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Author

Lind, Christian, Boschen, Mark J, Morrissey, Shirley

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Technological Advances in Psychotherapy: Implications for the Assessment and Treatment of
Obsessive Compulsive Disorder

Christian Lind, Mark J. Boschen* and Shirley Morrissey

School of Applied Psychology, Griffith University

***Correspondence concerning this article should be addressed to: Dr Mark Boschen,
School of Applied Psychology, Griffith University, Southport, Australia. Ph: +61 7
55528283, Fax: +61 7 55528291, m.boschen@griffith.edu.au**

Abstract

Obsessive Compulsive Disorder (OCD) is a prevalent and costly condition that causes significant functional impairment and reduced quality of life. Although treatments with demonstrated efficacy for OCD, such as cognitive behavior therapy and antidepressants, have existed for over three decades, many patients remain inadequately treated or untreated. Challenges encountered in the treatment of OCD include problems with homework compliance, frequent relapse, difficulties in simulating the spontaneous nature of intrusive thoughts, and infrequent treatment sessions. Accumulated research now indicates that computerized assessment and therapy tools can significantly improve the cost/time-effectiveness of conventional psychotherapeutic interventions for anxiety disorders such as OCD without impairing therapeutic progress and outcome. In this paper we examine the potential of such technology, address current challenges in the assessment and treatment of OCD, and provide a rationale for future research in the field. We outline the general utility of computer technology in psychotherapeutic interventions, critically evaluate the existing literature on computer-assisted assessment and treatment specific to OCD, as well as discuss potential implications of portable technology for OCD treatment delivery and outcomes.

Keywords: OBSESSIVE-COMPULSIVE DISORDER, HANDHELD COMPUTER, CELLULAR PHONE, COMPUTERS, PSYCHOTHERAPY

1.0 Introduction

Rapid progress in personal computer technology over the past few decades has greatly expanded the potential of computer-assisted therapy programs (Kaltenthaler & Cavanagh, 2010; Kaltenthaler, Parry, & Beverley, 2004). Accumulated research now indicates computer and internet-based assessment and therapy tools have the potential to increase the cost-effectiveness of current psychotherapeutic interventions by reducing therapist contact time, increasing client participation in therapeutic activities in non-clinical settings, and streamlining the input and processing of client data from therapeutic activities (Kaltenthaler & Cavanagh, 2010; Newman, Szkodny, Llera, & Przeworski, 2011; Taylor & Luce, 2003). Although research on Obsessive Compulsive Disorder (OCD) and studies evaluating the efficacy of computer-assisted treatment modalities have been growing since the 1980s, the field of computer-assisted psychotherapy for OCD specifically is still in its infancy (Boschen, 2008; Lack & Storch, 2008; Newman et al., 2011).

With this in mind, our aim was to present a rationale for future research investigating the use of computer technology in the assessment and treatment of OCD. The paper is structured such that we (1) summarise the problem and significance of OCD, (2) provide an outline of the utility of computer-assisted assessment and therapy in general, (3) assess the potential of portable technologies such as handheld computers and mobile phones to augment the utility of computer-based assessment and therapy tools, (4) critically evaluate existing literature on computer-assisted assessment and treatment specific to OCD, and (5) discuss potential implications of portable technology for OCD treatment delivery and outcomes.

2.0 Problem and Significance

OCD is an anxiety disorder characterised by persistent thoughts, impulses or images (obsessions) that trigger discernible anxiety or distress, and actions such as repetitive behavior and/or mental acts (compulsions) that are used to suppress the obsessions and

provide relief from the distress brought on by them (American Psychiatric Association, 2000; Szechtman & Woody, 2004). OCD is recognized as a fairly common psychological disorder with reported lifetime prevalence between 1.6 and 3.3%, and 1 year prevalence between 1.0 and 2.1% (Crino, Slade, & Andrews, 2005; Somers, Goldner, Waraich, & Hsu, 2006). The life of an individual diagnosed with OCD is, to a large degree, dominated by obsessive compulsive symptoms (Koran, Thienemann, & Davenport, 1996; Skoog & Skoog, 1999) that typically cause chronic and severe impairment in social, academic/professional, and family functioning (de Silva, 2003; Leon, Portera, & Weissman, 1995; National Institute of Mental Health, 2006). The adverse impact of OCD involves a substantial cost to individual sufferers and their immediate social environment, and represents a huge economic burden to the wider community (Andrews, Henderson, & Hall, 2001; National Institute of Mental Health, 2006).

Treatments with demonstrated efficacy for OCD have existed for over three decades (e.g., serotonergic medication and cognitive-behavioral therapies such as Exposure and Response Prevention [ERP]; Franklin, Abramowitz, Kozak, Levitt, & Foa, 2000) even for the most severe cases (Boschen, Drummond, & Pillay, 2008; Boschen & Drummond, 2012). Despite this, many patients remain inadequately treated or untreated (Fisher & Wells, 2005), and prediction of those who will respond is difficult (e.g., Boschen, Drummond, Pillay, & Morton, 2010). Research has shown that psychological treatments for OCD produce statistically reliable improvement in approximately 75% of patients, with recovery rates around 60% (Fisher & Wells, 2005). However, when the asymptomatic criterion is used as the index of outcome, recovery rates drop to approximately 25% (Fisher & Wells, 2005). Thus, although the majority of OCD sufferers make advances over the course of treatment, many are left with significant residual symptoms, while some show no improvement at all by the end of treatment (Eddy, Dutra, Bradley, & Westen, 2004).

Challenges encountered in the treatment of OCD include problems with homework compliance, frequent relapse, difficulties in simulating the spontaneous nature of intrusive thoughts, and infrequent treatment sessions often due to expense. Non-compliance with homework is frequently reported as a major reason for treatment failure in OCD sufferers (Keijsers, Hoogduin, & Schaap, 1994; Marks, 1997; Rachman, 2003). Such individuals are often difficult to treat behaviorally because the repetitive/ritualistic behaviors are usually most frequent when at home alone (Rachman, 2003). Consequently, OCD individuals are often left to self-administer the behavioral treatment, but are frequently unable to comply with response prevention when faced with the intense anxiety and doubt typical of this disorder (Baer, Minichiello, Jenike, & Holland, 1988; Rachman, 2003). Those who seek help for OCD are often faced with the problem of long waiting lists for trained therapists which causes many OCD sufferers to remain untreated or inadequately treated (Baer & Minichiello, 2008; Mataix-Cols & Marks, 2006). Taken together, the existing treatment difficulties, relatively high prevalence rate, chronicity, as well as personal and societal costs associated with OCD suggest there is considerable room for improvement in the understanding, assessment, and treatment of this disorder.

One possible way of reducing long waiting lists, heavy demands on therapist time, and the high implementation costs associated with OCD treatment, is to place greater emphasis on *self-assessment* and *self-treatment* in clinical practice without reducing treatment efficacy (Mataix-Cols & Marks, 2006). The introduction of user-friendly *self-help* methods may also serve to positively impact patients' self-efficacy and sense of mastery, and as such, may improve treatment adherence/compliance (Barlow, Ellard, Hainsworth, Jones, & Fisher, 2005; Buchmann, 1997). Examples of effective self-assessment and treatment for OCD include brief treatment instructions from a clinician via telephone (Lovell, Fullalove, Garvey, & Brooker, 2000), bibliotherapy (Fritzler, Hecker, & Losee, 1997), self-help groups (Black &

Blum, 1992), and various computer-aided assessment and treatment modalities (Lack & Storch, 2008; Lovell & Bee, 2011).

3.0 Utility of Computer-Assisted Assessment and Therapy

Recent reviews of self-help interventions in mental health have concluded that such programs are based primarily on Cognitive Behavioral Therapy (CBT) principles and that computers could be seen as a way of providing better access to CBT-based self-help materials (Kaltenthaler & Cavanagh, 2010; Newman, Szkodny, Llera, & Przeworski, 2011; Olthuis, Watt, & Stewart, 2011). Because CBT relies on the systematic application of clearly defined interventions to specific symptoms of mental disorders, it is particularly well suited for computer-administration (Przeworski & Newman, 2004; Selmi, Klein, Greist, Sorrell, & Erdman, 1990). It is therefore feasible that computer-assisted CBT interventions, with reduced therapist contact, might be as effective as conventional therapist-administered treatments (Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010; Newman et al., 2011; Przeworski & Newman, 2006).

Rapid advances in technology over recent decades have paved the way for a wide range of computer-based innovations in the field of mental health (Emmelkamp, 2005; Marks et al., 2009; Newman et al., 2011). Computer systems are now being used more often to aid CBT-based assessment and treatment of mental health problems in children and adults (Butcher, Perry, & Hahn, 2004; Kaltenthaler & Cavanagh, 2010; Newman et al., 2011). Such systems have been applied using various administration methods including the internet (Andersson, Bergström, Carlbring, & Lindefors, 2005), virtual reality (Krijn, Emmelkamp, Olafsson, & Biemond, 2004), videoconferencing (Capner, 2000), and standardized computer-assisted/guided packages implemented on desktop computers, portable/handheld computers, and mobile phones (Kenardy et al., 2003; Newman, Kenardy, Herman, & Taylor, 1997; Newman et al., 2011).

Computer aids have become a relatively common and accepted part of psychological assessment (Butcher et al., 2004; Carroll & Rounsaville, 2010) in that they are used for the collection, scoring, and interpretation of research data, history taking, momentary assessment, record-keeping, and diagnosis in clinical practice (Emmelkamp, 2005; Kaltenthaler & Cavanagh, 2010; Newman et al., 2011; Titov, Andrews, & Sachdev, 2010). The use of computers as a treatment delivery tool is also becoming increasingly popular (Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010; Kaltenthaler & Cavanagh, 2010).

3.1 Handheld Technology in Assessment and Therapy

The use of handheld computers (i.e., computers built around a form factor which is small enough to be operated from the palm of a hand) as an adjunct to conventional CBT has emerged as a particularly promising line of research for improving the implementation, cost, and outcome expectancies of computer-assisted treatment for anxiety disorders (Anderson, Jacobs, & Rothbaum, 2004; Clough & Casey, 2011). Handheld computer-assisted CBT has now been successfully implemented for various anxiety disorders (Clough & Casey, 2011; Ehrenreich, Richter, Rocke, Dixon, & Himelhoch, 2011) including panic disorder (Kenardy et al., 2003; Newman, Kenardy et al., 1997), social phobia (Przeworski & Newman, 2004), generalized anxiety disorder (Newman, 1999, 2000; Newman et al., 1999), and OCD (Baer et al., 1987; Baer et al., 1988).

The use of handheld computers as an in vivo assessment/data collection tool has several potential advantages, including computer-administered questionnaires and the automatic time-stamping of data. Handheld computers also have the advantage of being able to cue participants to enter data, yielding information that is more accurate than retrospectively provided reports. Branching algorithms also serve to simplify and shorten measures, such that participants can skip irrelevant questions based on previous data entry. Data entered via computer-administered questionnaires can also undergo validity checks

when automatically uploaded for statistical analysis, reducing data-entry errors and eliminating the need for manual transcription. Given these advantages, the use of handheld computers to collect in vivo self-report data presents as a promising methodology for psychological research (Boschen, 2009a; Boschen & Casey, 2008; Herman & Koran, 1998).

In addition to their utility as an assessment tool, handheld computers have several potential benefits when used for treatment delivery. They can for example, be programmed to deliver detailed instructions for specific therapeutic techniques. Such instructions could either be initiated by the user at will, at scheduled intervals, or as a consequence of certain responses to self-monitoring questionnaires. In turn, this functionality could serve to improve homework compliance and aid the assimilation of therapeutic techniques into the individual's natural environment (Newman, 1999).

The potential utility of handheld computers in clinical assessment and therapy has been further recognized through recent developments in mobile phone technology. Mobile phones are robust networked devices designed to transmit and receive data, and most current versions possess enough computing power to run the type of programs used with computerized psychotherapy and assessment (de Sá, Carriço, Duarte, & Reis, 2009).

Mobile phones hold particular appeal as a vehicle for assessment and therapy due to their relatively low cost and common use (Morris et al., 2010). Ownership of mobile phones is widespread across the globe (Ling, 2001; Marist Institute for Public Opinion, 2009; Van Veen, 2007): Norway, for example, has almost 100% saturation of mobile phones across genders for people aged 13 and older; 9 out of 10 US American and UK adults own a mobile phone. Similar figures have been reported across most of the developed world (Marist Institute for Public Opinion, 2009). In a recent US population survey by the Pew Internet & American Life Project (Pew, 2012), a majority of the 83% who reported owning a mobile phone claimed to own a smartphone; that is, device combining the functionality of a feature

phone with the advanced computing ability and connectivity of a portable computer. On a global scale, smartphone ownership has increased rapidly, with a 58% increase in sales in 2011 (Brownlow, 2012).

Recent reviews (Boschen, 2009a, 2009b; Boschen & Casey, 2008) on the capability and applicability of mobile phones in psychotherapy present a long list of attributes identifying the mobile phone as an excellent tool both for data collection and treatment delivery. These authors point out that apart from their initial application as voice communication tools, modern mobile handsets also have other therapy-relevant attributes (e.g., portability, acceptability, low initial cost, low maintenance cost, societal penetration and ubiquity, always on, always connected, programmability, audio/video output, keypad and audio input, and user-friendliness/ease of use) that make them excellent devices for enhancing cognitive and behavioral interventions (Boschen, 2009a; Boschen & Casey, 2008).

Research on the utility of mobile phones as an assessment and treatment adjunct in mental health is currently at a preliminary stage, therefore it is important to not draw conclusions beyond the empirical evidence (Ehrenreich et al., 2011). Although the findings so far are encouraging, many challenges and unknowns remain regarding the effectiveness of mobile phones as psychotherapeutic tools (Boschen, 2009a, 2009b; Ehrenreich et al., 2011).

4.0 Computers in the Assessment and Treatment of OCD

The anxiety disorder spectrum is one of the best-researched areas in the field of computer-supported psychological intervention (Kaltenthaler et al., 2004; Lack & Storch, 2008). Computers have been used in the assessment and treatment of anxiety since the late 1970s (e.g., Biglan, Villwock, & Wick, 1979). Despite this, research into the applicability of computer-based interventions for OCD specifically, has lagged behind that of other anxiety disorders.

In the following section we review the existing literature on the utility of computer-assisted assessment and therapy for OCD. Studies were identified and selected for inclusion on the basis that they were peer reviewed and incorporated some form of computer technology to aid the assessment and/or psychotherapeutic treatment of OCD. Studies in which computer use was limited to facilitate direct communication (e.g., therapy delivered by a clinician via webcam, videoconferencing or virtual environments) were excluded (for reviews covering these topics, see Clough & Casey, 2011; Lovell & Bee, 2011). No restriction was placed on study design, population, or publication date (beyond those set by database coverage). The terms (OCD OR Obsess* OR Compuls*) AND (compute* OR tech*) AND (assess* OR Screen* OR eval* OR therap* OR treat* OR interv*) were used to systematically search through the databases *Web of Science*, *Scopus*, *Science Direct*, the *OVID* platform (*Medline*, *PsycINFO*, etc), *ProQuest*, *The Cochrane Library* and *Google Scholar* up until January 2012. Reference lists from all identified papers were also examined for additional inclusions.

The earliest published records on the use of computers in the assessment and treatment of OCD are two single case studies conducted by Baer and colleagues in the late 1980s (Baer, Minichiello, & Jenike, 1987; Baer et al., 1988). The first of these cases involved a 25-year-old man with a 4-year history of OCD; the second involved a 58-year-old woman with a 37-year history of the disorder. Both individuals presented with extensive checking rituals. A computer program (*OC-CHECK*) was developed and installed on portable computers to assist in behavioral treatment. The program had two functions: To (1) provide treatment instructions and/or remind patients of instructions given during previous treatment sessions; and (2) store information that patients supplied about the date, time, intensity, and frequency of urges and checking rituals.

To aid learning, Baer and colleagues' patients were first equipped with a laptop computer which they used in the home until they had become familiar with the procedure. The laptop was then substituted for a calculator-sized computer that could be carried outside the home. When the computers were added to conventional behavior therapy, both patients showed rapid reductions (to near zero-levels) in checking rituals. This reduction was specific to whether only the laptop computer was used at home (reduction at home only), or the calculator-sized computer was carried outside the home (reduction in both locations). Removal of the computers led to an increase in checking for both patients and a subsequent decrease when the computers were reinstated. A suggested explanation for the relapse of symptoms following the removal of computers is that they may operate as a safety signal (Baer et al., 1988). That is, the computers could possibly replace the rituals that patients use to alleviate anxiety felt in response to obsessive thoughts (Anderson, Jacobs, & Rothbaum, 2004). As such, it was concluded that the use of the computer was more "a method of control, and not a method of procuring change" (Baer, et al., 1988, p. 239). Notably, no strategies for helping patients prepare to manage their symptoms without relying on the computers (or any other relapse prevention procedures) were implemented during or after termination of treatment. Despite apparent shortcomings, these studies paved the way for further development of computer-aided assessment and treatment for OCD.

4.1 Assessment

Whilst the decade following Baer and colleagues' (1987, 1988) studies produced little work on the use of computers in OCD treatment, several studies investigated the utility of computers in OCD assessment. Roca-Bennasar, Garcia-Mas, Llaneras, Blat, and Roca (1991), for example, were first to introduce a computerized diagnostic system for OCD called *Kraepelin*. This program used 50 questions in natural language combined with 115 rules of reasoning to reach the diagnosis of OCD (or suggest one of several differential diagnoses).

Based on a lack of follow-up studies using *Kraepelin* and the authors' noted difficulties with program design and user acceptance, the system appears to have been discarded from further clinical use.

Shortly after Roca-Bennasar et al.'s (1991) study, Rosenfeld, Dar, Anderson, Kobak, and Greist, (1992) converted the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS; Goodman et al., 1989) to an interactive computer-administered format. To examine its validity, the computer version was administered in a design counterbalanced with the clinician-administered version to a sample of patients with OCD, patients with other anxiety disorders, and non-clinical controls. Results suggested the computerized version of the Y-BOCS was as good as the clinician-administered Y-BOCS for measuring the symptoms of OCD patients. For the anxious and non-clinical samples, however, participants rated themselves as experiencing more OCD symptoms than observed by the clinicians. In addition to its validity in assessing OCD symptoms, the computerized version was rated as being user-friendly, with participants showing no preference for the clinician interview over the computer interview.

Similar to Rosenfeld et al. (1992), Baer, Brown-Beasley, Sorce, and Henriques (1993) adapted the Y-BOCS to a computer-assisted telephone system. More specifically, their program allowed patients to complete the Y-BOCS by responding to digitised human speech via their telephone. In a sample of 18 people diagnosed with OCD, the same Y-BOCS scores were obtained using this system compared to a clinician administration via telephone and a paper-and pencil version returned by mail.

Using a somewhat different approach, Herman and Koran (1998) investigated the utility of handheld computers for collecting in vivo information on OCD symptoms and other environmental and mood variables. Participants were 13 outpatients diagnosed with OCD. Patients carried a handheld computer with them for 3 consecutive days and were prompted

every 3 hours (by a beep from the palmtop computer) to complete a computerized questionnaire which included a modified version of the Y-BOCS. Results showed only moderate agreement between computer-administered Y-BOCS questionnaires and clinician-administered Y-BOCS interviews ($r = .53, p = .08$). Data were also examined for evidence of circadian patterns in symptom intensity. No such patterns were evident. Several methodological difficulties regarding the use of the computers (e.g., limited sampling period duration, participants' failure to provide computer-ratings at all prompts, differences between meanings of computer and clinical Y-BOCS probes) and the small sample size were noted as possible explanations for this outcome (Herman & Koran, 1998).

More recently, Kim et al. (2010) developed a computer-based behavioral measure of compulsive checking using virtual reality technology. The psychometric properties of the measure were assessed using a sample of 30 patients diagnosed with OCD and 27 matched controls. The task involved participants navigating through two virtual environments (home and office) using a joystick and head-mounted display. After a brief training and distraction phase, participants were instructed to check the virtual environments freely as if they were in their natural environment. The primary dependent measures included indices of frequency and duration of checking behaviors. Although several methodological limitations (e.g., no measure of compulsive checking in participants' natural environments, possible confounding effects of Selective Serotonin Reuptake Inhibitors (SSRIs) in the OCD group, and the absence of structured diagnostic interviews) and important discrepancies in findings (e.g., scores on the Y-BOCS, but not the Maudsley Obsessional-Compulsive Inventory were significantly correlated with task performance) were noted by the authors, the results nevertheless revealed that OCD patients had significantly greater problems with compulsive checking compared to controls, and that the performance on the task was positively correlated with both self-reported symptoms and interviewer-rated measures associated with OCD.

In summary, research examining the use of computers in the assessment of OCD is limited. In addition, there are methodological problems associated with this form of assessment. Considering these issues, it is difficult at this point to draw firm conclusions about the utility of employing computers as a means by which to assess OCD. As such, although the accumulated findings of the individual studies reviewed so far suggest computers have potential to aid OCD assessment, more research is needed to determine the appropriate use of such technology within clinical settings.

4.2 Treatments

Consistent with the potential for aiding assessment of OCD, computers are emerging as helpful assets in OCD treatment. Since Baer and colleagues' work (Baer et al., 1987; Baer et al., 1988), the major advance came with the introduction of *BT STEPS* (Baer & Greist, 1997; Marks, 1998), a computer system designed to assist OCD sufferers in carrying out both CBT-based self-assessment and self-treatment on a day-to-day basis. The *BT STEPS* program consists of a nine-step computer driven interactive voice-response system that guides users through a self-paced work book via telephone. Each step begins with the participant reading a prescribed chapter in the accompanying work book and then telephoning the computer for further assistance. Table 1 outlines the nine steps. As can be seen in Table 1, the first four steps involve psycho-education and self-assessment, Steps 5 through 8 involve the actual treatment plan, and Step 9 deals with maintaining gains and relapse prevention.

Baer and Greist (1997) primarily focused on evaluating the need for a system such as *BT STEPS*. Although they did not report actual statistics, Baer and Greist's preliminary report described a reduction in symptoms for *BT STEPS* users comparable to that of patients using serotonergic medication. The researchers stated that two thirds of participants completing two or more sessions of ERP were much or very much improved, participants liked using the program, and 71% thought their lives improved as a result.

The utility of the *BT STEPS* system has since been assessed with promising results in both observational studies and RCTs (Bachofen et al., 1999; Greist et al., 2002; Greist et al., 1998; Kenwright, Marks, Graham, Franses, & Mataix-Cols, 2005; Marks et al., 2000). The first of these studies was an open 12-week observational trial conducted in the US and UK (Greist et al., 1998). It involved a 1-week baseline period (assessment phase) followed by 12 weeks of self-assessment and self-treatment using *BT STEPS*. This was followed by a 22-week extension phase in which patients could continue using the system at their own convenience. Of the 40 OCD patients recruited, 35 completed the self-assessment module and 17 completed at least two sessions of ERP. Results revealed that patients who underwent two or more ERP sessions with the help of *BT STEPS* reported significant improvement on the Y-BOCS, and that the improvement increased with number of sessions.

The pre-treatment versus post-treatment reduction in Y-BOCS scores reported by Greist et al. (1998) represented an effect size ($d = 0.97$), approaching that reported among patients in clinical trials involving SSRIs prescribed for OCD (e.g., Greist, Jenike, Robinson, & Rasmussen, 1995). Moreover, 77% of Greist et al.'s patients reported being "much improved" or "very much improved". Participants also reported significant improvement ($d = 0.79$) on the Work and Social Adjustment Scale (WSA; Marks, 1986), a measure of impairment in functioning across work, home, social situations, and private leisure time.

Bachofen et al. (1999) subsequently examined 21 OCD patients who were on a waiting list for clinician-guided ERP. In this study, patient feedback was modified to include brief praise for progress from the study coordinator (clinician), either on handwritten sheets or via brief telephone calls. Results were similar to Greist and colleagues (Greist et al., 1998) in that significant improvements were observed for patients who engaged in two or more *BT STEPS* guided sessions of ERP. Mean reductions in Y-BOCS and WSA pre- versus post-test scores were 39.2% ($d = 0.73$) and 33.3% ($d = 0.40$), respectively. It was, however, noted that

patients progressed more rapidly in this study than in Greist et al.'s (1998). The authors suggested this might have reflected the use of personal feedback from the clinician and the possibility that patients might have been more encouraged by this. Bachofen et al. also made comparisons between gains made while using *BT STEPS* and subsequent clinician-guided ERP. Outcomes revealed that additional clinician-guided therapy resulted in significant decreases in Y-BOCS scores, but only for patients who did not engage in self-exposures during *BT STEPS*.

Nakagawa et al. (2000) compared the WSA scores from the participants in Bachofen et al.'s (1999) study with those of 20 matched historical controls who had undertaken clinician-guided ERP without prior use of *BT STEPS*. Results showed that both groups had significant post-treatment improvement on the WSA with no significant difference in the magnitude of the effect between the two treatment types.

The *BT STEPS* system has also been assessed in conjunction with brain imaging techniques. In a small randomized trial, Marks et al. (2000) assigned 13 patients diagnosed with OCD to one of three conditions: exposure therapy which was either computer (*BT STEPS*) or clinician guided, or audio-tape guided relaxation therapy. At pre- and post-treatment, whilst undergoing fMRI scanning, patients imagined three types of previously rehearsed scenarios: (1) OCD-related and designed to evoke the urge to ritualise, (2) anxiety non-OCD, and (3) neutral. Patients subsequently rated their level of discomfort. Results showed that discomfort during OCD imagery, but not anxiety non-OCD imagery, decreased significantly after exposure therapy but not after relaxation. Interestingly, participants in the *BT STEPS* group had considerably larger pre- versus post-treatment decreases in Y-BOCS scores (mean decrease = 9.1, $d = 2.12$) and WSA scores (mean decrease = 9.0, $d = 0.99$), than those in the clinician-guided exposure group (Y-BOCS mean decrease = 2.7, $d = 0.49$ and WSA mean decrease = 2.0, $d = 0.22$). Although methodological limitations (e.g., small

sample size, atypically small effect for exposure therapy, relaxation treatment delivered via audiotape) allow for tentative conclusions only, the results support clinical suggestions that cancelling images (imagining having satisfactorily completed rituals) reduces OCD discomfort (Marks et al., 2000), and that this can effectively be achieved through computer-assisted therapy.

Greist et al. (2002) were the first to examine the utility of *BT STEPS* through a larger scale randomized controlled trial. In this study, they randomly assigned 218 OCD patients to 10 weeks of behavior therapy guided by either: (1) a computer (*BT STEPS*), (2) a clinician, or (3) systematic audiotape-guided relaxation and treatment manual. Their intent-to-treat analysis revealed that by Week 10, the mean change in Y-BOCS scores was significantly greater in clinician-guided therapy (mean decrease of 7.6) than in *BT STEPS* (mean decrease of 5.6), and that changes in scores for both therapies were significantly greater than with relaxation (mean decrease of 1.7), which was ineffective. Reported effect sizes were correspondingly largest for clinician-guided therapy ($d = 1.39$), followed by *BT STEPS* ($d = 0.94$), and relaxation control ($d = 0.29$). No significant differences were found between clinician-guided therapy and *BT STEPS* regarding the decrease in number of hours spent on rituals and compulsions (3.4 for both) or WSA scores (5.0 versus 6.8). It is important to note that although clinician-guided therapy was more effective than *BT STEPS* overall, no significant difference was found between the two groups on reduction in Y-BOCS scores post-treatment when only those who completed at least one or more self-exposure session with *BT STEPS* (65%) were included in the analysis (8.1 for clinician-guided versus 9.3 for *BT STEPS*). Also, unlike the two other groups, patients assigned to *BT STEPS* improved further by week 26 follow-up (i.e., greater improvement the longer they spent telephoning the computer and carrying out self-exposure).

Greist et al. (2002) outlined several important issues in their study's design. For example, they were unable to assess the potential effect of patients having been screened face-to-face by a clinician before enrolment. In addition, patients were required to see a clinician for ratings at Weeks 2, 6, 10, and 22, which might have motivated them to engage in more self-exposure than if they had not been required to report to the clinician. Furthermore, Greist et al. pointed out that their sample was limited to patients with extensive rituals (primarily cleaning and checking). Thus, although their patients improved similarly in rituals and in obsessions, results may not generalize to patients who have obsessions with no overt rituals. Notwithstanding these methodological limitations, Griest et al.'s findings indicate that *BT STEPS* can be helpful in treating OCD symptoms.

The efficacy of the *BT STEPS* system has been further assessed in a British study involving treatment-resistant OCD patients (Kenwright et al., 2005). Forty-four patients who used *BT STEPS* over 17 weeks were randomised to have brief live phone support from a clinician in either: (1) nine *scheduled* clinician-initiated calls; or (2) *requested* by the patient only calls. Call content and mean duration of phone call were similar across conditions. Results showed that scheduled support patients dropped out significantly less often, did more homework of self-exposure and self-imposed ritual prevention (95% versus 57% for scheduled- and requested-support, respectively), and reported greater improvement in OCD symptoms and disability than requested support patients. Pre- and post-test Y-BOCS and WSA effect sizes for scheduled and requested calls were $d = 0.85$ versus $d = 0.33$, and $d = 0.23$ versus $d = 0.08$, respectively. The mean total support time per patient over the 17 weeks was 76 min for the scheduled condition and 16 min for the requested condition. Kenwright et al. (2005) concluded that giving brief support proactively by phone enhanced OCD patients' completion of, and improvement with, computer-aided self-help. These findings indicate that although computer-guided therapy can be helpful by itself, treatment compliance and efficacy

increases with therapist involvement. This further suggests that computerized therapy might be best utilised as an adjunct to clinician-guided therapy rather than as a standalone treatment modality.

Clark, Kirkby, Daniels, and Marks (1998) made a similar suggestion. These authors reported on a small study investigating the use of computer-aided vicarious exposure and ritual prevention as an adjunct to conventional behavioral therapy for OCD. Thirteen OCD patients and 10 non-OCD controls completed three 45-min sessions scheduled at weekly intervals. Each session involved guiding a person pictured on a computer screen through exposures to dirt without washing their hands. Outcome measures included the Y-BOCS, Padua Inventory (PI), and Beck Depression Inventory (BDI). Results revealed that OCD patients' scores were significantly reduced on the PI (mean decrease of 14, $d = 0.80$) and BDI (mean decrease of 6.3, $d = 0.60$), but not on the Y-BOCS (mean decrease of 5.2, $d = 0.46$). The authors concluded that the vicarious program, although not sufficient as a standalone treatment, might have a role to play as an adjunct in behavior therapy and could perhaps function as a useful introduction to face-to-face therapy.

Adding Clark et al.'s (1998), Kirby et al. (2000) reported on the dose-response relationships between behavior on the computer-delivered treatment program and outcome, and the use of human-computer interactions (HCIs) as a process measure in psychotherapy research. Recorded HCIs were analyzed to provide a detailed description of the behavioral strategies used in treatment. They examined the relationship between subject characteristics, process measures, and outcome. All participants showed a marked increase in vicarious exposure behavior across the three computer treatment sessions (i.e., enacting a hand-dirtying behavior sequence on the interactive computer program). Whilst some participants did enact hand-washing, this decreased across sessions. Moreover, Kirby et al. found that a higher amount of vicarious hand-dirtying behavior predicted symptom reduction on the PI.

Accordingly, the authors proposed that HCIs could be seen as a new and objective process measure that might aid in clarifying specific treatment factors. The association between hand-dirtying and outcome also supports the notion of an increased benefit from higher treatment dosages (Kirby et al., 2000).

Computer-assisted CBT for OCD has more recently been administered via the internet. Muroff et al. (2011) were first to assess the effectiveness of an existing private online CBT-based group intervention to help people with hoarding symptoms. Participants were provided online access to relevant psycho-education and a chat-group. Symptom severity of chat group members ($n = 106$) was compared with a wait-list control group ($n = 155$). Results showed that recent members reported greater improvement and less clutter at 6-months compared to waitlist members. In addition, long-term members reported milder hoarding symptoms than recent members, suggesting benefits from group participation over time. However, methodological limitations, particularly the quasi-experimental design, prevent firm conclusions from being made.

Wootton and colleagues (Wootton, Titov, Dear, Spence, Andrews, et al., 2011; Wootton, Titov, Dear, Spence, & Kemp, 2011) also investigated the acceptability and feasibility of internet based treatment for OCD. Wootton, Titov, Dear, Spence, Andrews et al. (2011) invited 129 people with OCD symptoms to complete an online internet survey enquiring about demographic characteristics, symptom severity, and acceptability of internet-based treatment. Demographic and symptom severity data were compared with people with OCD identified in a national epidemiological survey ($N = 297$) and with a sample of patients with OCD from a specialist outpatient anxiety clinic ($N = 135$). They found that the internet sample was demographically similar to those identified in a national survey and had symptoms as severe as those identified in other clinical samples. This suggests that internet-based treatment using techniques used in face-to-face treatment may be effective in an

internet sample. Moreover, respondents to the survey reported they were willing to try internet-based treatment (Wootton, Titov, Dear, Spence, & Kemp, 2011).

In another study, Wootton and colleagues (Wootton, Titov, Dear, Spence, Andrews, et al., 2011) assessed the efficacy of a computerized 8-week CBT protocol (*The OCD Program*) to treat OCD remotely via the internet. The protocol comprised eight online lessons, homework assignments, twice weekly contact from a clinical psychologist, and automated emails. Participants also had access to written information on skills likely to be of relevance (e.g., communication skills, strategies dealing with sleep difficulties). Participants demonstrated significant improvement on the primary outcome measures. Three-month follow-up assessment on the Y-BOCS and Obsessive Compulsive Inventory revealed within-groups effect sizes of $d = 1.28$ and $d = 0.60$, respectively. There were no changes between post-treatment and follow-up on these measures. Participants also rated the procedure as highly acceptable. Methodological issues such as the open trial design and small sample do, however, preclude firm inferences being made from these findings.

Along similar lines, Andersson et al. (2011) conducted an open trial in which 23 OCD individuals received a 15-week internet-administered CBT intervention. Therapist support consisted of psycho-education, cognitive restructuring, and ERP. Results revealed marked within-group reductions in OCD symptoms as measured by the Y-BOCS ($d = 1.56$). At the end of treatment, 61% of the participants showed clinically significant improvement, with 43% no longer meeting the diagnostic criteria for OCD. Participants also reported significant post-treatment improvements on self-report measures of OCD symptoms, general functioning, and depression. These findings suggest that internet delivered CBT with therapist support has the potential to reduce OCD symptoms and improve general functioning. However, Andersson et al. identified several important methodological limitations regarding their study's design, recruitment procedures, and sample demographics,

and therefore cautioned any inferences regarding the actual utility of internet-delivered CBT for OCD.

In summary, although the current body of research on the use of computers in the assessment and treatment of OCD is limited, the outcomes thus far are promising. The use of computers in OCD assessment has demonstrated some utility both as stand-alone applications and as part of more comprehensive assessment packages (Kim et al., 2010; Lack & Storch, 2008). Evidence is also accumulating showing that OCD patients can benefit from computer-assisted treatment programs (Lack & Storch, 2008; Lovell & Bee, 2011; Moritz, Wittekind, Hauschildt, & Timpano, 2011). Computer-assisted treatment modalities for OCD have consistently been shown to be superior to no treatment, and in some cases, as efficacious as conventional therapist-administered treatments (Lack & Storch, 2008; Lovell & Bee, 2011). To illustrate this last point, Figure 1 lists the weighted average pre-post treatment effect size for the *BT STEPS* studies reviewed above, together with placebo control and conventional OCD treatment effect sizes derived from Eddy et al.'s (2004) meta-analysis of psychological and pharmacological treatment studies for OCD.

As indicated above, while preliminary research provides support for the use of computer technology in the assessment and treatment for OCD, further investigation is needed (particularly larger-scale RCTs), before firm conclusions can be drawn regarding the utility of such programs. The optimal level of therapist involvement with computer-assisted treatment is also uncertain, and as such, requires further inquiry (Newman et al., 2011; Tumur et al., 2007). Further to this, although some studies suggest that computer-based treatment modalities can be useful on their own accord, treatment compliance and outcomes have been shown to improve with therapist involvement (Lovell & Bee, 2011; Newman et al., 2011). As such, research into optimizing the combination of face-to-face therapy and computerized treatment modalities for OCD is warranted.

4.3 Handheld Technology and OCD

Despite the fact that research on computer-assisted assessment and treatment for OCD was initiated with the use of small portable computers in the late 1980s, little has since been done with this modality as far as OCD is concerned (Lack & Storch, 2008; Lovell & Bee, 2011). The current body of research is limited to Baer and colleagues' two single case studies undertaken in the 1980s (Baer et al., 1987; Baer et al., 1988), and Herman and Koran's (1998) report on the utility of handheld computers as in vivo data collection tools. The methodological limitations of these studies (i.e., lack of appropriate control conditions, small sample sizes, and absence of individually tailored treatment programs) make it difficult to draw firm conclusions regarding the specific contribution of handheld computers over and beyond the effects attributed to conventional assessment and treatment for OCD. However, notwithstanding their limitations, the preliminary results from these studies are encouraging, in that they indicate the acceptability of portable computer devices as an adjunct to conventional CBT by individuals seeking treatment for OCD. As well, given the demonstrated efficacy of handheld computer-assisted therapy for other anxiety disorders (e.g., Kenardy et al., 2003; Newman, 1999; Przeworski & Newman, 2004), further research investigating the utility of portable computers in the assessment and treatment of OCD is warranted.

4.4 Implications for Treatment Delivery and Outcomes

The existing body of research on the utility of computers in the assessment and treatment of OCD is relatively small. Thus, additional data are required before firm conclusions on this matter can be drawn. Having said this, the recent advances in portable technology, particularly with mobile phones, may have potential implications for both treatment efficacy and treatment costs associated with OCD. The use of an electronic device, such as a mobile phone, that can spontaneously simulate intrusive obsessional thoughts

represents an innovative advance on current delivery methods (e.g., use of an audio-tape) that require activation by the patient. Pre-programming of the device by the patient and therapist also has the potential to assist with homework compliance. With the provision of instructions on how to appropriately apply specific techniques, patients will have the opportunity to practice these outside of sessions. For the same reason, such a device could serve as a useful tool in relapse prevention. Moreover, because mobile electronic devices can collect monitoring data (e.g., continuous symptomatic assessment, records of initiation and termination of techniques), homework compliance can be assessed more accurately, subsequently allowing problematic areas to be addressed more efficiently.

Mobile devices also have potential implications for the administration of standardized assessment measures. Pre-programmed computerized questionnaire functions could, for example, allow for automatic and exact time-stamping of data, which is difficult to obtain with conventional paper-and-pencil formats. Moreover, mobile devices can be installed with software that can simplify and shorten measures by incorporating branching algorithms into the questionnaires, such that the user can skip irrelevant questions. In addition, data entered via device-administered questionnaires can undergo validity checks when automatically uploaded for statistical analysis, thereby reducing data-entry errors and eliminating the need for manual transcriptions of data from paper-and-pencil forms.

Considering treatment costs, if the use of a portable electronic device (installed with specialised monitoring and treatment software) as an adjunct to conventional treatment has the capacity to reduce therapist contact hours without compromising treatment quality, OCD sufferers' access to what would otherwise be a very expensive, but effective treatment could be improved.

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Table 1

*The Nine Steps of the BT STEPS Program**

Steps	
1.	Learning about BT STEPS
2.	Identifying major rituals and their costs
3.	Identifying triggers and setting goals
4.	Involving a relative or friend in co-therapy
5.	First exposure and ritual prevention
6.	Fine-tuning
7.	Continuing Treatment
8.	Troubleshooting
9.	Maintaining gains (relapse management)

*Adapted from Baer & Greist (1997)

Figure Captions

Figure 1. Pre- versus post-treatment effect sizes for psychotherapeutic and pharmacological interventions for OCD as measured by the Y-BOCS.

