



Comparing human and automated support for depression: Fractional factorial randomized controlled trial



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ARTICLE INFO

Article history:

Received 29 October 2014

Received in revised form

25 June 2015

Accepted 29 June 2015

Available online 6 July 2015

Keywords:

Web-based intervention

Depression

Support

Adherence

Persuasive technology

ABSTRACT

Web-based interventions for people with depressive symptoms are needed and show promising effects. However, it is a consistent finding that human support is needed and this makes implementation costly. This study investigates the adherence and effectiveness of a human-supported and automated-supported web-based intervention for people with mild to moderate depressive symptomatology, and studies the impact of four persuasive technology components. People with mild to moderate depressive symptoms according to the Center of Epidemiological Studies depression scale self-report questionnaire were included, but no diagnosis was made for the study. Participants ($n = 239$) were randomized into one of eight intervention arms, where each level of each component is present in half of the intervention arms. On clinical outcomes, there was a significant interaction effect between support condition and time, but there was no difference on the extent of improvement from baseline to follow-up, only a difference in the time-path of improvement. Effect sizes from baseline to follow-up were 0.89 for automated and 1.00 for human support. There was no significant difference on adherence between support condition. We conclude that an automated-supported web-based intervention for treatment of depression with persuasive technology may achieve similar adherence and effectiveness as the same intervention with human support.

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1. Introduction

Web-based interventions for people with mild to moderate depressive symptomatology are needed and show promising effects (Andersson & Cuijpers, 2009; Andersson et al., 2005; Barak, Hen, Boniel-Nissim, & Shapira, 2008; Jorm & Griffiths, 2006; Kaltenthaler, Parry, Beverley, & Ferriter, 2008; Musiat & Tarrier, 2014; Spek et al., 2007). However, it is a consistent finding that human support is necessary to ensure adherence (i.e. following the intervention protocol) and to increase the effects (Andersson & Cuijpers, 2008, 2009; Hilvert-Bruce, Rossouw, Wong, Sunderland, & Andrews, 2012; Musiat & Tarrier, 2014; Spek et al., 2007). This counselor involvement makes large scale implementation still a costly business. Therefore, a major challenge is to develop web-based interventions that are as effective as human-supported interventions, but have less counselor involvement.

However, questions remain on what support is needed within

web-based interventions. E.g. does the effectiveness of support stem from the actual involvement of a counselor, or (partly) from other factors, such as having clear deadlines within the treatment (Andersson & Cuijpers, 2009) or contact before and after treatment (Johansson & Andersson, 2012)? Moreover, research shows that guidance of a therapist is not essential to produce significant benefits as long as nonguidance contact is provided, e.g. from a technician (Talbot, 2012; Titov et al., 2010). This poses the question whether support needs to come from a human, or whether (some of) the support can be automated (Andersson & Cuijpers, 2009; Johansson & Andersson, 2012).

Studies have shown that automated support can be effective, although less than human support or with lower adherence rates (Furmark et al., 2009; Morgan, Jorm, & Mackinnon, 2012; Titov, Andrews, Choi, Schwencke, & Johnston, 2009). It seems that automated-supported interventions need to be enhanced to reach similar effectiveness and adherence as human-supported interventions. Persuasive technology may provide the means to enhance these interventions (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2009). Promising persuasive technology features are text-messages, interaction, tailoring and personalization. Review

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studies have shown that interventions that include text messages are more effective than interventions that do not include text messages (Webb, Joseph, Yardley, & Michie, 2010) and that reminders increase the effect and adherence of web-based interventions (Fry & Neff, 2009). Furthermore, interactivity has been shown to increase adherence and effectiveness of web-based interventions (Hurling, Fairley, & Dias, 2006; Ritterband et al., 2006). Also tailoring (i.e. adapting content to a particular group of people (de Vries & Brug, 1999)) has been shown to be effective in health behavior change interventions (Noar, Benac, & Harris, 2007; Strecher et al., 2008). Lastly, personalization is proposed to increase the persuasiveness of technology (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2009). This can be achieved by adaptation (e.g. a shopping website shows recommended products based on the history of the user) and adaptability (e.g. a website provides the opportunity to show a self-chosen picture on your personal page) (Knutov, De Bra, & Pechenizkiy, 2009; Velsen, 2011).

For the present study, the web-based intervention 'Living to the full' was developed based on an evidence-based intervention for adults with mild to moderate depressive symptomatology (Fledderus, Bohlmeijer, Pieterse, & Schreurs, 2011; Kelders, Pots, Oskam, Bohlmeijer, & van Gemert-Pijnen, 2013). The intervention is based on Acceptance and Commitment Therapy (ACT) and targets psychological flexibility; the ability to accept thoughts and feelings in order to create space for evaluating and pursuing valued life activities (Hayes, Strosahl, & Wilson, 1999). ACT has been recognized by the APA as an evidence-based treatment of depression. The intervention is aimed at adults with mild to moderate depressive symptomatology, because having clinically relevant depressive symptoms is the most important risk factor for developing a depression (Cuijpers & Smit, 2004) and web-based interventions can be a good strategy to reach this target group (Andersson & Cuijpers, 2008; Cuijpers, van Straten, Warmerdam, & van Rooy, 2010). The web-based intervention includes persuasive technologies that have been found to impact adherence and effectiveness of interventions. Furthermore, a human-supported and an automated-supported version were created. Additionally, process measures were included to assess how participants evaluate the intervention.

2. Method

2.1. Experimental design

In order to compare the human-supported intervention with the automated-supported intervention and to study the relative impact of each persuasive technology component, the screening phase of the Multiphase Optimization Strategy (MOST) was used (Collins, Murphy, & Strecher, 2007). The purpose of this methodology is efficiently selecting active components of interventions. Most behavioral interventions can be seen as consisting of multiple components. Some of these components are part of the intervention itself (e.g. the program content consisting of text and exercises) and other components are related to the delivery of the program (e.g. feedback by an expert or through an automated system). Standard randomized controlled trials can only investigate the effect of the intervention as a whole, i.e. as the sum of the components. However, it may be that some components are very effective and others provide little value or even diminish the effect of other components. It is important to identify and select the active components (the components that provide the wanted effects) and this is the purpose of the MOST screening phase. This is done through randomized experimentation by a fractional factorial trial. Numerous authors have suggested using this methodology to better assess active components in web-based interventions (e.g.

Glasgow, 2007; Norman, 2008; Morrison, Yardley, Powell, & Michie, 2012).

Following the MOST screening phase, we have identified a number of components of which we would like to know whether they are active components. These components are: support (human or automated feedback); text message coaching (present or absent); interaction (high or low); tailoring of success stories (high or low); and personalization (high or low). A full factorial design to investigate these five components with two levels each would require a study with $2^5 = 32$ arms (component combinations) which would not be feasible for this study. However, according to MOST, a fractional factorial design provides an alternative: to be able to answer the research question, not all the arms are needed (Collins, Murphy, Nair, & Strecher, 2005). For this study, the main effects of the components are most important. Furthermore, there is no theory or hypothesis to support an effect of 2-way interactions (the effect of one component influencing the effect of another component), therefore we assume that the impact of these interactions is negligible. Based on these assumptions, we identified a balanced 8 arm fractional factorial design which allowed us to compare the human-supported web-based intervention with the automated-supported web-based intervention and to screen for the effects of the other four components (a 'resolution III' design (Box, Hunter, & Hunter, 2005), see Appendix A). Each arm of the trial includes a different combination of the levels of the components. E.g. participants randomized in the first arm receive the intervention with automated support, text messages, high interaction, high tailoring and high personalization. Participants in the second arm receive the intervention with automated support, text messages, low interaction, low tailoring and low personalization. The design is balanced, which means that each level of each component is present in half of the intervention arms (e.g. four intervention arms include automated support and the other four arms include human support). For the analysis of the effects of the levels of each component, we compared all participants that received a certain level of a component with the participants that received the other level of the component (e.g. comparing all participants who received human feedback with all participants who received automated feedback).

2.2. Recruitment and participants

Inclusion criteria were an age of 18 year or older and mild to moderate depressive symptoms (>9 and <39 on the Center of Epidemiological Studies – depression scale; CES-D) (Radloff, 1977). Exclusion criteria were severe depressive symptomatology and/or severe anxiety symptoms (more than 1 standard deviation above the population mean on the CES-D (cut-off score 39) (Bouma, Ranchor, Sanderman, & Van Sonderen, 1995)) and/or on the Hospital Anxiety and Depression Scale – anxiety subscale (HADS-A (Zigmond & Snaith, 1983); cut-off score 15 (Olsson, Mykletun, & Dahl, 2005)), because for these people more comprehensive diagnosis and psychiatric treatment is warranted. Other exclusion criteria were: receiving psychological or psycho-pharmacological treatment within the last 3 months; having less than 3 h per week time to spend on the web-based intervention; poor Dutch language skills.

2.3. Procedure

Participants were recruited through advertisements in Dutch newspapers between February and March 2011. Interested people visited the study website. After reading information about the study, informed consent was obtained from the participant through a checkbox and a pop-up screen to check whether they were sure to

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