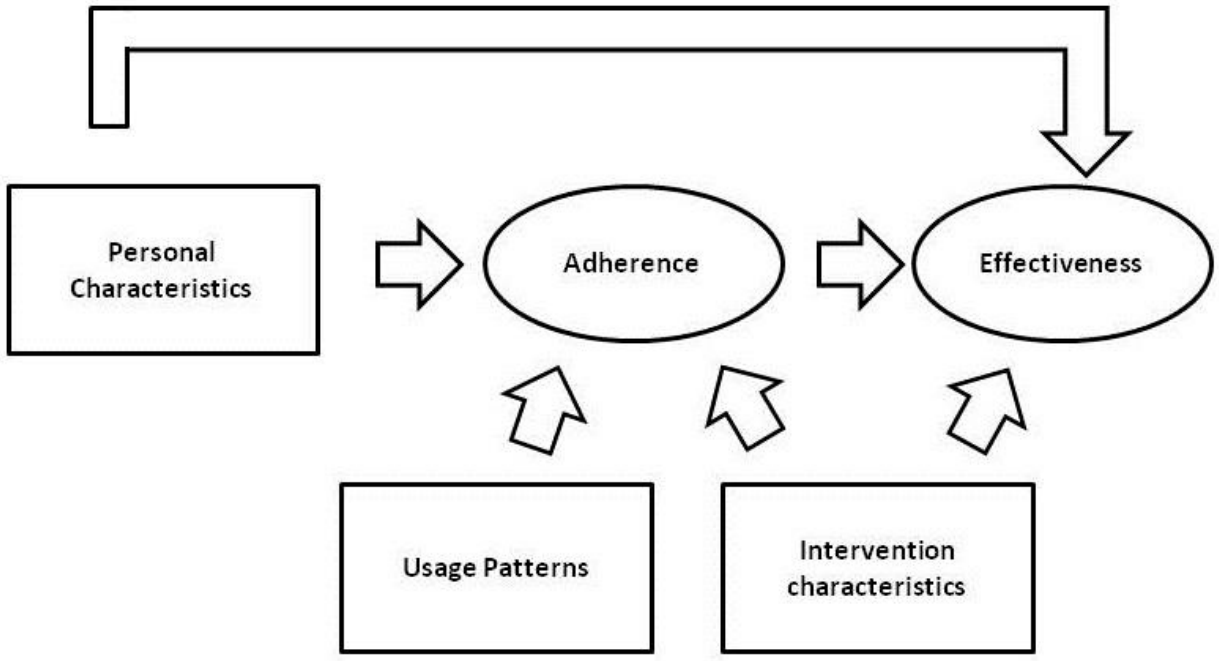

Figure 1: Effectiveness of web-based interventions and its determinants

The model in figure 1 depicts the current findings in literature with regards to effectiveness of a web-based intervention and its determinants: Personal characteristics, intervention characteristics, usage patterns and adherence.

Personal Characteristics

It has been established in the literature (e.g. Anderson 2009; Barak et al., 2008; Melville, Casey & Kavanagh, 2010) that personal characteristics play a role in determining the effectiveness of an intervention. This includes variables such as gender, age, computer experience and socio-economic status, as well as factors such as the number of depressive episodes prior to starting an intervention for depression (Andersson, Bergström, Holländare, Ekselius, & Carlbring, 2004). Mention has also been made of limitations with regards to the ability to understand the text portions of web-based interventions as well as to the computer skills necessary for such an intervention (Anderson, 2009).

Intervention Characteristics

Webb et al. (2010) have identified three main intervention characteristics that can produce larger positive effect sizes: Firstly, a web-based intervention has to be firmly grounded in theory. Interventions that were designed without the benefit of a reliance on theoretical background were less successful in producing actual change in participants. Secondly, the more techniques for behavior change were used, the greater the interventions' effects were. Such techniques included stress management and development of general

communication skills training which were employed to improve problem-solving and self-efficacy as well as to reduce the negative impact of stressors on behavioral change. The third intervention-related factor that determined the effect of a web-based intervention was the mode of delivery. Inclusion of delivery features such as automated feedback and text messages produced better outcome measures than an absence of these features.

Usage patterns

Participants' usage patterns refer to the way they employ the intervention, with regards to frequency of use as well as combinations of features that are being used. At this point, it has not been established, if different usage patterns might also have a direct influence on the effectiveness of an intervention. Since effectiveness is partially determined by the types of features included in an intervention, however, it stands to reason that it would also be crucial which of these features a participant actually uses. It has therefore been included in the research model.

Adherence

Users who follow an intervention protocol, completing all required lessons are said to adhere to the intervention. In a research study, participants who complete all study questionnaires but fail to complete the intervention program itself, are classified as non-adherent. It is important to note the difference between non-adherence and drop-out. Whereas non-adherence, or non-usage attrition (Eysenbach, 2005), refers to participants not using the intervention (or not as much as intended), dropout, or dropout attrition (Eysenbach, 2005), refers to participants stopping with the research study (e.g. by not filling in questionnaires), although possibly continuing to use the intervention itself and finishing all lessons thereof (Christensen, Griffiths and Farrer, 2009).

Participants not following the program as prescribed, i.e. being non-adherent, is one of the most important challenges when it comes to web-based interventions (Eysenbach, 2005; Christensen et al., 2009), since it affects the interventions effectiveness. Non-adherent users of web-based interventions do not reach a sufficient 'dose' to reach a maximum 'response'.
In other words: Users who partake in all prescribed activities within the intervention have greater exposure to the parts of it that inspire change than do their non-adherent counterparts. Adherent users are therefore more likely to experience the intended effect of the intervention.

Determinants of Adherence

While adherence is one of the factors influencing an intervention's effectiveness, the model in Figure 1 also shows that adherence itself is determined by a number of factors, namely personal characteristics, intervention characteristics and usage patterns.

Although there have been a number of studies that have examined the relationship between personal characteristics and non-adherence in web-based interventions, no single specific factor could be identified that could predict all observed (non-)adherence (Christensen et al., 2009; Kelders, Bohlmeijer & van Gemert-Pijnen, 2013a; Melville et al., 2010). Rather, the studies point to interactions between a number of factors. Nevertheless, there are studies that suggest that women are more likely to adhere to the intervention protocol, especially if they exhibit a high need for cognition (Christensen et al., 2009; Kelders et al., 2013a) and that older participants with good computer skills, but without those socio-economic difficulties and without a life partner are more likely to use an intervention as intended (Melville et al., 2010).
Issues such as users not having sufficient skills for full participation in web-based interventions have been included in previous research (Anderson, 2009). It is important to consider these factors, since deficits with regards to literacy or technological skills can prevent participants from using the intervention as intended.

In addition to the literature dealing with the connection between personal characteristics and adherence, there have also been a number of systematic reviews (Barak et al., 2008; Brouwer et al., 2011; Kelders, Kok, Ossebaard & van Gemert-Pijnen, 2012b; Schubart, Stuckey, Ganesharmoorthy & Sciamanna, 2011), examining the relationship between intervention characteristics and adherence. These reviews have established that there are factors that can have a positive effect on adherence, such as professional feedback (Schubart et al., 2011) and greater exposure (e.g. in terms of time) to intervention components (Brouwer et al., 2011).

Besides intervention and personal characteristics, a third factor has been identified as being linked to adherence: Usage patterns. Frequency of use during the first week has been shown to predict greater adherence later on in the intervention (Freyne et al., 2012). Kelders, Bohlmeijer and van Gemert-Pijnen (2012a) found that in a web-based intervention for adults with mild depression and symptoms of anxiety, adherers showed more log-ins per lessons than non-adherers and also downloaded more mindfulness exercises and viewed more text-messages than their non-adhering counterparts. According to Mohr et al. (2013), the total number of days that a user logged in, the number of lessons they participated in, as well as the number and variety of tools they used were vital in predicting effectiveness. This supports a link between adherence and effectiveness, where better adherence causes users to be more exposed to and involved with the program, which- in turn- leads to better results (Graham et al., 2013; Kelders et al., 2012a; Mohr et al., 2013).

Being able to identify participants that are likely not to adhere to the program, would make it possible to step in and provide these individuals with extra motivators that would make them more likely to follow the program after all. If this in turn were to lead to better adherence, the overall effectiveness of the intervention would also be likely to increase.

An automatic feature to this effect could be embedded into the web-based intervention and could achieve a big difference: First of all, users would profit from completing the intervention, instead of giving up along the way and inadvertently reinforcing their depression or anxiety by confirming their believe that they cannot be helped and/or do not have the drive, energy or ability to help themselves. Additionally, the overall cost-effectiveness of the intervention would increase, since resources would not have to be wasted on support for the large group of participants that have previously taken up room on the enrolment list without actively pursuing completion of the intervention.

Intervention components in current study

Because there is no evidence with which to test for the effect of different intervention components or characteristics in this study, these characteristics will be excluded from analysis, although it should be noted that they are vital in forming a comprehensive model for predicting adherence and effectiveness in web-based interventions.

It has been established that the effectiveness of and the adherence to an intervention are dependent on a number of factors, as depicted in Figure 1. However, as of yet, these factors are mostly described in general terms like ‘personal characteristics’ or ‘usage patterns’ and, with a few exceptions, lack specificity for practical use. Being able to identify specific usage patterns in combination with the personal characteristics of a user that add enough predictive power to the model to single out users who are likely to not adhere to the program, would add the specificity that has been absent up till now. It would also help to provide a more comprehensive model for predicting adherence and effectiveness, in order to optimize web-based interventions, which, in turn, could simultaneously increase their effectiveness and cost-effectiveness. In the current study, this was attempted for the case of the intervention “Living to the full”, a web-based program aimed at preventing depression in people with mild to moderate depressive and anxiety symptoms.

Intervention background

The target group for this intervention, adults suffering from symptoms of depression and anxiety, is an ever-growing one. Depression is one of the most prevalent psychological conditions world-wide. It is a mood disorder that causes great personal suffering by impairing a person’s capacity for clear thinking and

the motivation to act, as well as bodily functioning, especially appetite and sleep (Segal, Williams & Teasdale, 2012). Because depression is such a pervasive problem, the costs it entails are immense. In 2007 alone, the cost of care for people with depression in the Netherlands was 966 million Euros (van Wieren, Schoemaker & Spijker, 2012). "Living to the full" is designed to prevent people with mild depression from developing the severe form of the disorder which would cause them even greater suffering and more costs for society at large. The disorder has been shown to be responsive to early intervention efforts (Jorm & Griffith, 2006), which makes suitable and effective programs to this effect vitally important.

The intervention is based on Acceptance and Commitment Theory (ACT) and Mindfulness and has previously appeared in the form of a self-help book (Bohlmeijer & Hulsbergen, 2008).
That book version of the intervention has been tested by way of a randomized controlled trial and has been shown to have large to moderate effects on symptoms of depression and anxiety at post-intervention and follow-up (Bohlmeijer, Fledderus, Rokx & Pieterse, 2011).
The online version of the course has been shown to also reduce symptoms of depression and anxiety in participants (Kelders, Pots, Bohlmeijer & van Gemert-Pijnen, 2012c). This online version is based on the same principles as the self-help book, but includes downloadable exercises, feedback messages and success stories of fictitious others who give an account of their positive experiences with the intervention.

ACT and Mindfulness

As mentioned above, "Living to the full" is based on Acceptance and Commitment theory and Mindfulness. ACT is about the acceptance of life experiences and living in the present, as well as about the commitment to behavior that is in line with one's values (Hayes, Luoma, Bond, Masuda & Lillis, 2004). It is designed to discourage people from using suppression, avoidance and other ways to not have to face their negative thoughts, feelings and bodily sensations, by teaching them psychological flexibility (Hofmann & Asmundson, 2008). This is vital for good psychological health, since studies have shown that people who score higher on different types of avoidance responses, experience greater emotional distress and more negative cognitions in emotional situations (Eifert & Hefner, 2003; Feldner, Zvolensky, Eifert, & Spira, 2003; Karekla, Forsyth, & Kelly, 2004). In a meta-analysis of 18 randomized controlled trials that examined the efficacy of ACT as opposed to control conditions including psychological placebos and treatment as usual, Powers and Zum Vörde Sive Vörding (2009) found that ACT was effective in alleviating anxiety and depression, although it was not more effective than established treatments.

The second concept, mindfulness, has been characterized as the ability to focus on the here and now, without judgment. It entails an attitude of attention, friendliness, openness and compassion towards what is experienced in the moment, whether it is pleasant or not (Kabat-Zinn, 2003). Originally, it was part of

Eastern meditation practices and only more recently it has been incorporated into Western culture and clinical practice, as mediation practices without a particular religious background (Baer, 2005). Approaches to teaching mindfulness vary from traditional mediation sessions to more practical applications of focusing attention in daily life (Baer, 2005). In a conceptual and empirical review, Baer (2003) found that there is evidence that supports the hypothesis that interventions based on mindfulness are effective in alleviating a variety of mental health problems and in improving psychological functioning.

Intervention Content and Procedure

Once the intervention had started, users could log in anytime from anywhere, using their username and password. Upon logging in, users were directed to their 'cockpit' (Figure 2) in which they could get an overview of all available features and from which they were able to navigate to those features.

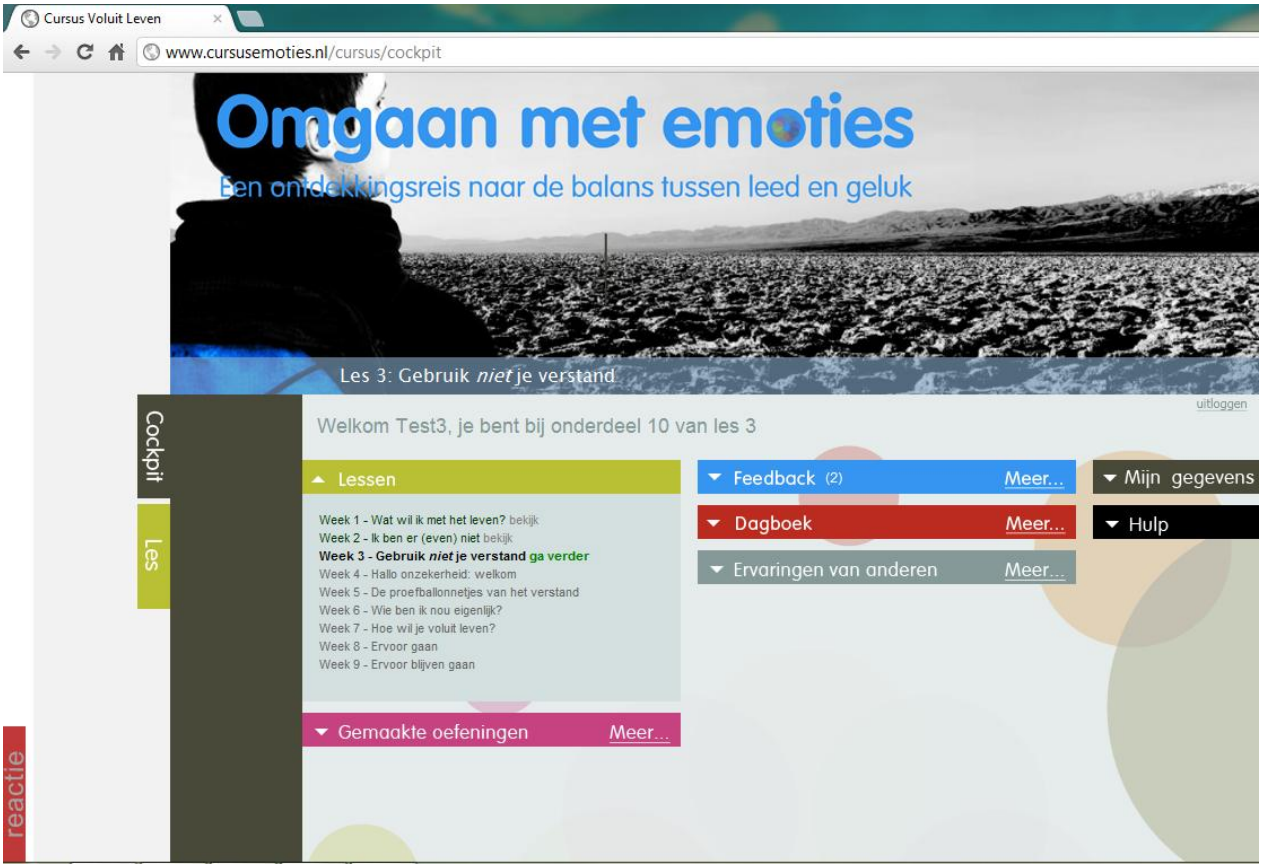

Figure 2: Example of a user's cockpit page

These included the 9 lessons themselves as well as the feedback for them that was either given automatically by the system or personally by a coach. This feedback served to simultaneously reflect on the previous lesson and give a preview of the next one, so as to motivate users to complete it. From the cockpit, users could also navigate to success stories of fictitious others who could serve as role models for

successful usage of the intervention. Other functions, such as a player for videos with mindfulness exercises and a download option for these same videos were embedded in the lessons and could be accessed through them.

The core of the intervention is formed by a total of nine lessons that participants have to complete in chronological order within a maximum of 12 weeks. Feedback is given after each lesson and participants are expected to spend about three hours per week on the intervention. The exercises included in the lessons are to be completed partly online and partly offline. Some exercises can be downloaded for offline use, for instance mindfulness MP3s.

Present study

The study presented here will delve further into the effectiveness of and adherence to the web-intervention "Living to the full" ("VLO", derived from its Dutch title "Voluit Leven Online"). Its effectiveness was measured as the mean difference between the baseline and follow-up scores on standardized questionnaires for the measurement of depression and anxiety while adherence was measured as the lesson that a participant reached.

The aim of this study is to predict the aforementioned adherence and effectiveness for specific users. Put into more concrete terms, the goal is to identify those (combinations of) characteristics and usage patterns within the context of the first two lessons that are indicators for higher effectiveness as well as a higher likelihood of a particular user adhering to the intervention. This will allow for the identification of a narrower target group that the web-based intervention is most effective for on the one hand, and an early intervention in cases where users are likely to eventually stop with the program on the other. Those users in particular might benefit from the new insights, by receiving additional motivation to see the program through and experience its mental health benefits.

Since there seems to be no single intervention component or personal characteristic that can predict to what degree users will comply with the intervention program (Kelders et al., 2012a; Melville et al.,2010), the study at hand will focus on a combination of factors.

The model presented in Figure 1 attempts to incorporate personal characteristics as well as the use of different intervention components and their influence on adherence and thereby on effectiveness.

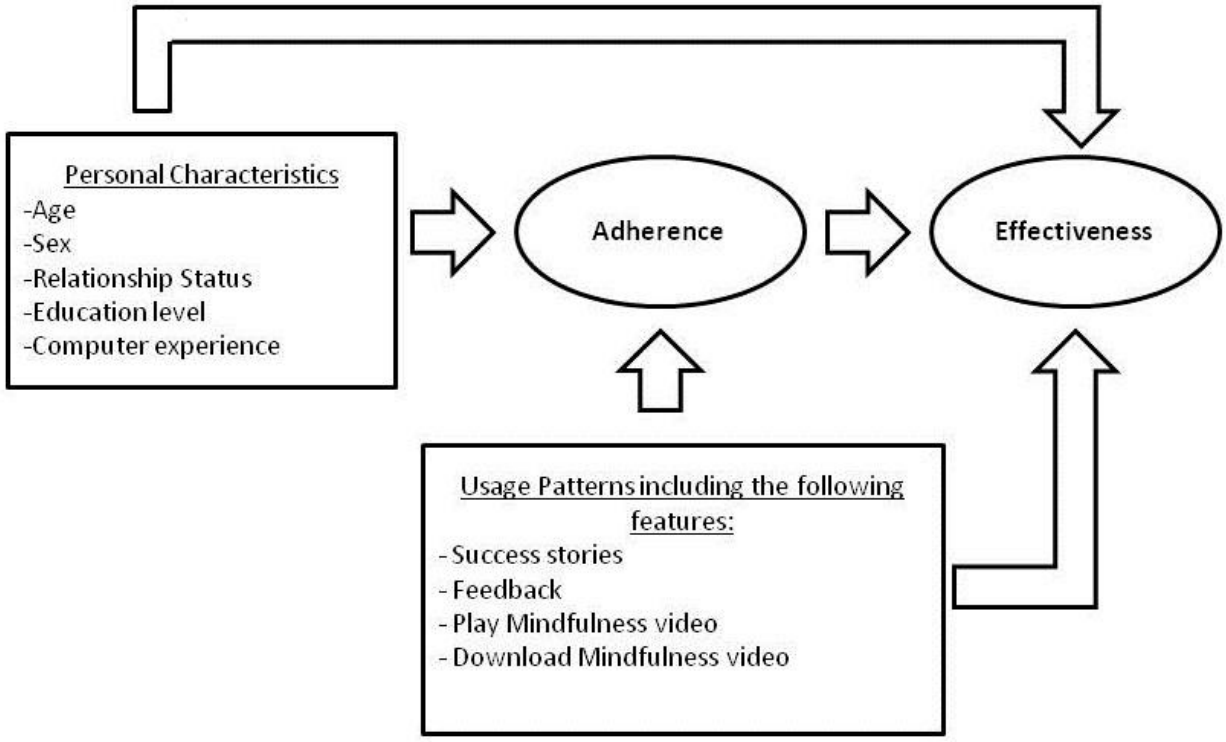

Figure 3: Research Model for predicting adherence and effectiveness

Personal characteristics such as age, sex, relationship status, education level and computer experience have previously been shown to have some predictive power (e.g. Kelders et al., 2013a; Melville et al., 2010) but the results have been inconclusive as to which characteristic had what effect, as mentioned above.

The different intervention features whose use will be examined as possible predictors of adherence and effectiveness include the use of a player with mindfulness exercises and the download of said exercise, as well as accessing feedback and success stories. The use of all of these components within the first two lessons of the intervention will be analyzed separately, as well as in combination with each other, since it has been suggested that patterns of use, may be different for adherers than non-adherers (Kelders et al.2012a).

These particular intervention features were selected, because they were available to all participants of the original study, regardless of the assigned research condition. This assures enough cases for significant findings, as well as applicability of these findings to all future users of the intervention, irrespective of which optional features might be included in future versions of the intervention.

There are two main research questions that will be answered using the model in figure 1 as a basis:

1. To what degree can the combination of personal characteristics, specific usage patterns of the first two lessons and adherence be used to predict the effectiveness of the web-based intervention "Living to the full"?
2. To what degree can the combination of personal characteristics and specific usage patterns of the first two lessons be used to predict the adherence to the web-based intervention "Living to the full"?

Additionally, the following sub-question will also be addressed:

- How much predictive power-if any- is gained by including usage patterns of the first two lessons, as opposed to the first lesson alone?
- How much predictive power-if any- is gained by including usage patterns instead of separate intervention features in the research model?

Method

Parent study and participants

The present study is based on data collected in the parent study on adherence and effectiveness of this web-based intervention for the prevention of depression which proved its effectiveness (Kelders et al., 2012c). Participants to the study were recruited through major Dutch newspapers and were asked to complete an online screening procedure before being granted access to the study. They were adults with mild to moderate depressive symptoms, as measured by a score between 9 and 39 on the Center of Epidemiological Studies- depression scale (CES-D, Bouman, Ranchor, Sanderman & Van Sonderen., 2012). People with scores higher than one standard deviation above the population mean on the CES-D and/or the Hospital Anxiety and Depression Scale (HADS-A; Zigmond & Snaith, 1983) were excluded from the study because their symptoms were considered to be too severe for a preventative intervention. Also excluded were those who had received psychological or psycho-pharmacological treatment in the 3 months prior to the study, those who did not have the required time of three hours per week to spend on the intervention and those whose lack of Dutch language skills would have prevented them from participating fully (Kelders et al., 2012c). A total number of 239 participants were included in the original study. For the purposes of this study, data from 195 participants of the parent study were used, all of whom had completed at least the first two of at total of nine lessons. Participants who had been included in the original study, but did not complete the first two lessons, were excluded from this subsequent study.

Measures

All measures for this study were made available by Kelders et al. (2012c) who conducted the initial research into "Living to the Full". Log files from this study provided the basis for the establishment of usage patterns as well as determining adherence.

Server-registration was used to log user's actions on the site. It is important to note that not all clicks or keystrokes were registered, but only certain actions, including logging in and out, clicking on features such as feedback or success stories, starting the embedded player, as well as downloading the mindfulness exercise. For each of these actions, the number of times they were executed during each lesson was registered. It was not logged how much time users spent using the intervention and its components.

Usage Patterns

For the examination of different usage patterns, all possible combinations of any two of the following four features were used: Reading success stories, reading feedback, playing a mindfulness video and downloading that same video. Combinations were scored as either "Yes" or "No", dependent on whether or not users had completed both actions in question. This was done for weeks one and two separately, as

well as combined, in which case users had to have completed both actions in both weeks in order to be scored as "Yes".

Personal Characteristics

The personal characteristics that were included in the analysis were age (at the start of the original study, April 1st 2011), sex, relationship status, education level (low, medium, high) and computer experience, as measured by the average amount of time spent online per day. All of these variables had previously been shown to be viable possible predictors of either adherence, effectiveness or both (Anderson, 2009; Barak et al., 2008; Christensen et al., 2009; Melville et al., 2010).

Effectiveness

Effectiveness was measured by comparing depressive and anxiety symptoms, on the CES-D and HADS-A respectively, at baseline (before starting the online course) and post-intervention (three months after the start of the intervention). The difference in scores was used as the outcome measures.

Adherence

Adherence was originally measured in two ways: Firstly as a categorical variable with those participants who had reached lesson 9 being defined as adherent and all others as non-adherent (Kelders et al., 2012c). Secondly, adherence was seen on a continuous spectrum, using the number of the lesson a participant reached as values. Ultimately, only the second measurement was used, since only 115 participants had actually reached lesson nine and using the continuous variable was shown to have more predictive power.

Data Analysis

Statistical analyses were conducted using SPSS 21 (IBM, USA). Throughout the analyses, a confidence interval of 95% was applied.

The first step of analysis was checking for correlations between the variables, using Pearson's r.

Based on these correlations, multiple regression analyses were conducted using the variables that had been shown to correlate with the measures for adherence and effectiveness. The first of these analyses aimed to predict adherence on the basis of personal variables and the use of the separate intervention features (e.g. use of player for mindfulness exercises, reading feedback, etc.) of weeks one and two separately, as well as combined. The second round of multiple regression analyses was then used to predict effectiveness based on personal characteristics, intervention features and adherence. Both sets of analyses were then rerun using all applicable usage patterns (e.g. use of player and reading feedback both, etc.) instead of separate intervention features.

The outcome measures thus predicted were the improvement scores (mean difference between baseline and post-intervention) for the two questionnaires used. This process was repeated for weeks one and two separately as well as combined.

The personal variables were age, sex, education level, marital status and average time spent online per day. For marital status, two dummy variables were created, using ‘married’ and ‘divorced’ as the two distinguishing factors.

The usage patterns included all possible combinations of any two of the features ‘reading success stories’, ‘reading feedback’, ‘playing a mindfulness video’ and ‘downloading a mindfulness video’.

Results

Participants

In total, results from 195 respondents were analyzed. As Table 1 shows, respondents were mostly higher educated (67%) and female (73%), and at the time of the intervention, 128 (65.6%) of them had never been or were no longer married.

Table 1: *Personal characteristics of study participants*

Characteristic		n	%
Sex	Male	52	26.7
	Female	143	73.3
Education level	Low	13	6.7
	Medium	51	26.2
	High	131	67.2
Marital Status	Married	67	34.4
	Divorced	39	20
	Widowed	3	1.5
	Never been married	86	44.1

Table 2 shows that the average age at the start of the intervention was 45 years and the average time spent online per day was two and a half hours. On average, respondents reached lesson seven out of nine, before stopping with the intervention. A total of 118 out of 195 participants (61%) reached the ninth and final lesson of the program and can be classified as adherers.

Examining the outcome measures for anxiety and depression shows that while there was an average difference of 7.7 in the score between the baseline and follow-up measures for depression, the difference was only 2.6 for anxiety.

Table 2: *Personal characteristics of study participants (continued)*

Characteristic	Mean	SD
Age	44.8	12.5
Time spent online per day	2.6	2.0
Lesson reached	7.2	2.7
MeanDifferenceHADS-A	2.6	2.7
MeanDifferenceCES-D	7.7	9.6

Usage Patterns

An overview of all intervention features and combinations thereof (usage patterns) along with the frequency of their use in the first two weeks each, as well as combined, may be found in Appendix A. It can be summarized that all features, whether examined separately or in combination with each other, were

used more in the first week than the second. A total number of 62 users (31.8%) made use of all examined intervention features within the first week, whereas this number dropped to 32 (16.4%) during the second week. Only 17 participants (8.7%) used all available features in both weeks.

Correlations

An examination of correlations was done with regards to the three outcome measures in combination with all other factors, the results of which may be found in Table 3. The outcome measures were the mean differences in questionnaire scores between baseline and follow-up for both anxiety (HADS-A) and depression (CES-D), which indicated effectiveness, as well as adherence, defined as the number of lessons completed.

Table 3: *Correlations between outcome measures and other factors*

	MeanDifference CESD	MeanDifference HADSA	Adherence
MeanDifferenceCESD		.680**	.231**
MeanDifferenceHADSA	.680**	-.066	.272**
Adherence	.231**	.272**	
Sex	.133	-.013	.108
Age	.069	.069	.072
Education level	-.055	-.066	.128
Marital Status			
- Married	-.025	.099	.102
- Divorced	.164*	.007	-.081
Time spent online per day	-.012	-.012	-.148*
PlayerWeek1	.157*	.169*	-.038
PlayerWeek2	.063	.030	.113
PlayerBothWeeks	.157*	.169*	-.038
DownloadWeek1	.099	.103	.079
DownloadWeek2	.054	.064	.169*
DownloadBothWeeks	.089	.100	.201**
FeedbackWeek1	.031	-.049	.044
FeedbackWeek2	.032	.087	.452**
FeedbackBothWeeks	.031	.011	.342**

SuccessStoriesWeek1	.037	.066	.056
SuccessStoriesWeek2	.154*	.102	.315**
SuccessStoriesBothWeeks	.192**	.163*	.270**
PlayerANDSuccessStoriesWeek1	.100	.137	-.033
PlayerANDSuccessStoriesWeek2	.188**	.069	.297**
PlayerANDSuccessStoriesBothWeeks	.227**	.145*	.221**
PlayerANDDownloadWeek1	.111	.121	.029
PlayerANDDownloadWeek2	.040	.035	.070
PlayerANDDownloadBothWeeks	.068	.092	.087
PlayerANDFeedbackWeek1	.149*	.096	.014
PlayerANDFeedbackWeek2	.061	.065	.276**
PlayerANDFeedbackBothWeeks	.066	.066	.215**
FeedbackANDSuccessStoriesWeek1	.073	.044	.090
FeedbackANDSuccessStoriesWeek2	.145*	.097	.328**
FeedbackANDSuccessStoriesBothWeeks	.148*	.134	.256**
FeedbackANDDownloadWeek1	.101	.062	.091
FeedbackANDDownloadWeek2	.063	.103	.403**
FeedbackANDDownloadBothWeeks	.020	.024	.226**
DownloadANDSuccessStoriesWeek1	.097	.117	.093
DownloadANDSuccessStoriesWeek2	.144*	.114	.334**
DownloadANDSuccessStoriesBothWeeks	.173*	.153*	.165*
AllFeaturesWeek1	.156*	.122	.020
AllFeaturesWeek2	.085	.024	.153*
AllFeaturesBothWeeks	.107	.092	.051

Note: *p<0.05, **p<0.01

Effectiveness and adherence correlated with each other as well as with a number of other factors.

Examining the correlation scores between the different personal factors and the outcome measures for depression and anxiety, showed that there was no correlation to be found between any of the personal variables and either the CES-D or HADS-A, with the exception of being divorced, which had a correlation of r=0.16 with the outcome measure for depressive symptoms.

With regards to the use of specific features or patterns of use of the intervention, a number of correlations were discovered, mostly where specific features were being used either during the second week only or

during both weeks. Overall, more significant correlations were discovered with regards to the CES-D than the HADS-A.

In further examining these correlations depicted below, adherence was found to be linked to a large number of different factors- besides the outcome measures for effectiveness- as well. The only personal variable significant here was the number of hours spent online per day. Also significant were different combinations of usage patterns in the second week as well as weeks one and two combined.

Regression Analysis

Based on the correlations above, regression analyses were run, the results of this may be found in Table 4, sorted by outcome measure, type of predictor and its timeframe. For each outcome measure, first come analyses involving separate features in week one, then week two and then both weeks combined, followed by the same analyses involving different usage patterns instead of separate intervention features.

Table 4: *Multiple logistic regression for all outcome measures*

Dependent Variable	Independent Variables	R^2	B	SE	ß	p
MeanDifferenceCESD		.11				
	Constant		-4.18	2.77		.13
	Adherence		.91	.25	.25	.00
	MaritalStatusDivorcedOrElse		4.25	1.64	.18	.01
	PlayerWeek1		5.03	2.15	.16	.02
MeanDifferenceCESD		.10				
	Constant		.36	2.00		.85
	Adherence		.78	.26	.22	.00
	MaritalStatusDivorcedOrElse		4.42	1.70	.19	.01
	SuccessStoriesWeek2		1.78	1.39	.10	.20
MeanDifferenceCESD		.14				
	Constant		-4.78	2.75		.08
	Adherence		.75	.25	.21	.00
	MaritalStatusDivorcedOrElse		4.38	1.62	.18	.01
	PlayerBothWeeks		5.45	2.14	.173	.01
	SuccessStoriesBothWeeks		3.15	1.37	.16	.02
MeanDifferenceCESD		.10				
	Constant		-1.73	2.29		.15
	Adherence		.88	.25	.24	.00

	MaritalStatusDivorcedOrElse	4.02	1.66	.17	.02
	PlayerANDFeedbackWeek1	2.95	1.64	.12	.07
MeanDifferenceCESD		.11			
	Constant	-.42	1.98		.83
	Adherence	.88	.25	.24	.00
	MaritalStatusDivorcedOrElse	4.34	1.64	.18	.01
	AllFeaturesWeek1	3.04	1.40	.15	.03
MeanDifferenceCESD		.10			
	Constant	.50	1.95		.80
	Adherence	.75	.26	.21	.01
	MaritalStatusDivorcedOrElse	4.29	1.66	.18	.01
	DownloadANDSuccessStoriesWeek2	1.25	1.87	.06	.50
	PlayerANDSuccessStoriesWeek2	2.56	2.11	.13	.23
	FeedbackANDSuccessStoriesWeek2	-.73	2.23	-.04	.75
MeanDifferenceCESD		.14			
	Constant	.33	1.92		.86
	Adherence	.73	.25	.20	.00
	MaritalStatusDivorcedOrElse	4.53	1.62	.19	.01
	DownloadANDSuccessStoriesBothWeeks	3.52	1.97	.14	.08
	PlayerAndSuccessStoriesBothWeeks	4.75	1.89	.23	.01
	FeedbackANDSuccessStoriesBothWeeks	-2.30	2.03	-.12	.26
MeanDifferenceHADSA		.11			
	Constant	-.84	.77		.28
	Adherence	.28	.07	.28	.00
	PlayerWeek1	1.60	.61	.18	.01
MeanDifferenceHADSA		.12			
	Constant	-.95	.77		.22
	Adherence	.25	.07	.25	.00
	PlayerBothWeeks	1.68	.61	.19	.01
	SuccessStoriesBothWeeks	.62	.39	.11	.11
MeanDifferenceHADSA		.09			
	Constant	.63	.54		.24
	Adherence	.25	.07	.24	.00

	DownloadANDSuccessStoriesBothWeeks		.67	.51	.10	.19
	PlayerANDSuccessStoriesBothWeeks		.38	.43	.07	.38
Adherence		.30				
	Constant		4.21	.49		.00
	Time spent online per day		-.20	.08	-.15	.02
	FeedbackWeek 2		2.93	.46	.40	.00
	DownloadWeek2		1.01	.33	.19	.00
	SuccessStoriesWeek2		1.01	.34	.20	.00
Adherence		.21				
	Constant		5.58	.44		.00
	Time spent online per day		-.22	.09	-.16	.01
	FeedbackBothWeeks		1.72	.41	.28	.00
	SuccessStoriesBothWeeks		.99	.36	.18	.01
	DownloadBothWeeks		1.11	.36	.20	.00
Adherence		.23				
	Constant		5.88	.40		.00
	Time spent online per day		-.20	.09	-.15	.02
	DownloadANDSuccessStoriesWeek2		-1.15	.64	-.18	.07
	PlayerANDFeedbackWeek2		.87	.41	.16	.04
	FeedbackANDDownloadWeek2		1.89	.47	.35	.00
	PlayerANDSuccessStoriesWeek2		.45	.41	.08	.46
Adherence		.15				
	Constant		6.51	.38		.00
	Time spent online per day		-.20	.09	-.15	.03
	FeedbackANDSuccessStoriesBothWeeks		.72	.56	.13	.20
	PlayerANDFeedbackBothWeeks		.71	.41	.13	.08
	FeedbackANDDownloadBothWeeks		1.42	.50	.25	.01
	PlayerANDSuccessStoriesBothWeeks		.41	.57	.08	.41
	DownloadANDSuccessStoriesBothWeeks		-.34	.68	-.05	.62
Adherence		.05				
	Constant		7.50	.32		.00
	Time spent online per day		-.21	.10	.15	.03
	AllFeaturesWeek2		1.12	.51	.15	.03

Effectiveness

CES-D

Conducting the range of regression analyses with the mean difference score of the CES-D as the dependent variable, yielded values between .10 and .14 for R^2. There were two independent variables that proved significant in all of these analyses: adherence and one of the dummy variables for marital status, which was scored as divorced or else. Proven to be significant were also the use of the mindfulness exercise player in week 1 as well using this player and reading success stories of others in weeks 1 and 2 both. Likewise, having used all features in week 1 was indicated as being significant, as was the combination of player and success stories in both weeks combined.

HADS-A

The HADS-A could not be significantly predicted using any personal variables or usage patterns. What did prove significant, just like for the other effectiveness outcome measure, was adherence. This, in combination with use of the mindfulness player in just the first week and in both weeks combined, produced low, but significant R^2 –values, ranging from .09 to .12

Adherence

Conducting the regression analyses again for adherence, produced a lot more significant factors, although it also resulted in a broad range of R^2 –values, between as little as .05 and as much as .30. The only personal factor of significance here, was the average time a participant spent online per day. Reading feedback and success stories, as well as downloading a mindfulness exercise in either week two (R^2 =.3) or in both weeks one and two (R^2 =.21), was indicated as being able predict adherence to a moderate degree. Also significant was a usage pattern including feedback and download in week two and weeks one and two combined, as well as a pattern consisting of player and feedback in week two. Finally, the use of all intervention features in the second week was indicated as being significant, but, together with the average time spent online per day, only produced a negligible R^2 of .05.

Discussion

The effectiveness of the intervention 'Living to the full' on clinical outcome measures has been established in previous research (Fledderus, Bohlmeijer, Pieterse & Schreurs, 2012), as has its positive perception by its participants (Kelders et al.,2012c). The present study has tried to augment these findings by addressing one of the limitations in the previous studies, namely being unable to predict for which users the intervention will not have a significant effect on CES-D and HADS-A scores and which users will not adhere to the intervention protocol. Identifying such users would allow for early intervention to encourage them to continue use of the intervention and derive more effect from them (Kelders et al., 2012b). Accordingly, the questions that were aimed to be answered were to what degree the combination of personal characteristics, specific usage patterns of the first two lessons and adherence can be used to predict the effectiveness of the web-based intervention "Living to the full" and to what degree the combination of personal characteristics and specific usage patterns of the first two lessons can be used to predict the adherence to the same intervention. Additionally, it was examined how much predictive power-if any- is gained by including usage patterns of the first two lessons, as opposed to the first lesson alone and by including usage patterns instead of separate intervention features.

Main results

The results have clearly shown that personal characteristics do not provide a good basis for predicting either effectiveness or adherence, while usage patterns produce better results with regards to adherence. Where effectiveness is concerned, usage patterns have some very limited predictive power, as do separate intervention features. Still, a large part of what will ultimately determine the successful completion of an intervention is still unaccounted for and should be examined in further research.

Personal Factors

This study concurs with previous ones in so far, as it can confirm the finding some personal variables may play a role in predicting effectiveness and adherence. However, they do so inconsistently and are of minor significance. While this study found a divorced marital status and average time spent online per day to have been of significance in some of the analyses, it could not confirm the finding that either higher age (Postel et al., 2011), lower age (Christensen et al., 2009), being female (Kelders et al., 2013a; Postel et al. 2011) or a higher education (Postel et al., 2011) had an influence on either adherence or effectiveness. Indeed, it was not possible to single out one or more personal characteristics that consistently predict better effectiveness of or adherence to the intervention. While being divorced had a significant influence on the outcome measure for depression, it did not have that same effect on either the anxiety or adherence outcome measures. Similarly, the average time a user spent online per day had a significant effect only on adherence, but not on either of the two measures for effectiveness.

Usage Patterns

Taking a closer look at different usage patterns had more promising results in that they have some predictive power and a clear and consistent difference was found between the two weeks that were included in the analysis. As far as frequency of use is concerned, it can be summarized that all features, whether examined separately or in combination with each other, were used more in the first week than the second. Usage of the intervention during the first week has no predictive power for the effectiveness of or adherence to the intervention during its course, which is quite surprising since it would seem logical that the basis for future success or failure would be laid early on, upon first being introduced to the intervention in week one. On the other hand, the first lesson serves as an introduction to the intervention and is therefore not representative of future lessons. The fact that the use of the intervention's second lesson yielded more predictive power, might have to do with the fact that the original excitement and novelty had worn off after the first week and participants started to use the intervention the way they would continue to do during its course. Since (to the best of the author's knowledge) specific usage patterns like this have never been included in a model for predicting adherence and effectiveness, these results do not concur with nor contradict any existing research, but offer new directions for future studies.

Predicting Effectiveness

Overall, effectiveness could be predicted only to a very limited degree on the basis of the usage patterns of the first two weeks or personal characteristics. Adherence, on the other hand, could be predicted with more success, with up to 30% of its variance being accounted for. In this context, it is noteworthy that there was no advantage to including usage patterns of different combinations of features over using just the separate features in the analysis. This is contrary to what has been found in previous studies (e.g. Donkin, Christensen, Naismith, Neal,Hickie, Glozier, 2011) but is also in line with theories that state that it is exposure to an intervention through frequent use that determines a user's adherence to it, rather than the use of specific intervention features (Freyne et al., 2012; Graham et al., 2013; Mohr et al., 2013).

Predicting Adherence

The finding that adherence could be predicted with more accuracy than effectiveness is somewhat surprising, since the literature makes it seem as if the two went almost hand in hand, with many of the same determinants (e.g. Christensen et al., 2009; Donkin et al., 2011; Kelders et al.,2012b ;Schubart et al., 2011). However, there is also clearly a causal relationship between the two, with better adherence leading to better clinical outcomes (Kelders, Pots, Oskam, Bohlmeijer & van Gemert-Pijnen, 2013b). Likewise, in all analyses of the current study, adherence was a significant predictor of effectiveness. Considering though, that there is still a lot of variance in the effectiveness of this intervention that is unaccounted for, there must be some missing factors. These could possibly be intervention characteristics or details related to participants' symptoms, like their nature or severity. Freyne et al. (2012) suggests factors like the

delivery mode of the intervention and a participant's state or readiness as well as their feeling of control as possible factors for an intervention's success.

Of the 195 participants were included in the study, 118 (61%) adhered to the program, reaching lesson nine. This can be classified as a moderate rate of adherence, since the average rate of adherence in web-based interventions is roughly 50%. However, it should be kept in mind that this high rate was achieved by first eliminating all users who had not completed at least the first two lessons. The actual, or 'true' adherence, based on data from all 239 participants in the original study, was an average 49% (Kelders et al. 2012a). Even after eliminating early non-adherers who did not complete the first two lessons, another 10% of participants did not return to the intervention after lesson two and another 9% did not return after completing the third lesson. These numbers make these lessons those with the highest loss of participants, followed by lesson six (7%). In the original study, Kelders et al. (2012a) argued that this had to do with the fact that in the second and third lessons the introductory period was over and participants were asked to take a good hard look at themselves and their coping mechanisms and lesson six marked the end of the learning phase. These inherent transitions should be considered in future intervention designs to lessen the likelihood of non-adherence. An overview of differences between adherers and non-adherers can be found with the authors of the original study in Kelders et al. (2012a).

Limitations

There were a number of factors that must be considered as limitations to the present study, some of them characteristics of the parent study. For instance, it was discovered in the parent study that not all features of the intervention were clear to participants, which might have caused some usability problems and thereby had an impact on adherence that had nothing to do with the content of the intervention itself. Furthermore, analyses were done solely on the basis of log-data, without any input from participants, who might have been able to give more insights. It is unclear, for instance, whether users stopped with the intervention because they did not perceive it as useful for them or because they had already gained so much from it that they no longer needed it.

It should also be mentioned that the study was conducted on the basis of data for just one intervention that was mainly used by Dutch women with a relatively high level of education. This means that the results- especially those concerning the very specific usage patterns- cannot be generalized to other web-based interventions or target groups. However, it should also be noted that there are similarly constructed interventions for comparable target groups and features (Kelders et al., 2012b), that might also display similar relationships between use, effectiveness and adherence.

The research model that was being used, excluded factors such as technological aspects of the intervention, which had proven to be of import in earlier research, with as much as 55% of the variance in adherence being explained by factors concerning technology and interaction (Kelders et al.2012b).
Lastly, an important limitation was the sheer number of analyses that were run without being accounted for by any form of statistical correction.

Recommendations for future research

Based on the results of the current study, future research should aim to form a comprehensive model for the prediction of effectiveness and adherence, consisting of technological features as well as details about the use of intervention features. This model would need to include more generalized findings about which types of usage patterns lead to better effectiveness and adherence, in order to be widely applicable to other web-based interventions. The next step would then be to examine whether early intervention is a feasible option for reducing non-adherence. It would be interesting to see if singling out those users that have been identified as being more likely to not adhere to the intervention, based on the intervention features they use and their personal characteristics, could help in motivating them to stick with the program after all. How exactly they would be motivated is another area that should be examined in future research.

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Appendix A

Table 5: *Frequencies of intervention features and usage patterns*

Feature(s)	Timeframe	Did use		Did not use	
		n	%	n	%
Player	Week 1	175	89.7	20	10.3
	Week 2	146	74.9	49	25.1
	Both weeks	175	89.7	20	10.3
Feedback	Week 1	174	89.2	21	10.8
	Week 2	165	84.6	30	15.4
	Both weeks	147	75.4	48	24.6
Success Stories	Week 1	162	83.1	33	16.9
	Week 2	92	47.2	103	52.8
	Both weeks	81	41.5	114	58.5
Download	Week 1	98	50.3	97	49.7
	Week 2	90	46.2	105	53.8
	Both weeks	76	39	119	61
PlayerANDSuccessStories	Week 1	145	74.4	50	25.6
	Week 2	75	38.5	120	61.5
	Both weeks	58	29.7	137	70.3
PlayerANDDownload	Week 1	84	43.1	111	56.9
	Week 2	62	31.8	133	68.2
	Both weeks	43	22.1	152	77.9
PlayerANDFeedback	Week 1	155	79.5	40	20.5
	Week 2	127	65.1	68	34.9
	Both weeks	105	53.8	90	46.2
FeedbackANDSuccessStories	Week 1	145	74.4	50	25.6

	Week 2	86	44.1	109	55.9
	Both weeks	70	35.9	125	64.1
FeedbackANDDownload	Week 1	87	44.6	108	55.4
	Week 2	76	39.0	119	61.0
	Both weeks	60	30.8	135	69.2
DownloadANDSuccessStories	Week 1	85	43.6	110	56.4
	Week 2	45	23.1	150	76.9
	Both weeks	35	17.9	160	82.1
AllFeatures	Week 1	62	31.8	133	68.2
	Week 2	32	16.4	163	83.6
	Both weeks	17	8.7	178	91.3