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# A review of technology-assisted self-help and minimal contact therapies for anxiety and depression: Is human contact necessary for therapeutic efficacy?

Michelle G. Newman *, Lauren E. Szkodny, Sandra J. Llera, Amy Przeworski

*The Pennsylvania State University, United States*

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ABSTRACT

Technology-based self-help and minimal contact therapies have been proposed as effective and low-cost interventions for anxiety and mood disorders. The present article reviews the literature published before 2010 on these treatments for anxiety and depression using self-help and decreased therapist-contact interventions. Treatment studies are examined by disorder as well as amount of therapist contact, ranging from self-administered therapy and predominantly self-help interventions to minimal contact therapy where the therapist is actively involved in treatment but to a lesser degree than traditional therapy and predominantly therapist-administered treatments involving regular contact with a therapist for a typical number of sessions. In the treatment of anxiety disorders, it is concluded that self-administered and predominantly self-help interventions are most effective for motivated clients. Conversely, minimal-contact therapies have demonstrated efficacy for the greatest variety of anxiety diagnoses when accounting for both attrition and compliance. Additionally, predominantly self-help computer-based cognitive and behavioral interventions are efficacious in the treatment of subthreshold mood disorders. However, therapist-assisted treatments remain optimal in the treatment of clinical levels of depression. Although the most efficacious amount of therapist contact varies by disorder, computerized treatments have been shown to be a less-intensive, cost-effective way to deliver empirically validated treatments for a variety of psychological problems.

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* Corresponding author. Department of Psychology, 310 Moore Building, The Pennsylvania State University, University Park, PA 16802-3103, United States. Tel.: +814 863 1148; fax: +814 863 7002.
*E-mail address:* mgn1@psu.edu (M.G. Newman).

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## 1. Introduction

Traditional treatment methods can be both expensive and time consuming. As a result, it has been necessary to develop and implement efficacious, but less time-intensive interventions (Newman, 2000; Newman, Erickson, Przeworski, & Dzus, 2003). Use of technology in psychotherapy has been a cost-effective way to disseminate empirically validated treatments for a wide variety of psychological problems. Studies have employed a range of technological interventions including palmtop computers, desktop computers, and automated telephone-guided therapy systems, Internet therapy, and virtual reality (VR) and exciting developments in technology are ensuring a new wave of technologically administered treatments in the future.

Technology-assisted therapy has many benefits, including increasing access to services for rural individuals, decreasing logistic barriers to treatment, portability (for technologies on hand held devices) and improved self-monitoring (e.g., Newman, Consoli, & Taylor, 1997; Palmer, Bor, & Josse, 2000; Yager, 2001). Further, technology-assisted therapies provide a means for therapists to circumnavigate time-consuming travel and costly logistic challenges that are often associated with the implementation of techniques, such as exposure to flight, heights, or bridges. Technology assisted therapies also provide a means for continued provision of structured instructions on the use of techniques and immediate feedback to clients during the use of techniques. This may improve efficacy of treatment as well as clients' ease of implementation of techniques. Finally, technology-assisted therapies may reduce cost of therapy, thereby improving the accessibility of therapy to individuals who previously may have been unable to afford treatment. Studies have estimated a savings of $540-$630 per client when compared with standard individual CBT (Newman, Kenardy, Herman, & Taylor, 1997; Newman, Consoli, & Taylor, 1999).

Numerous published reviews of technology-administered treatments for anxiety and depression have concluded that such treatments are efficacious alternatives to traditional therapy for anxiety and mood disorders (Anderson, Jacobs, & Rothbaum, 2004; Kaltenthaler et al., 2002; Kaltenthaler, Parry, & Beverley, 2004; Kaltenthaler et al., 2006; Krijn, Emmelkamp, Olafsson, & Biemond, 2004; Newman et al., 1997; Proudfoot, 2004). However, only one published review has examined in detail, the degree of therapist contact that is advisable in the treatment of specific anxiety disorders (Newman et al., 2003). Therapist contact is an important variable in understanding whether or not these technologies are cost-effective as well as in determining how best to effectively implement them. The current review adds to Newman et al. (2003) in a number of ways. In this prior review, we did not include studies on virtual reality therapy, or treatments for depression. Further, the prior paper reviewed studies that were published up until the year 2000. Over 100 papers have been published since 2000 examining technology-administered treatments for anxiety and depression, therefore, an updated review of this literature is greatly needed. We have continued to include previously reviewed studies, as these are important in our full understanding of the state of the field. Thus, the present article aims to: (1) discuss different technological applications to psychotherapy for anxiety and mood disorders, (2) comprehensively review the treatment studies that have incorporated these innovative techniques with varying levels of therapist contact through 2009, and (3) provide conclusions regarding the degree of therapist contact that is advisable for specific anxiety and mood disorders. Given the primary purpose of the current review, which focused on technological devices that reduced therapist time, we excluded studies that focused on full-length email, video, or phone therapy.

## 2. Critical review of the literature

Below we critically review technology-based studies. This section is organized by disorder or condition, and is presented within the context of differing amounts of online or face to face therapist contact, employing four categorical descriptors modified from those used by Glasgow and Rosen (1978). These descriptors are: (1) self-administered therapy (SA; therapist contact for assessment, at most), (2) predominantly self-help (PSH; therapist contact beyond assessment is for periodic check-ins, teaching clients how to use the self-help tool, and/or for providing the initial therapeutic rationale. If any assistance in the use of therapeutic tools is provided, it does not involve more than 1.5 h of a therapist's time), (3) minimal-contact therapy (MC; active involvement of a therapist, though to a lesser degree than traditional therapy for this disorder, includes any treatment in which the therapist assists the client in the application of specific therapy techniques and that involves more than 1.5 h of a therapist's time), and (4) predominantly therapist-administered treatments (TA; clients have regular contact with a therapist for a typical number of sessions, but the study attempts to determine whether the use of a self-help tool augments the impact of the standard therapy). In a previous review paper (Newman et al., 2003), we found that imposed structure wherein participants engaged a self-help tool in an office or clinic often led to a better outcome compared to programs used at home when employing SA interventions. Therefore, we discriminate between studies in which participants were required to use the program in an experimenter's facility, wherein a participant might need to make an appointment and interact with people before or after using a technological device (referred to as a lab or clinic) versus computer technologies accessed from home or other unstructured settings (see Table 1). We also critically evaluate the ability of these computerized self-administered, and decreased therapist-contact interventions to reduce the mental health burden of each disorder.

## 3. Use of technology to treat anxiety disorders

Technology-based treatments for anxiety have focused on mixed anxiety disorders, panic disorder, and or agoraphobia, obsessive-compulsive disorder (OCD), generalized anxiety disorder (GAD), post traumatic stress disorder (PTSD), generalized and specific social phobia, and a variety of simple phobias including flight phobia, acrophobia, and spider phobia. Such treatments have tested desktop computer programs used in a clinic or at home and Internet programs accessed from a clinic or home, virtual reality, interactive voice response systems (IVR) and palmtop computer programs. Although most studies examined treatments for clinical levels of each disorder, some also used treatments that targeted prevention and or subclinical disorders.

### 3.1. Mixed anxiety disorders

Mixed anxiety disorders have been treated mostly with either desktop computers or Internet sites, although one study used a portable biofeedback device to help participants increase their heart rate variability. Computers and Internet sites permit use of multimedia technology including text, video, and audio instruction of techniques, video and audio case examples to model use of therapeutic techniques, and printable therapy worksheets.

For mixed anxiety disorders examining PSH interventions, uncontrolled studies showed improvement in participants treated in the lab with a therapist available at all times to answer questions. Such improvement was noted in response to PSH computer-delivered cognitive behavioral therapy (CBT; Shaw, Marks, & Toole, 1999; White, Jones, & McGarry, 2000), and PSH computer-delivered systematic desensitization plus relaxation (Chandler, Burck, Sampson, & Wray, 1988), with gains maintained up to 8-month follow-up. In addition, a PSH Internet site plus one introductory therapy session was superior to waitlist at post-treatment for students at risk for developing an anxiety disorder (Kenardy, McCafferty, & Rosa, 2003). Also, in two quasi-experimental studies, PSH clinic based computer self-exposure treatments with associated brief contact before and after each use were not significantly different from

**Table 1**

| Author | SH device | How SH Used | Therapist Contact (min) | Sample sizes comparison conditions | Attrition (%) | Compliance rate | FU (months) | Outcome | Main Weaknesses |
|---|---|---|---|---|---|---|---|---|---|
| *Mixed Anxiety* | | | | | | | | | |
| Chandler et al. (1988) | CA clinic | PSH | NR | 5 CAE | 29% CAE | 71% c | 8 | Improved | 1, 4, 5, 6, 7, 9, 10, 12 |
| Shaw et al. (1999) | CA clinic | PSH | NR | 23 CCBT | 65% CCBT | 35% sess | none | PSH>SA | 2, 4, 6, 8, 9 |
| White et al. (2000) | CA clinic | PSH | NR | 26 CCBT | 17% CCBT | 83% c | 6 | Improved | 2, 5, 6, 9 |
| Carr et al. (1988) | CA clinic | PSH | 90* CAE 690*TDE | 20 TDE 20 CAE | 5% TDE, 16% CAE | 95% CAE c 84% TDE c | 6 | CAE = TDE | 3, 6, 8, 9, 10, 12 |
| Kenwright et al. (2001) | CA clinic | PSH | 63* CAVE, 444* TDE | 54 CAVE 31 TDE | 41% CAVE, 40% TDE | NR | none | CAVE = TD | 3, 4, 6, 7, 8, 9 |
| (Kenardy, McCafferty, & Rosa, 2003, 2006) † | Int home | PSH | 1 brief session | 36 IBT 38 WL | 14% ICBT, 5% WL | 50%* sess | 6 | ICBT>WL on 3/6 measures | 5, 6, 8, 10,11 |
| Marks et al. (2004) | CA clinic | PSH | 76* CAE, 283*TDE, 76* CA AR | 37 CAE, 39 TDE , 17 CA AR | 43% CA exp, 26/% TD, 5% CA AR | NR | 3 | CAE = TDE and both>CA AR | 6, 8, 9 |
| Hayward et al. (2007) | Int home | MC ph | 92* CCBT | 32 CCBT | 26% CCBT | 74% c | 1–8 | Improved | 2, 7, 8, 9, |
| Kenwright et al. (2004) | Int home vs clinic | MC ph | 99* Int clinic, 113* Int home | 10 ICBT home 17 ICBT clinic | 16 (37%) | 16 visits* | 1 | ICBT Clinic = ICBT home | 3, 5, 6, 7, 8, 9, 10, 12 |
| Ghosh et al. (1988) | CA clinic BA home | MC | 192* CAE, 186* TDE, 0 BA | 28 CAE 19 TDE 24 BA | 18% CAE 21% TDE 17% BA | NR | 3 and 6 | CAE = TDE = BA | 5, 6, 8, 9, |
| Schneider et al. (2005) | Int home | MC ph | 115 ICBT, 87 ICT | 43 ICBT, 21 ICT | 23% ICBT, 29% ICT | NR | 1 | ICBT>ICT at FU | 6, 8, 9, |
| Craske et al. (2009) | CA clinic | TA | 457.8* CCBT | 261 CCBT | NR | 7.63*ß sess | none | Improved | 2, 4, 6, 8, 9 |
| Reiner (2008) | Bio home | TA | 30 Bio | 20 Bio | 5% Bio | NR | none | Improved | 2,4, 5, 7, 8, 9, 10, 12 |
| *OCD* | | | | | | | | | |
| Kirkby et al. (2000); Clark et al. (1998) | CA clinic | SA | 0 CCBT | 13 CCBT | 7% CCBT | 7.6% didn't complete txs | none | 31% improved | 2, 4, 6, 8, 9, 10, 12 |
| Mouton-Odum, et al. (2006) † | Int home | SA | 0 ICBT | 265 ICBT | 32–37% after 1 week | Av use 11.7 wks | none | Improved | 2, 4, 6, 7, 9, 14 |
| Bachofen et al. (1999) | IVR home | MC Ph | 99* IVR | 21 IVR | 52%<2 sess | 48% >1 sess. | none | Improved | 2, 4, 5, 6, 8, 9, 10 |
| Marks et al. (1998) | IVR home | MC ph | 99* IVR | 53 IVR | 46% IVR | 46% >1 sess | none | > 2 sess = improvement | 2, 4, 5, 6, 8, 9,10 |
| Greist et al. (2002) | IVR home | MC ph | 99* IVR, 660* TD | 55 IVR 55 TD 66 AR | NR | 35%>1 sess | 6.5 | TD>IVR>AR | 6, 8, 9, 10 |
| (Baer et al. 1987, 1988) | Lap and Palm home | TA | As needed | 2 CCBT | 0 CCBT | NR | 22.75 | Relapse when computer taken away | 1, 5, 6, 8, 9, 10, 12 |
| Nakagawa et al. (2000) | IVR home | TA ph | 597* IVR 867* TD | 21 IVR 20 TD | 50% | 50%>1 sess | none | IVR = less therapist time but = TD | 3, 4, 5, 7, 8, 9, 10, 12 |
| *Panic Disorder* | | | | | | | | | |
| Chandler et al. (1986) | CA clinic | SA | 0 | 1 CAE | 0 CAE | good | 8 | Improved | 1, 4, 6, 7, 8, 9 |
| Farvolden et al. (2005) | Int home | SA | 0 | 1, 2004 ICBT | 99% ICBT | 3%>half | none | 1% improved | 2, 4, 5, 6, 7, 8, 9, huge attrition |
| Klein et al. (2008) | Int home | SA | 0 | 6 ICBT | 16.7% ICBT | NR | none | Improved | 2, 4, 6, 8, 9, 10, 12 |
| Klein & Richards (2001) | Int home | SA | 0 | 11 ICBT 12 No tx | 8% ICBT, 0 no tx | NR | none | ICBT>No tx | 4, 5, 8, 9, 10, 12 |
| Carlbring et al. (2001) | Int home | PSH em | 90* | 16 ICBT, 15 WL | 20% ICBT 6% WL | NR | none | ICBT>WL | 4, 5, 6, 8, 9, 10, 11, 12 |
| Carlbring et al. (2003) | Int home | PSH em | 30* | 11 ICBT, 11 Int AR | 27% ICBT, 18% Int AR | 56.3% c | 12 | Int AR = ICBT | 5, 6, 8, 9, 10, 12 |
| Harcourt et al. (1998) | CA clinic | MC | RA present | 18 CAVE | 5% CAVE | NR | none | Improved | 2, 4, 5, 6, 7, 8, 9, 10 |
| Newman et al. (1996) | Palm home | MC | 360 | 1 BCCBT | 0 BCCBT | good | 3 | Improved | 1, 5, 6, 8 |
| Richards & Alvarenga (2002) | Int home | MC ph | 300* | 9 ICT | 36% ICT | 79% c | 3 | Improved | 2, 5, 8, 9, 10, small sample |
| Bergström et al. (2009) | Int home | MC em | 114* | 18 ICBT | 10% ICBT | 78% sess | 6 | Improved | 2, 6, 8, 9, 10 |
| Carlbring et al. (2006) | Int home | MC em ph | 234* ICBT | 30 ICBT 30 WL | 7% ICBT, 3%WL | 80% c | 9 | ICBT>WL | 5, 6, 8, 10, 11 |
| Meuret et al. (2008) | Cap home | MC | 300 | 20 Cap 17 WL | 0 | 100% c | 12 | Cap>WL | 6, 8, 10, 11 |
| Newman et al. (1996); North et al. (1995) | VR clinic | MC | 700 VRE | 30 VRE 30 WL | 0 | NR | none | VRE>WL | 4, 5, 6, 7, 8, 9, 10, 11 |
| Shandley et al. (2008) | Int home | MC em | 378.62* em, 7.14 visits GP | 53 ICBT + GP 43 ICBT + em | 16.3% ICBT + em, 37.7% ICBT + GP | NR | 6 | ICBT + em = ICBT + GP | 3, 6, 8,10 |
| Carlbring et al. (2005) | Int home | MC em | 150* ICBT, 600 TD | 24 TDCBT 25 ICBT | 12% TDCBT, 12% ICBT | 28% ICBT 88% TD c | 12 | TD = ICBT | 6, 8, 10, Low compliance |

(*continued on next page*)

**Table 1** (*continued*)

| Author | SH device | How SH Used | Therapist Contact (min) | Sample sizes comparison conditions | Attrition (%) | Compliance rate | FU (months) | Outcome | Main Weaknesses |
|---|---|---|---|---|---|---|---|---|---|
| *Panic Disorder* | | | | | | | | | |
| Kiropoulos et al. (2008) | Int home | MC em | 352 ICBT, 568 TD | 46 ICBT 40 TD | 11 % ICBT, 5% TD | NR | none | TD = ICBT | 4, 6, 8, 10 |
| Klein, Austin et al. (2009) | Int home | MC em | 205 infreq, em 308 freq em | 23 freq em, 25 infreq em | 21% freq em, 28% infreq em | NR | none | Freq em = infreq em | 4, 6, 8, 9, 10 |
| Klein et al. (2006) | Int home | MC em or ph | 332.5 ICBT 245.3 BA, 64.5 IED | 18 ICBT, 15 BA, 13 IED | 5% ICBT 17% BA, 28% IED | NR | 3 | ICBT and BA > IED | 6, 8, 9, 12 short FU, |
| Richards et al. (2006) | Int home | MC em | 376.3 ICBT, 300.3 Int + SM | 12 ICBT, 11 ICBT + SM, 9 IED | 17% ICBT, 9% ICBT + SM, and 22% IED | NR | 3 | ICBT and ICBT + SM > IED | 8, 9, 12 |
| Ghosh & Marks (1987) | CA clinic BA home | MC | 186* TDE, 72 CAE, 0 BA | 15 CAE, 12 TDE, 13 BA | 11% CAE, 14% TDE 13% BA | good | 3 and 6 | CAE = TDE = BA | 6, 8, 9, 10, 12 |
| Newman, Kenardy et al. (1997) | Palm home | MC | 360 BCCBT, 720 CBT | 9 BCCBT, 9 CBT | 10% BCCBT, 10% CBT | good. | 6 | BCCBT = CBT | 5, 6, 8, 9, 12 |
| Kenardy, Dow, et al. (2003) | Palm home | MC | 360 BCBT, 360 BCCBT, 720 CBT | 41 WL, 39 BCBT, 42 CBT 41 BCCBT | 19% | NR | 6 | CBT = BCCBT = BCBT at FU | 5, 6, 9 |
| Choi et al. (2005) | VR clinic | MC | 216 VRCBT, 288 TDCBT | VRCBT = 20 TDCBT = 20 | none | NR | 6 | TDCBT > VRCBT at FU | 6, 8, 10 |
| Vincelli et al. (2003) | VR clinic | MC | 480 VRCBT, 720 TDCBT | 4 VRCBT 4 TDCBT 4 WL | none | good | none | VRCBT and TDCBT improved WL did not | 4, 5, 6, 8, 9, 12 |
| *Social Phobia* | | | | | | | | | |
| Botella, Hofmann, et al. (2004) | Int clinic | SA | 0 | 1 IEX | 0 | good | 1 | Improved | 1, 5, 6, 7, 8, 9, 10, 12, 13 |
| Botella et al. (2007) | Int clinic | SA | 0 | 12 IEX | 14% | NR | 1 | Improved | 2, 5, 6, 7, 8, 9, 10, 12, 13 |
| Harris et al. (2002) † | VR clinic | PSH | 60 | 8 VRE 6 WL | 20% VRE 13% WL | 80% c VR | none | VRE = WL | 4, 5, 6, 7, 8, 9, 11, 12, 13, 14 |
| North et al. (1997) † | VR clinic | PSH | 65–90 | 6 VRAE, 8 VRTE | 25% VRAE, 0 VRTE | 75% c | none | VRAE > VRTE | 4, 6, 8, 9, 10, 12, 14 |
| Amir et al. (2008) † | CA clinic | PSH | 40 | 47 Amp, 47 Placebo | NR | NR | none | Amp > placebo | 4, 6, 7, 9, 14 |
| Beard & Amir (2008) † | CA clinic | PSH | 40 | 13 Amp, 14 Placebo | NR | NR | none | Amp > placebo | 4, 5, 6, 7, 9, 12, 13, 14 |
| Amir, Beard, Taylor et al. (2009) | CA clinic | PSH | 40 | 22 Amp, 22 Placebo | 0 Amp 15% placebo | NR | 4 | Amp > placebo | 13, 14 |
| Schmidt et al. (2009) | CA clinic | PSH | 40 | 18 Amp, 18 placebo | 0 Amp 10% placebo | NR | 4 | Amp > placebo | 6, 7, 13, 14 |
| Anderson et al. (2003) | VR clinic | MC and TA | 360 and 600 | 2 VRE + CBT | 0 VRE + CBT | 100% c | 8. | Improved | 1, 6, 7, 8, 9, 10, 12 |
| Przeworski & Newman (2004) | Palm home | MC | 120 | 1 palm CBT | 0 palm CBT | 80% | 6 | Improved | 1, 5, 6, 8, 12, 13 |
| Anderson et al. (2005) | VR clinic | MC | 480 | 10 VRE + CBT | 0 VRE + CBT | NR | 3 | No change on BAT | 2, 6, 7, 8, 10, 12 |
| Anderson et al. (2006) | Int home | MC | 231.6* | 32 ICBT, 32 WL | 6% ICBT, 0% WL | 56% did all modules | 12 | ICBT > WL | 5, 6, 7, 11, 13 |
| Carlbring, Furmark et al. (2006) | Int home | MC em | 180* | 26 ICBT, 26 WL | 7% ICBTt, 3% WL | 61 % did all modules | 6 | ICBT > WL | 5, 6, 8, 9,11, 13 |
| (Carlbring et al. 2007, 2009) | Int home | MC em ph | 150 | 29 ICBT, 28 WL | 3% Int, 0 WL | 93% c | 12 | ICBT > WL | 5, 6, 8, 9, 11, 13 |
| Titov et al. (2008a) | Int home | MC em disc | 125* | 50 ICBT, 49 WL= | 22% ICBT, 0 WL | 78% c | none | ICBT > WL | 4, 5, 6, 8, 9, 11, 13 |
| Titov et al. (2008b) | Int home | MC em disc | 127* | 41 ICBT, 40 WL | 20% ICBT, 0 WL | 80% c | none | ICBT > WL | 4, 5, 6, 8, 9, 11, 13 |
| Berger et al. (2009) | Int home | MC em | NR | 31 ICBT, 21 WL | 10% ICBT, 10% WL | 57.1% did all modules | none | ICBT > WL | 4, 5, 6, 7, 8, 9, 11, 13 |
| Tillfors et al. (2008) | Int home | MC em disc | 318 ICBT, 394.8 ICBT + GTDE | 19 ICBT + GTDE, 19 ICBT, 23 WL | 5% ICBT + GTDE, 5% ICBT | 48.6 % did all modules | 12 | ICBT + TDE = ICBT > WL | 5, 6, 8, 9, 13 |
| Gruber et al. (2001) | Palm home | MC | 199 BCCBT, 300 GTD | 18 BCCBT, 18 GTD, 18 WL | 17% BCCBT, 22% GTD, 6% WL | Computer used 20* times | 6 | BCCBT = GTD FU | 6, 8, |
| Klinger et al. (2005) | VR clinic | TA | 540 VRE, 180 GTD | 18 VRE, 18 GTD | 0 | 100% | none | VRE = GTD | 3, 4, 6, 8, 9, 10, 13 |
| *GAD* | | | | | | | | | |
| Newman et al. (1999) | Palm home | MC adjunct | 120 | 3 Palm CBT | 0 | Dropped off at end of tx | 6 | Improved | 1, 6, 8, 12 |
| Draper et al. (2008) | Int home | SA ph | NR | 3 ICBT | 0 | NR | 5 | Improved | 1, 5, 6, 8, 9, 12 |
| Amir et al. (2009) | CA lab | PSH | 40 min | 14 AMP, 15 placebo | 0 AMP 15% placebo | NR | 4 | AMP > placebo | 12 |

**Table 1** (*continued*)

| Author | SH device | How SH Used | Therapist Contact (min) | Sample sizes comparison conditions | Attrition (%) | Compliance rate | FU (months) | Outcome | Main Weaknesses |
|---|---|---|---|---|---|---|---|---|---|
| *GAD* | | | | | | | | | |
| Pallavicini et al. (2009) | VR clinic and home | TA | NR | 4 VR AR + bio, 4 VR AR, 4 WL | 20% VR 0 VR + bio, 0 WL | NR | none | VR AR + bio > VR AR > WL | 4, 6, 8, 9, 10, 12 |
| *PTSD* | | | | | | | | | |
| Hirai & Clum (2005) | Int home | SA | 0 | 18 ICBT, 15 WL | 28% ICBT, 7% WL | NR | none | ICBT > WL | 4, 5, 6, 7, 9, 11, 12 |
| Lange et al. (2000) † | Int home | MC em | NR | 20 IEX | 13% IEX | NR | 1.5 | Improved | 2, 5, 6, 7, 8, 9, 14 |
| Klein, Mitchell et al. (2009) | Int home | MC em | 238.70 | 12 ICBT | 25% ICBT | 75% ICBT c | none | Improved | 2, 4, 6, 8, 9, 12, 14 |
| Lange et al. (2001) † | Int home | MC em | NR | 13 IEX, 12 WL | 13% IEX 20% WL | NR | 1.5 | IEX > WL | 5, 6, 7, 8, 9, 11, 12, 14 |
| Lange et al. (2003) † | Int home | MC em | NR | 69 IEX 32 WL | 39% IEX 48% WL | low | 1.5 | IEX > WL | 5, 6, 7, 8, 9, 11, 14 |
| Knaevelsrud & Maercker (2007) † | Int home | MC em | NR | 49 IEX 47 WL | 16% IEX 2% WL | NR | 3 | IEX > WL | 5, 6, 7, 8, 9, 11,14 |
| Litz et al. (2007) | Int home | MC ph em | NR | 17 IED, 14 ICBT | 30% | NR | 3 | ICBT > IED | 6, 8, 9, 10, 12 |
| (Ready et al., 2006); (Rothbaum et al., 2001) | VR clinic | TA | 900* | 21 VRE | 28.5% | NR | 3 and 6 | Improved | 2, 6, 8, 9, |
| Zucker et al. (2009) | Bio home | TA inpatient | 30 | 19 bio, 19 AR | 0 | NR | none | bio > AR on nonPTSD symptoms | 4, 7, 8, 10, 12, 14 |
| *Claustrophobia* | | | | | | | | | |
| Botella et al. (2000) | VR clinic | TA | 270–360 | 4 VRE | 0 | NR | 3 | Improved | 1, 6, 8, 10, 12, |
| *Driving phobia* | | | | | | | | | |
| Walshe et al. (2003) | VR clinic | TA | 720 | 7 VRE game reality | 0 | NR | none | Improved | 2, 4, 6, 7, 8, 9, 10, 12, 13 |
| Wald & Taylor (2003) | VR clinic | TA | 480 | 5 VRE | 29% | NR | 12 | No behavioral change | 2, 6, 7, 8, 9, 10, 12, 13 |
| *Acrophobia* | | | | | | | | | |
| Lamson (1994) † | VR clinic | MC | 120 | 30 VRE | NR | NR | none | Improved | 2, 4, 5, 6, 7, 8, 9, 10, 13, 14 |
| Coelho et al. (2006) | VR clinic | MC | 90–120 | 10 VRE | 0 | NR | 12 | Improved | 2, 6, 7, 8, 9, 10, 12 |
| Rothbaum et al. (1995) † | VR clinic | MC | 245–280 | 10 VRE 7 WL | 16% VRE 13% WL | NR | none | VRE > WL | 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 |
| Krijn et al. (2007) | VR clinic | MC | 390 | 13 VRE + CT first, 13 VRE first | 0 | NR | 6 | gains not maintained at FU | 5, 6, 7, 8, 9, 10, 12, 13 |
| Emmelkamp et al. (2001) † | VR clinic | MC | 240 | 10 VRE then TDE | 0 | NR | none | VRE = TDE | 2, 4, 5, 6, 7, 8, 9, 12, 13, 14 |
| Emmelkamp et al. (2002) | VR clinic | MC | 180 | 16 TDE 17 VRE | 0 | NR | 6 | VRE = TDE | 6, 7, 8, 9, 12 |
| Krijn, Emmelkamp, Biemond, et al. (2004) | VR clinic | MC | 270 | 14 VRE HP 10 VRE LP, 11 WL | 21% HP 70% LP 18% WL | NR | 6 | HP = LP VRE > WL | 6, 7, 8, 9, 10 12, |
| Ressler et al. (2004) | VR clinic | MC | 70–90 | 10 placebo, 8 50 mg DCS, 9 500 mg DCS | 0 | NR | 3 | DCS > placebo, 50 mg DCS = 500 mg DCS | 6, 7, 8, 9, 10, 12, |
| *Flying phobia* | | | | | | | | | |
| Bornas et al. (2002) | CA lab | MC | 222.5* | 21 CAE | 13% Study 2 | all completed | none | 37.5% recovered | 2, 4, 6, 7, 8, 9, 12 |
| Kahan et al. (2000) | VR clinic | MC | 345* | 31 VRE | 16% | NR | 8* | 23% flew at FU | 2, 5, 7, 8, 9, 13 |
| Botella, Osma, et al. (2004) | VR clinic | MC | 315–420 | 9 VRE | 0 | NR | 12 | Improved | 6, 7, 8, 9, 10, 12 |
| Bornas et al. (2006) | CA clinic | MC | 300 CAE; 300 CANE | CAE = 19, CANE = 21 | 0 | all completed | 6 | CAE = CANE | 6, 8, 9, 10, 12 |
| Bornas et al. (2001) | CA clinic | MC | 360 CAE 660 IRCAE | 15 CAE; 13 CANE 17 WL | 0% CAE 28% CANE 0% WL | NR | 6 mo. | CAE > CANE > WL | 6, 8, 9, 12, |
| Maltby et al. (2002) | VR clinic | MC | 330 VRE, 60 SG | 20 VRE 23 SG | 9% VRE, 0 SG | NR | 6 | VRE = SG at FU | 6, 7, 8, 9, 12, |
| Mühlberger et al. (2001) | VR clinic | MC | 420 VRE, 330 AR | 15 VRE 13 AR | 0% VRE 13% AR | NR | 3.5 | VRE > AR | 6, 7, 8, 9, 10, 12, |
| Mühlberger et al. (2003) † | VR clinic | MC | 200 VRE + CT, 200 VREM + CT 60 CT | 13 VREM + CT 13 VRE + CT, 11 CT 10 WL | 0 | NR | 6 | VREM + CT = VRE + CT, VRE > CT = WL | 5, 6, 7, 8, 9, 12, 14 |

(*continued on next page*)

**Table 1** (*continued*)

| Author | SH device | How SH Used | Therapist Contact (min) | Sample sizes comparison conditions | Attrition (%) | Compliance rate | FU (months) | Outcome | Main Weaknesses |
|---|---|---|---|---|---|---|---|---|---|
| *Flying phobia* | | | | | | | | | |
| Mühlberger et al. (2006) † | VR clinic | MC | 280 nonTD flight, 400 TD flight | 15 TD flight, 15 nonTD flight | 6% at FU | 87% TD flight, 67% non TD flight | 12 mos. | TD flight = nonTD flight | 6, 7, 8, 9, 12, 14 |
| (Wiederhold et al., 2002); Wiederhold & Wiederhold (2003) | VR clinic | MC | 360 | 10 VREPF 10 VRE 10 IME | 0 | NR | 3, 36 | VRE > IME, VREPF = VRE | 6, 7, 8, 9, 10, 12, |
| Banos et al. (2002) | VR clinic | TA | 280–360 | 4 VRE | none | NR | none | Improved | 1, 4, 6, 7, 8, 10, 12, |
| (Rothbaum et al., 2000, 2002) | VR clinic | TA | 510 VR 510 TD | 15 VR 15 TDE 15 WL | 3 VRE (17%) 1 IV (6%) | NR | 6 and 12 | VRE = TDE > WL | 5, 6, 8, 10, 12, 13 |
| (Rothbaum et al., 2006); (Andersson et al., 2006) | VR clinic | TA | 510 VRE 510 TDE | 29 VRE, 29 TDE, 25 WL | 0.25 | NR | 6 and 12, 27.6 | VRE = TDE > WL | 6, 7, 8, 10 |
| *Spider phobia* | | | | | | | | | |
| Botella et al. (2008) | VR clinic | SA | 0 | 12 VRE no head gear | 0 | | 3 | Improved | 2, 6, 7, 8, 12 |
| (Gilroy et al., 2000); (Gilroy et al., 2003) | CA clinic | SA | 5 CAVE, 135 TDE | 15 TDE, 15 AR, 15 CAVE | 27% AR 6% TDE | NR | 3, 33 | TDE = CAVE > AR | 6, 7, 9, 12, |
| Dewis et al. (2001) | CA clinic | SA | 5 CAVE 135 TDE | 9 TDE 10 CAVE 9 WL | 0 | NR | 1 | TDE > CAVE > WL | 6, 8, 9 12, |
| Fraser et al. (2001) | CA clinic | SA | 5 CAVE-3 sess 5 CAVE-6 sess | 15 CAVE-3 sess 15 CAVE-6 sess | 27 % CAVE-3 sess, 20% CAVE-6 sess | good | 1 | 3 sess CAVE = 6 sess CAVE | 6, 8, 9, 12, |
| Smith et al. (1997) | CA clinic | SA alone | 5 CA | 15 CAVEF, 15 CAVE 15 CAIVEF | 27% | NR | 9 | CAVEF = CAVE = CAIVEF | 5, 8, 9, 12, 13 |
| Heading et al. (2001) | CA clinic | SA 5 min w/ client | 5 CAVE 180 TDE | 14 TDE, 13 CAVE 13 WL | 0 | Low HW compliance | 1 | TDE > CAVE | 6, 8, 9, 10, 12, |
| Andersson et al. (2009) | Int home | PSH video em | 25* IEX 180 TDE | 14 TDE, 13 IEX | 13% IEX, 7% TDE | NR | 12 | TDE > IEX at post TDE = IEX at FU | 6, 7, 8, 12, |
| Côté & Bouchard (2005) | VR clinic | MC | 360 VRE | 28 VRE | 0 | NR | none | Improved | 2, 4, 6, 8, 9, 13 |
| Garcia-Palacios et al. (2002) | VR clinic | MC | 240 VRE | 12 VRE 11 WL | 0 | NR | none | VRE > WL | 4, 6, 7, 11, 12, |
| Nelissen et al. (1995) | CA lab | MC | 60 CAVE, 120 TDE | 2 CAVE then TDE | 0 | NR | none | TDE > CAVE | 1, 4, 6, 9 10, 12 |
| Hoffman et al. (2003) † | VR clinic | MC | 180 | 13 VRETA, 12 VRE 11 No tx | 0 | NA | none | VRETA > VRE > No tx | 4, 9, 12, 14 |
| *Depression* | | | | | | | | | |
| Patten (2003) † | IVR | SA | 0 | 420 IVR 366 IED | 3.3% IVR 2.2% IED | NR | 1, 2, and 3 | IVR = IED | 5, 6, 7, 8, 9 |
| Spek et al. (2007; 2008) † | Int home | SA | 0 ICBT, 120 TD | 102 ICBT, 99 GTD, 100 WL | 35% ICBT, 43% GTD 42% WL | 94.5% GTD, 48.3% ICBT c | none | GTD = ICBT > WL | 4, 5, 6, 7, 8, 9 |
| Christensen et al. (2006) † | Int home | SA | 0 | 1099 BICBT 1133 EICBT | 21% BICBT, 19% EICBT | 27% did all modules | none | EICBT > BICBT | 4, 5, 6, 7, 8, 14 |
| Osgood-Hynes et al. (1998) | IVR home | PSH ph | Very little | 41 IVR | 0.32 | 85% did 1/3 modules | none | >use = >benefit | 2, 4, 5, 6, 8, 9, 10 |
| O'Kearney et al. (2006) † | Int classroom | PSH | 55 | 40 ICBT, 38 SSD | 34% ICBT, 0% SSD | 40% > 2 sess | 4 | ICBT = SSD | 3, 5, 6, 7, 8, 9, 10, 14 |
| O'Kearney et al. (2009) † | Int classroom | PSH | 55 | 35 ICBT, 24 SSD | 21% ICBT, 10% SSD | 30% > 2 sess | 4 | ICBT > SSD at FU | 3, 5, 6, 7, 8, 9, 10, 14 |
| Christensen et al. (2004) † | Int home | PSH ph | 60* IED, 60* ICBT, 60* SL | 165 IED, 182 ICBT, 178 SL | 17% IED 34% ICBT, 12% SL | 50% ICBT c | none | ICBT = IED > SL | 4, 5, 7, 8, 9, 10, 14 |
| Van Voorhees et al. (2009) † | Int home | PSH | 36* MI + ICBT, 1.79 advice + ICBT | 40 advice + ICBT, 42 MI + ICBT | 5% advice + ICBT, 2% MI + ICBT | 61% MI + Int 67% advice + Int | 3 | MI + ICBT > advice + ICBT | 5, 6, |
| Alvarez et al. (2008) | CA lab | PSH . | 60 | 11 Ccog, 10 Ccog + med, 10 med | 9% | NR | 8 | Ccog = Ccog + med > med | 6, 8, 9, 10, 12 |
| Selmi et al. (1990) | CA lab | MC | 120 CCBT vs. 360 TD | 12 CCBT, 12 TD, 12 WL | 0 | 100% | 2 | CCCBT = TD > WL | 6, 7, 8, 9, 12 |
| Seligman et al. (2007) † | Int home | MC em | 96* | 113 = ICBT 127 = no tx | 5% | 84% with workshop | 6 | ICBT > No tx | 6, 7, 11 |
| Warmerdam et al. (2008) † | Int home | MC em | 100* IPST, 160* ICT | ICT = 88; IPST = 88; WL = 87 | 34% | 38.6% ICT, 37.5% IPST c | 1 | ICT = IPST > WL | 5, 6, 7, 9, 14 |
| Andersson et al. (2005) | Int home | MC em disc | 120 ICBT, 60 Disc | 36 ICBT + Disc 49 Disc | 37% ICBT + Disc, 18% Disc | 65% Int c | 6 | ICBT > Disc | 5, 6, 8, 9, 10, |
| Wright et al. (2005) | CA lab | MC | 450 TD, 250 CCT | 15 CCT 15 TD, 15 no Tx | 13% | 95.1% TD, 90.5% CCT | 3 and 6 | CCT = TD > WL | 6, 12, |
| Robertson et al. (2006) | ICBT | TA | Concurrent tx | 144 ICT | 23% | 84% > 8 sess | none | Improved | 2, 4, 5, 7, 8, 9, 10, 14 |

**Table 1** (*continued*)

| Author | SH device | How SH Used | Therapist Contact (min) | Sample sizes comparison conditions | Attrition (%) | Compliance rate | FU (months) | Outcome | Main Weaknesses |
|---|---|---|---|---|---|---|---|---|---|
| *Depression* | | | | | | | | | |
| Siepmann et al. (2008) | Bio lab | TA | 300 bio + concurrent tx | 14 bio | NR | NR | none | Improved | 2, 4, 6, 7, 8, 9, 10, 12 |
| Houston et al. (2002) | ISG home | TA | Concurrent tx | 103 ISG | 18.4% | 53% heavy use | 6 & 12 | Improved | 2, 5, 9, 10, 14 |
| Bowers et al. (1993) | CA hospital | TA | Concurrent Inpt care | 6 CCBT + Inpt, 8 Inpt | 32% CCBT | NR | none | CCBT + Inpt = Inpt | 4, 7, 8, 12 |
| Eisdorfer et al. (2003) | CTIS in home | TA | 840* FT | 75 FT, 77 FT + CTIS, 73 SL | 28% FT, 24% FT + CTIS 44% SL | NR | 6 and 18 | FT + CTIS > FT and SL | 5, 6, 7, 9, 14 |
| Clarke et al. (2002) | Int home | TA | Concurrent tx | 144 ICT 155 TAU | 26% reported no FU | low site use | 1, 2, 4, 8 | ICT = TAU | 5, 7, 9, 14 |
| Clarke et al. (2005) | Int home | TA | Concurrent tx | 100 IED 75 ICT + mail, 80 ICT + ph | 36% | >1 visit: 25% ICT ph, 28% ICT mail | 1.25, 2.5, 4, 12 | ICT + ph = ICT + mail > IED | 5, 7, 9, 14 |

Note. † used a nonclinical sample; CA computer assisted; Palm = palmtop computer; Lap—laptop computer; Bio—biofeedback device; TD—therapist directed; CBT—cognitive behavioral therapy; GTD—group therapist directed CBT; BCBT—brief individual CBT; BCCBT— Brief computer-assisted CBT; GTDE—group therapist-directed exposure; TDCBT—therapist directed CBT; BA—bibliotherapy assisted; VRE—virtual reality exposure; LP—low presence; HP—high presence; Int—Internet based; IVR—Interactive voice response system; CTIS—computer–telephone integrated system; CAP—capnometry assisted breathing retraining; SG—support group; SSD—standard self-development activities; Tx—treatment; TAU—treatment as usual; SA—entirely self-help; PSH—predominantly self-help, MC—Minimal contact; TA—therapist assisted; Ph—phone contact; Exp—exposure; TDE—therapist delivered in vivo exposure; CAE—computer-assisted exposure; CANE—computer assisted treatment without exposure; CCBT—computer administered CBT; CCT—computer administered cognitive therapy; CCog—computer administered cognitive training; CAVE—computer assisted vicarious exposure; CAIVE—Computer assisted irrelevant vicarious exposure; CAVEF—computer assisted vicarious exposure with feedback; CAIVEF—computer assisted irrelevant vicarious exposure with feedback; VRETA—virtual reality exposure with tactile augmentation; VREPF—virtual reality exposure with physiological feedback; VREM—virtual reality exposure with motion simulation; VRAE—Virtual reality active exposure; VRTE—Virtual reality trivial exposure; VRCBT—virtual reality assisted CBT; IME—imaginal exposure; CT—cognitive therapy without exposure; CBT—exposure plus cognitive therapy; ICBT—Internet delivered CBT; ICT—Internet delivered cognitive therapy; IEX—Internet assisted exposure; IED—Internet information only site; ISG—Internet support group; BICBT—brief Internet delivered CBT; EICBT extended Internet delivered CBT; IPST—Internet delivered problem solving therapy; SM—stress management; AR—applied relaxation; AMP—Attention Modification Program; FT—family therapy; med—medications; MI—motivational interviewing; GP—general practitioner visits; ED—educational control condition; DCS—D-cycloserine; mg—milligrams; Em—email feedback and support; Disc—online discussion group; HW—homework; NR—not reported; c—% participants who completed treatment; sess—percentage of sessions completed; FU—follow-up; Inpt—Inpatient; *amount of time reported is based on an average. Codes for weaknesses: 1. Case study, 2. Uncontrolled, 3. Quasi experiment, 4. No follow-up, 5. Used only self-report measures, 6. Did not assess additional therapy, 7. Did not stabilize medications prior to study entry, 8. No adherence or quality checks on treatment, 9. No reliability check on diagnosis, 10. No information on therapist training, 11 Only used a waitlist or no treatment comparison, 12 small sample, 13. No in vivo behavioral avoidance test, and 14. Did not assess DSM criteria.

therapist-guided exposure (Carr, Ghosh, & Marks, 1988; Kenwright, Liness, & Marks, 2001) with gains maintained 6 months after treatment ended. Similarly, in a randomized controlled trial, PSH computer-instructed exposure was superior to PSH computer plus audiotape-delivered relaxation in a clinic and not significantly different from therapist-instructed exposure (Marks, Kenwright, McDonough, Whittaker, & Mataix Cols, 2004) with gains maintained at 3-month follow-up.

In studies employing minimal contact for mixed anxiety disorders, improvement was noted in response to an MC Internet site accessed by rural community members (Hayward, MacGregor, Peck, & Wilkes, 2007). An MC clinic-based computer self-exposure system included nurse therapists who provided an initial rationale and spent 10 min with participants before and after each computer use. In a randomized controlled trial using this system to deliver exposure, outcome from computer-administered therapy was not significantly different from therapist-directed exposure at post-treatment and 6-month follow-up (Ghosh, Marks, & Carr, 1988). Additional results from a quasi-experimental study showed that this system was not more effective than MC Internet delivered exposure accessed from home with regular scheduled 10-minute phone contact with therapists (Kenwright, Marks, Gega, & Mataix-Cols, 2004). Moreover, MC Internet guided exposure accessed from home plus regular brief contact via phone or email was superior to Internet-delivered CBT without exposure (Schneider, Mataix-Cols, Marks, & Bachofen, 2005) at 1-month follow-up. In less supportive results, MC computer-assisted exposure in a clinic was not superior to SA bibliotherapy exposure and bibliotherapy was not significantly different from therapist-directed in vivo exposure at post-treatment and at 6-month follow-up (Ghosh et al., 1988).

In terms of TA interventions, there were two uncontrolled studies for mixed anxiety disorders. Improvement was found in response to a computer program that provided therapist guidance (Craske et al., 2009). Also, participants currently receiving psychotherapy or medication improved in response to a portable heart-rate variability biofeedback device (Reiner, 2008).

Taken together, the most cost-effective option for mixed anxiety disorders, may be SA bibliotherapy exposure, as it was not less effective than either MC computer assisted exposure or therapist-delivered graded exposure (Ghosh et al., 1988). However, this finding is based on only one study that used an older computer system as a comparison and it is possible that newer computer systems with greater multimedia capacity and engagement may prove to be superior to SA bibliotherapy for mixed anxiety disorders. Also, all comparisons to active treatments used pure exposure therapies. It is therefore unclear whether SA bibliotherapy involving multi-component CBT would be as effective as computer- or therapist-administered CBT for mixed anxiety disorders. In addition, most controlled findings for mixed anxiety disorders support the use of MC interventions and as such, these may be the optimal choice. No studies of clinically diagnosed participants with mixed anxiety examined the efficacy of SA or PSH technology-guided treatments used from home. Thus, it remains to be seen whether using a technology with SA or PSH contact is efficacious without the imposed structure offered by a clinic.

These studies included several methodological limitations. For example, none of them reported reliability of the diagnosis obtained and only 3 of them (see Table 1) included either placebo or active treatment comparisons within a randomized controlled trial. In addition, although many of these studies required stabilization of medications prior to entry, none of them assessed for additional treatment seeking outside of the study. Also, none of the trials that included human contact or therapist directed comparison conditions provided adherence or quality checks. Further, all studies had relatively short follow-up assessments with none longer than 8 months.

### 3.2. Obsessive-compulsive disorder

Technologies to treat obsessive-compulsive disorder (OCD) have made use of either computer delivered vicarious exposure or interactive voice response systems (IVR) using exposure and response prevention (ERP) techniques. IVR typically involves the client calling into a computer,

which is programmed with therapy modules. The client navigates these modules using a touch-tone phone. Instructions are provided entirely via oral directions. Vicarious exposure programs require clients to move an avatar on a computer screen toward an image of the feared object or in some other way to engage the figure in the exposure task.

Obsessive-compulsive disorder (OCD) has been examined less frequently and results are less promising than for mixed anxiety disorders. In an open trial of an SA Internet intervention for trichotillomania there were significant reductions of self-reported hair pulling (Mouton-Odum, Keuthen, Wagener, Stanley, & DeBakey, 2006). However, an SA uncontrolled trial for OCD showed nonsignificant improvement in response to vicarious exposure and response prevention (ERP) delivered in a lab using a desktop computer (Clark, Kirkby, Daniels, & Marks, 1998). Studies employing a manual plus interactive voice response system accessed by telephone found that although it led to statistically significant improvement (Bachofen et al., 1999; Marks et al., 1998), as an MC intervention it was not as effective at post-assessment and 6.5 month follow-up as therapist-delivered ERP (Greist et al., 2002). On the other hand, when this intervention was used as an adjunct to therapist-delivered therapy, in a quasi-experiment, participants required fewer sessions with the therapist but did as well (averaging 597 vs. 867-minute contact; Nakagawa et al., 2000). In addition, a TA case study (conducted after standard therapy failed) found that a participant improved as long as he had access to ERP guidance via software, but relapsed when it was taken away (Baer, Minichiello, & Jenike, 1987).

Taken together, these studies suggest that for OCD treatment, technologies required the least amount of therapist contact (9.95 h) without loss to efficacy when used as an adjunct to therapist directed exposure and response prevention (Nakagawa et al., 2000). However, this result is based on a quasi-experimental study and it has not been replicated. There are additional limitations to all of the OCD studies, which suggest that perhaps these technologies are not optimal for this disorder. For example, reported compliance rates (defined as having engaged in more than one session) for IVR have ranged from 35 to 48% (Greist et al., 2002; Marks et al., 1998). In addition, only one randomized controlled trial has been conducted on any technological device for OCD. Further, none of the reviewed studies conducted a reliability check for diagnoses, none assessed for additional treatment seeking outside of the study, and only one conducted adherence checks for the treatment provided (Greist et al., 2002).

Aside from implications that more controlled trials are needed, the data reviewed above suggest that a critical change mechanism is provided by the therapist in computer-assisted therapy for OCD, even if this is limited to guidance through the computerized exposure tasks. Perhaps this is due simply to the support or coaching provided by another individual when approaching a feared stimulus, or the contribution of the alliance to these exercises. Therefore, an important future direction would be to test various levels of therapist involvement when using identical technological devices to determine the optimal balance using a cost-benefit ratio.

### 3.3. Panic disorder

In addition to including technologies already described for other disorders, treatment of panic disorder has included mobile technologies such as palmtop computers and capnometry devices. Palmtop computers teach and prompt people to use specific techniques in their natural environments and similarly, capnometry devices provide immediate $CO_2$ feedback to help retrain panic disorder clients' breathing in their natural environment. Moreover, virtual reality (VR) has been used to conduct exposure therapy to a feared environment (e.g., balcony, grocery store) and to provide optimal control over this exposure via manipulations of the environment (e.g., making the environment more or less crowded with people).

For panic disorder, very few studies have examined SA technology-based treatments. A case study found improvement lasting up to 8 months in response to SA computer CBT delivered in the lab (Chandler, Burck, & Sampson, 1986) and in a controlled trial SA Internet cognitive therapy was superior to self-monitoring alone at post-treatment (Klein & Richards, 2001). However, although a pilot SA Internet treatment led to improvement in some panic symptoms, panic attack frequency was unchanged (Klein, Shandley, Austin, & Nordin, 2008). Also, in an open trial with no exclusion criteria, only 1% of those who registered for an Internet treatment completed all segments (Farvolden, Denisoff, Selby, Bagby, & Rudy, 2005), suggesting that SA treatments may not be optimal for panic disorder.

Similar to SA studies, few studies have examined PSH technology-based treatments for panic disorder. PSH Internet CBT plus email check-in was superior to a waitlist (Carlbring, Westling, Ljungstrand, & Andersson, 2001). However, PSH Internet CBT plus standardized email feedback was equivalent at post-assessment to PSH Internet applied relaxation plus standardized email (Carlbring, Ekselius, & Andersson, 2003). Because relaxation alone is not a recommended treatment for panic disorder (Chambless & Ollendick, 2001), this suggests the possibility that PSH interventions may not be optimal in the treatment for panic disorder.

In case studies or uncontrolled trials examining MC interventions for panic disorder, MC Internet cognitive therapy plus phone calls or email feedback (Bergström et al., 2009; Richards & Alvarenga, 2002), MC vicarious exposure with therapist guidance in the lab (Harcourt, Kirkby, Daniels, & Montgomery, 1998), and MC palmtop computer CBT plus 6 h therapist-delivered therapy (Newman, Kenardy, Herman, & Taylor, 1996) all led to significant improvement. In addition, MC Internet CBT plus phone and email contact (Carlbring et al., 2006), MC VR desensitization (North, North, & Coble, 1995), and MC ambulatory capnometer-assisted breathing retraining (Meuret, Wilhelm, Ritz, & Roth, 2008) were superior to waitlist at post-treatment and up to 12 month follow-up. Additional studies found no significant differences between greater contact therapist-delivered CBT and either MC palmtop-delivered CBT (Kenardy, Dow, et al., 2003; Newman, Kenardy, et al., 1997), MC Internet CBT plus email contact (Carlbring et al., 2005; Kiropoulos et al., 2008), MC desktop computer-assisted exposure delivered in a clinic (Ghosh & Marks, 1987) or MC VR exposure (Vincelli et al., 2003) with gains maintained up to 1-year follow-up. Again, perhaps these findings point toward the critical role of at least some amount of therapist contact before, during, or after exposure to feared stimuli (i.e., panic triggers/symptoms), whether that is guided exposure or provision of coping strategies, even though varying levels of contact appear to promote significant gains.

In studies trying to discern optimal ingredients of MC technology based treatments for panic disorder, non-randomly assigned MC Internet CBT plus email contact was not significantly different from MC Internet CBT plus general practitioner assistance (Shandley et al., 2008) at post-treatment and 6-month follow-up. However, MC Internet CBT plus email contact was superior to MC bibliotherapy at reducing visits to a general practitioner and at reducing negative health ratings, and both treatments were superior to a PSH information only Internet site (Klein, Richards, & Austin, 2006). Further, MC Internet CBT plus stress management was superior at post-assessment to MC Internet CBT alone on panic severity and general anxiety and both were better than an information only website, although there were no longer any differences between the two active treatments at 3-month follow-up (Richards, Klein, & Austin, 2006). In addition, MC Internet CBT plus 1 email per week was not less effective than MC Internet CBT plus 2 emails per week (Klein, Austin, et al., 2009) at post-treatment.

In less promising results, in a subset of the sample reported by Ghosh et al. (1988) focused only on agoraphobic clients, MC desktop computer-assisted exposure delivered in the lab was not significantly better at post-therapy and 6-month follow-up than SA bibliotherapy exposure used at home, and bibliotherapy was not significantly different from therapist-directed exposure (Ghosh & Marks, 1987). Also, a palmtop computer plus 6 h therapist-delivered CBT was comparable at 6-month follow-up to 6 h therapist-delivered CBT

without the computer (Kenardy, Dow, et al., 2003). In addition, four sessions of group CBT plus individual VR exposure was less effective at 6-month follow-up than 12 sessions of group CBT without VR exposure at enabling medication reduction (Choi et al., 2005).

Thus, for optimal amount and type of technologically based treatment for panic disorder, the most consistent finding is that such treatment entails minimal therapist contact involving a computer administered program (either Internet, palmtop or desktop). Such a treatment appears to be effective when used in conjunction with as little as 150 min of contact (Carlbring et al., 2005). Further, this treatment may be enhanced with the addition of a stress management component (Richards et al., 2006). As an MC intervention, it does not seem to matter whether the device is used at home or in a clinic. However, most SA and PSH interventions were accessed from home and perhaps testing such interventions in the clinic would confer better results. There are several caveats to these conclusions. As highlighted in Table 1, these studies are not without methodological flaws. Also, most of the studies have involved MC interventions using computers and more research is needed to determine if equally effective PSH treatments can be developed as well as effective panic disorder treatments involving VR technologies.

### 3.4. Social phobia

Technologies used in the treatment of social phobia have included VR, Internet, desktop, and palmtop computer assistance. Most VR studies targeted public speaking anxiety with treatment involving exposure via presentations to a virtual audience. However, Klinger, Bouchard, Legeron, Roy, Lauer, Chemin et al. (2005) employed VR using a number of additional environments meant to target social phobia more broadly, including virtual situations requiring interaction with friends, acquaintances and strangers as well as virtual situations requiring assertiveness, and initiation and maintenance of conversations. Whereas Internet treatments for social phobia typically entailed instruction of multicomponent CBT techniques, some newer desktop computer programs focused on attention-retraining tasks meant to target biased attention to threatening stimuli found in social phobia.

Only 2 technology-based social phobia treatments involved SA interventions. A case study and an open trial using a cognitive therapy Internet site, video exposure, and external focus instructions led to reduced speech anxiety maintained for a month after treatment ended (Botella et al., 2007; Botella, Hofmann, & Moscovitch, 2004). In terms of PSH interventions to treat public speaking anxiety, VR exposure was superior to waitlist (Harris, Kemmerling, & North, 2002). In addition, PSH VR group active exposure was superior to PSH VR group trivial exposure (North, North, & Coble, 1997). Moreover, for social phobia symptoms, in four studies PSH computer-guided attention retraining was superior to placebo programs (Amir, Weber, Beard, Bomyea, & Taylor, 2008; Amir, Beard, Taylor, et al., 2009; Beard & Amir, 2008; Schmidt, Richey, Buckner, & Timpano, 2009), suggesting that this treatment is promising.

For MC interventions, in case studies therapist-guided cognitive therapy, breathing retraining, and VR exposure decreased symptoms of public speaking (Anderson, Rothbaum, & Hodges, 2003). However, there have also been some less positive findings with respect to VR using MC interventions. For example, an open trial of 8 individual sessions of anxiety management training plus VR exposure reduced self-reported symptoms; however, participants were not more likely to complete a speech at post-treatment (Anderson, Zimand, Hodges, & Rothbaurn, 2005). Also, 12 individual sessions of VR exposure were not significantly different from 12 group sessions of standard CBT at post-assessment (Klinger et al., 2005), requiring more therapist time per person in the individual VR treatment (540 min) than the standard group therapy (180 min). Perhaps this was due to the beneficial effects of real-life exposure to a group of people compared to the virtual exposure provided by VR.

In MC treatments using computer programs, a case study series found that 6 group sessions of CBT plus a palmtop computer led to symptom improvement that was maintained at 6-month follow-up (Przeworski & Newman, 2004). In addition, in four controlled trials, MC CBT Internet sites in conjunction with therapist email contact were superior to waitlist (Andersson et al., 2006; Berger, Hohl, & Caspar, 2009; Carlbring, Furmark, Steczkó, Ekselius, & Andersson, 2006; Carlbring et al., 2007; Carlbring, Nordgren, Furmark, & Andersson, 2009) with gains maintained up to 2.5-year follow-up. In two additional studies an MC Internet site plus moderated chat room discussion plus email contact were superior to waitlist (Titov, Andrews, & Schwencke, 2008; Titov, Andrews, Schwencke, Drobny, & Einstein, 2008). Moreover, an MC Internet site plus moderated chat room plus email and phone contact was not differentially successful when augmented by five therapist administered sessions with both treatments leading to significant improvement and gains maintained up to 1-year follow-up (Tillfors et al., 2008). Finally, MC group CBT plus a palmtop computer was not significantly different from 12 group sessions without the computer (Gruber, Moran, Roth, & Taylor, 2001) at 6-month follow-up. Given these findings, it is possible that one critical factor leading to improvement in social phobia is contact with others, be it real-life or virtual (e.g., email, chat rooms, VR), with some virtual options allowing for time-unlimited contact.

In sum, promising reductions in social phobia symptoms have been shown with PSH interventions focused on attention retraining and exposure delivered in a clinic as well as with MC palmtop computer and Internet treatments used at home (see Table 1). However, some methodological limitations make it difficult to draw conclusions regarding amount of optimal time as well as with respect to the optimal technology. One problem is that very few social phobia studies included a behavioral avoidance test, often considered an important objective outcome measure when treating social phobia. Further, only 3 social phobia studies compared technology driven treatments to therapist-administered treatments and these studies all had cell sizes under 20 suggesting the possibility that they may have been underpowered to find differences. Interestingly, all of the SA and PSH treatments for social phobia involved making appointments and going to a lab or clinic and therefore, it is unclear whether these interventions would work as well if administered from home.

### 3.5. Generalized anxiety disorder and posttraumatic stress disorder

There are only a few studies of generalized anxiety disorder (GAD) or posttraumatic stress disorder (PTSD). These studies have made use of palmtop computers, desktop computers, Internet treatments, ambulatory biofeedback, and VR assistance. VR has been used creatively to engage Veterans with PTSD in exposure to war related scenes and experiences as well as to enhance relaxation in participants with GAD via immersion into relaxing environments.

For GAD treatment (Table 1), a case series using an SA CBT Internet site (plus occasional phone contact to prompt adherence) led to reliable change and recovery in 2/3 of participants at post-treatment and with gains maintained at 5-month follow-up (Draper, Rees, & Nathan, 2008). Moreover, a PSH attention retraining computer program was significantly better than a placebo program at diminishing GAD symptoms with gains maintained at 4-month follow-up (Amir, Beard, Burns, & Bomyea, 2009). Further, a case series using MC palmtop computer-assisted CBT showed diminished symptoms in all 3 participants with gains maintained at 6-month follow-up (Newman et al., 1999). Also, in a small sample of patients, MC VR (immersing participants in relaxing scenes) with non-navigable scenes added to participants' mobile phones for use at home was augmented with the addition of biofeedback (Pallavicini, Algeri, Repetto, Gorini, & Riva, 2009).

In the treatment of subclinical PTSD symptoms, an SA CBT Internet intervention was superior to waitlist at post-treatment (Hirai & Clum, 2005). Also, for individuals with elevated PTSD symptoms, MC Internet treatment plus email feedback led to clinically significant change (Lange et al., 2000) and in 3 separate studies was superior to waitlist at 6-week follow-up (Lange, van de Ven, Schrieken, & Emmelkamp, 2001; Lange et al., 2003), and 3-month follow-up (Knaevelsrud & Maercker, 2007). Moreover, in a sample of individuals in an inpatient facility for substance abuse treatment who had elevated PTSD symptoms, an ambulatory biofeedback device was superior to audio-recorded progressive muscle relaxation on measures of depression and heart rate variability but not significantly different on measures of PTSD at post assessment (Zucker, Samuelson, Muench, Greenberg, & Gevirtz, 2009).

In the treatment of clinically diagnosed PTSD, an MC Internet treatment plus email feedback led to clinically significant change (Klein, Mitchell, et al., 2009). Also, in service members with PTSD such a treatment was superior to a supportive Internet site at 3-month follow-up (Litz, Engel, Bryant, & Papa, 2007). Also, an uncontrolled study found that TA VR exposure led to clinically meaningful and statistically significant reductions in combat veterans' symptomatology, which were maintained at 3- and 6-month follow-up (Ready, Pollack, Rothbaum, & Alarcon, 2006; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001).

Taken together, for the treatment of GAD or PTSD, more studies are needed before any conclusions can be drawn about the optimal amount of human contact needed. As noted, within the handful of studies conducted there is quite a diversity of methods and sample selections (see Table 1). For the treatment of GAD, PSH attention retraining holds some promise and for the treatment of PTSD, MC Internet sites hold promise. Nonetheless, these methods have not been directly compared to therapist-directed treatments and therefore, it is not known if they would achieve comparable efficacy.

### 3.6. Simple phobias

By far, most technology-based treatment studies have been conducted on simple phobia examining enhanced exposure techniques. These treatments have entailed VR exposure, computer exposure to images and sounds associated with the feared object, Internet-assisted exposure, or vicarious exposure. Almost all of the studies were done in a lab or a clinic with only one Internet-based study providing treatment from home.

#### 3.6.1. Claustrophobia and driving phobia

Only uncontrolled studies examined claustrophobia or fear of driving. In a case series with multiple baselines, MC VR exposure reduced symptoms of claustrophobia and this reduction was maintained at 3-month follow-up (Botella, Banos, Villa, Perpina, & Garcia Palacios, 2000). In addition, TA VR reduced self-reported and physiological symptoms of driving phobia, with reductions maintained up to 12-month follow-up (Wald & Taylor, 2003; Walshe, Lewis, Kim, O'Sullivan, & Wiederhold, 2003). However, in one of the latter studies, treatment did not change participants' driving behavior (Wald & Taylor, 2003).

#### 3.6.2. Acrophobia

Similar to driving phobia, there are limited technology-based studies on acrophobia. In the one study on PSH for acrophobia, VR exposure plus D-cycloserine was superior to VR exposure plus placebo with gains maintained at 3-month follow-up (Ressler et al., 2004). In terms of MC acrophobia treatments, in an uncontrolled study VR exposure reduced self-reported fear and behavioral avoidance with gains maintained at 1-year follow-up (Coelho, Santos, Silvério, & Silva, 2006). Moreover, MC VR exposure was superior to waitlist with gains maintained up to 6 months (Krijn, Emmelkamp, Biemond, et al., 2004; Lamson, 1994; Rothbaum et al., 1995). In addition, MC VR exposure was not significantly different from MC in vivo exposure (Emmelkamp, Bruynzeel, Drost, & Van Der Mast, 2001; Emmelkamp et al., 2002). Further, MC VR exposure using a more expensive system with greater presence was not superior to a less expensive MC system with less presence and results were maintained at 6-month follow-up (Krijn, Emmelkamp, Biemond, et al., 2004).

#### 3.6.3. Flight phobia

In interventions for flight phobia using virtual reality, clinical case series (Banos et al., 2002; Botella, Osma, Garcia Palacios, Quero, & Banos, 2004) and open trials (Bornas et al., 2002; Kahan, Tanzer, Darvin, & Borer, 2000) showed that MC VR exposure reduced symptoms, with gains maintained up to one year. In controlled trials, MC VR exposure was superior to MC relaxation (Mühlberger, Herrmann, Wiedemann, Ellgring, & Pauli, 2001). Also in an MC format, adding VR exposure to cognitive therapy led to superior outcome compared to PSH cognitive therapy alone and both were superior to a waitlist with gains maintained at 6-month follow-up (Mühlberger, Wiedemann, & Pauli, 2003). Further, at 3-month and 3-year follow-up the addition of physiological feedback improved upon MC VR exposure alone, and both were better than imaginal exposure (Wiederhold, Jang, Kim, & Wiederhold, 2002; Wiederhold & Wiederhold, 2003). On the other hand, motion simulation did not add anything beyond cognitive therapy plus VR exposure (Mühlberger et al., 2003). Also, during a one-year follow-up of this study, therapist accompaniment did not impact significantly whether or not participants took a flight (Mühlberger, Weik, Pauli, & Wiedemann, 2006). Less positive results showed that MC VR exposure led to a flight in 67% of participants at post treatment, but only 23% at 1 year follow-up in an uncontrolled study (Kahan et al., 2000). Also, MC VR exposure was not superior to a PSH attention placebo on a behavioral avoidance task at post therapy and 6-month follow-up (Maltby, Kirsch, Mayers, & Allen, 2002).

Two additional MC flight phobia treatments used computerized image exposure. In one study, adding relaxation and information, to computer-assisted image exposure in a TA format actually detracted from the efficacy of MC image exposure alone although both were superior to waitlist (Bornas, Tortella Feliu, Llabres, & Fullana, 2001). However, contrary to findings for VR suggesting that exposure was an important element of treatment, MC computer-aided exposure plus flight sounds did not add anything above and beyond cognitive therapy, breathing retraining, and relaxation (Bornas, Tortella-Feliu, & Llabrés, 2006), suggesting that perhaps computer image exposure is not optimal for the treatment of flight phobia.

In terms of TA treatments for flight phobia, VR exposure (simulated flights including take-off and landing) plus anxiety management training was not significantly different from therapist-guided in vivo exposure (to airport stimuli and a parked airplane) plus anxiety management training, and both were superior to waitlist (Rothbaum, Hodges, Smith, Lee, & Price, 2000; Rothbaum, Hodges, Anderson, Price, & Smith, 2002; Rothbaum et al., 2006) with gains maintained after September 11th and at 2.3 year follow-up (Anderson et al., 2006).

#### 3.6.4. Spider phobia

In the treatment of spider phobia all SA treatments made use of computer-aided vicarious exposure. Results indicated that 3 SA computer sessions were not different from 6 sessions (Fraser, Kirkby, Daniels, Gilroy, & Montgomery, 2001), and in the treatment of children, 3 sessions were superior to waitlist (Dewis et al., 2001). However, relevant SA vicarious exposure plus feedback was not superior to irrelevant SA vicarious exposure with feedback (Smith, Kirkby, Montgomery, & Daniels, 1997). Also, whereas MC in vivo graded exposure was not significantly different from SA vicarious exposure in one study (Gilroy, Kirkby, Daniels, Menzies, & Montgomery, 2000, 2003) it was superior in three studies (Dewis et al., 2001; Heading et al., 2001; Nelissen, Muris, & Merckelbach, 1995). Moreover, although SA vicarious exposure was superior to progressive muscle relaxation at 3-month

follow-up (Gilroy et al., 2000), it was not different at 33-month follow-up (Gilroy et al., 2003), suggesting that SA vicarious exposure is not an optimal treatment of spider phobia.

Spider phobia treatments involving more time and making use of different methods showed more promise. For example, PSH in vivo exposure was superior to Internet-assisted exposure on clinically significant change at post-treatment using a behavioral avoidance test. Nonetheless, there were no longer any significant differences between the compared treatments at 1-year follow-up (Andersson, Waara, Jonsson, Malmaeus, Carlbring, & Öst, 2009) at which time additional gains had been demonstrated within the Internet-assisted treatment. For MC treatments, an open trial of MC VR exposure led to significant change on subjective, behavioral, and physiological outcome measures at post-assessment (Côté & Bouchard, 2005). Additional controlled studies of MC VR exposure found that it was superior to both waitlist (Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002) and no treatment at post-assessment (Hoffman, Garcia Palacios, Carlin, Furness, & Botella Arbona, 2003). Moreover, tactile augmentation improved upon MC VR exposure alone (Hoffman et al., 2003).

#### 3.6.5. Summary and conclusions for simple phobia

Within the domain of simple phobias, more studies are needed on claustrophobia, driving phobia, and acrophobia. However, for acrophobia 2–3 h of VR exposure was not significantly different from the same amount of time for in vivo exposure (Emmelkamp et al., 2001). In treatment for flying phobia adding physiological feedback or cognitive therapy may enhance the efficacy of MC virtual reality exposure. Nonetheless, the minimum contact time for VR for flight phobia that has demonstrated comparability to in vivo exposure is 8.5 h (Rothbaum et al., 2002). Also, vicarious exposure was not as helpful as therapist directed exposure in the treatment of spider phobia. However, as little as 25 min email contact plus an Internet intervention for spider phobia was not significantly different from 3 h of therapist directed exposure at 1-year follow-up suggesting that Internet treatment for this disorder is promising.

Nonetheless, conclusions for simple phobia come with several caveats. First, almost all of these studies had small cell sizes, limiting their power to find differences between compared conditions (see Table 1). Thus, it is not clear whether nonsignificant findings were meaningful. Further, almost all of the studies involved virtual reality or computer-assisted exposure methods used in a lab or clinic, thus other technology-guided methods of treating simple phobias and methods to treat people at home have yet to be fully explored. Moreover, it was rare that studies assessed reliability of the diagnoses and in the use of simple phobia technologies there has been little documentation of degree of compliance with the treatment. Ultimately, more research is needed regarding the optimal amount of therapist contact when using technology-based exposure treatments for simple phobias.

## 4. Technology-based depression treatments

Computer technologies have also been used to treat of depression. Whereas most studies focused on current depression, including in caregivers of Alzheimers' patients (Eisdorfer et al., 2003), and in current inpatients (Bowers, Stuart, MacFarlane, & Gorman, 1993), several studies focused on prevention of future depression (O'Kearney, Gibson, Christensen, & Griffiths, 2006; O'Kearney, Kang, Christensen, & Griffiths, 2009; Seligman, Schulman, & Tryon, 2007; Van Voorhees et al., 2009). Most studies employed CBT, however, Eisdorfer et al. (2003) incorporated family therapy for Alzheimer's caregivers. The technological devices included Internet-based websites, computer programs located in the clinic, and telephone systems, including computerized interactive voice response, as well as a computer-telephone integrated system (CTIS). The CTIS could be used to contact family members and therapists, engage conference calls, as well as to access information helpful to Alzheimer's caregivers.

### 4.1. Subthreshold depression

Only a few studies have employed SA interventions and all of these treatments targeted individuals with subthreshold depression. Results indicated that an Internet program accessed from home was superior to waitlist and not significantly different from 10 sessions of group CBT at post-treatment and 1-year follow-up (Spek et al., 2007; Spek et al., 2008). Nonetheless, less than half of the Internet treated participants in this study completed all modules. Further, although an SA Internet treatment with multiple modules was more effective than a brief single module SA Internet treatment (Christensen, Griffiths, Mackinnon, & Brittliffe, 2006), only about 27% of participants actually completed either treatment. Similarly, an SA CBT website was not superior to information-only websites in an unselected sample of adults (Patten, 2003). Thus, an SA intervention may not be optimal for any group at risk for developing depression.

In PSH treatment of subthreshold depression, in a quasi-experimental study, an Internet CBT intervention delivered to classrooms of unselected adolescent girls was superior to usual self-development activities on depressive symptoms (O'Kearney et al., 2009). However, the same treatment delivered to unselected adolescent boys was not significantly different than standard self-development activities in reducing depression symptoms but it did improve self-esteem (O'Kearney et al., 2006). Also, when added to a CBT Internet treatment, a 5–10-minute physician directed motivational interview plus 3 motivational phone calls was superior to 1–2 min of physician advice (Van Voorhees et al., 2009). Nonetheless, although a PSH website plus weekly phone calls (Christensen, Griffiths, & Jorm, 2004) was superior to phone-based supportive listening, it was not significantly different from an information only website. In terms of MC and TA treatments, an MC Internet problem-solving therapy and an MC Internet CBT site were superior to a waitlist control with no differences between the two Internet treatments (Warmerdam, van Straten, Twisk, Riper, & Cuijpers, 2008). Also, a TA computer telephone integrated system plus family therapy (Eisdorfer et al., 2003) was superior to phone-based supportive listening. Moreover, a TA website plus group treatment for depression prevention (Seligman et al., 2007) did not lead to maintained gains at follow-up, emphasizing a need for further investigation into the long-term effects of computerized therapy for subthreshold depression.

### 4.2. Major depression

In the treatment of clinically diagnosed depression, in a PSH open trial, 75% of participants with major depression who called an IVR system 10 or more times over a 12 week period improved at post-assessment (Osgood-Hynes et al., 1998). In terms of MC interventions, a lab-based computer program with support staff (Selmi, Klein, Greist, Sorrell, & Erdman, 1990), and an MC therapy plus laboratory-based computer program (Wright et al., 2005) were superior to waitlist or no treatment controls. Further, an MC Internet treatment plus Internet based discussion group was superior to the discussion group alone in participants with self-reported mild to moderate depression (Andersson et al., 2005). In addition, a 120-minute lab-based computer program was not significantly different from 360 min of face-to-face therapy (Selmi et al., 1990) and a 250-minute lab-based computer program was not significantly different from 450 min of therapist delivered therapy (Wright et al., 2005).

With respect to therapist assisted interventions, a TA Internet site plus email and phone reminders, led to a decline in level of depressive symptomatology in participants who were currently receiving adjunctive treatment for depression (Robertson, Smith, Castle, & Tannenbaum, 2006). Similarly, biofeedback delivered to depressed individuals receiving concurrent treatment led to

improved depressive symptoms and increased heart rate variability (Siepmann, Aykac, Unterdorfer, Petrowski, & Mueck-Weymann, 2008). A comparison to an information only website showed a TA CBT Internet site plus mail or phone-based reminder prompts was superior in participants who had also received medication or psychotherapy for their major depression (Clarke et al., 2005). In university students, a TA computer program used in conjunction with researcher assistance improved cognitive impairment and academic performance in addition to improving depressive symptoms, whereas antidepressants only improved depressive symptoms (Alvarez, Sotres, León, Estrella, & Sosa, 2008). Finally, a TA computer telephone integrated system plus family therapy was superior to the family therapy alone in the treatment of depressed caregivers of individuals with Alzheimer's disease (Eisdorfer et al., 2003). In terms of less positive results, an Internet site offered to depressed adults receiving adjunctive medical services as well as to nondepressed adults was not superior to a usual care control in the treatment of adult outpatients (Clarke et al., 2002). Also, TA computer CBT plus inpatient treatment was not superior to inpatient treatment alone and was inferior to therapist-delivered CBT plus inpatient treatment (Bowers et al., 1993).

### *4.3. Summary and conclusions regarding computer-based depression treatments*

In summary, more research is needed before determining the minimum contact required to confer efficacy for depression. In the treatment of subthreshold depression, a completely self-help Internet site was not less effective than group treatment (Spek et al., 2007; Spek et al., 2008), notwithstanding a large amount of attrition for both treatments and significantly lower compliance with the Internet site (Table 1). However, this finding has yet to be replicated and the low compliance may indicate that SA is not optimal for subthreshold depression. A PSH intervention that includes a brief motivational interview also holds some promise for subthreshold depression but has yet to be compared to either placebo or a therapist directed intervention. Nonetheless, for sites accessed from home, the latter intervention was associated with lower attrition and better compliance than the SA Internet treatment of Spek and colleagues and therefore appears more promising. For clinical levels of depression, PSH and SA computer treatments have not been tested without receipt of additional medical services. The most cost-effective option tested for these individuals was a 250-minute minimal contact treatment (Wright et al., 2005). However, similar to findings with subthreshold depression, this result has yet to be replicated.

As highlighted in Table 1, there were several methodological shortcomings to these studies. For instance, few studies assessed reliability of the diagnoses. As expected for online and telephone treatment, attrition levels were occasionally high, ranging from 2 to 37% and with compliance ranging from 30 to 90%. Five of these studies performed intent-to-treat analyses (Christensen et al., 2004; Clarke et al., 2002; Osgood-Hynes et al., 1998; Spek et al., 2007; Spek et al., 2008), and one found that noncompleters had higher levels of depression at baseline (Eisdorfer et al., 2003). Also, there were quite a few different systems used, each one developed by a different research group with little replication using the same system across or within research groups.

## 5. Conclusions and future directions

Overall, efficacy of computerized interventions has been demonstrated in the treatment of anxiety and depression. In particular, studies of mixed anxiety disorders, panic disorder, and social phobia are promising. However, similar to our prior review, there continues to be a pattern of lower compliance when technologies are used at home in conjunction with little or no human contact. A more thorough investigation into the utility of diverse technology-based treatments is needed for GAD, OCD, and PTSD. Although the most efficacious level of therapist contact varies by disorder, taking attrition and compliance rates into account, MC therapies have been most beneficial for the greatest variety of disorders, indicating that some structured interaction with a therapist is important in the treatment of various psychological problems.

Of course, there are newer technological advances yet to be tested therapeutically that go beyond our typical notions of computer-assisted treatment for anxiety and depression. For example, with technologies such as Skype or Voice over Internet Protocols (VoIP), therapists have a variety of options for distal contact with clients that can include visual imagery, and this type of contact is increasing in popularity (see Strong, 2010, July 30). In the future it even may be possible for entire therapy groups to be conducted using this technology, with each individual in a different location. There have also been many advances in the world of interactive VR, such as Second Life, There, and Active Worlds, in which multiple users can interact in simulated environments, increasing the experience of social presence (Gorini, Gaggioli, Vigna, & Riva, 2008). This technology opens up new possibilities for exposure treatment for anxiety and behavioral activation for depression, in which the client and therapist may interact in the virtual world together, or the client can interact virtually with social groups. Moreover, combining extant technologies such as global positioning systems (GPS), ambulatory electrophysiological monitoring, and telephone contact would allow therapists to coach clients distally through real-world exposure techniques. Other possibilities that haven't been fully explored include Wii-like wireless controllers, automated text-messaging, personal digital assistant, physiological feedback, and smartphone technology that allows ongoing data collection and transmission. Such technologies also increase possibilities for automated ecological momentary intervention (Heron & Smyth, 2010). While this is by no means an exhaustive review of available new technologies, we feel it is important to provide a glimpse at possible future technologies and their potential for treatment.

Whereas results of the studies reviewed in this article suggest the promise of technology-based treatment, they are limited by various methodological problems. Very few studies included any follow-up assessments, thereby limiting our knowledge about the long-term effects of these treatments. Further, very few studies examined whether the technology-based treatment led to clinically significant change or even whether clients met diagnostic criteria for the treated disorder at post-therapy. This severely limits the conclusions that may be drawn regarding the utility and efficacy of these treatments. In addition, it is often the case that each research group has developed a separate idiosyncratic version of VR, Internet treatments, etc. Also none of the researchers has provided any data about the quality of their software, level of engagement/immersion experienced, and/or the ability of the software to facilitate learning. This makes it difficult to know whether failures to demonstrate efficacy in some cases, are due to a problem with the software version versus a problem with the approach more broadly. Moreover, researchers have not yet made full use of mobile phone and palmtop software, automated text messaging, physiological feedback, and other ambulatory technologies in the treatment of anxiety disorders and depression.

In addition to examining diagnosis at post-treatment, the feasibility and efficacy of technology-based treatments must be evaluated for individuals from varying geographic areas, socioeconomic statuses, and age groups. To date few studies have evaluated the efficacy of computer-assisted therapy for children and no studies examined the feasibility of these treatments in specialized or diverse populations, subsequently limiting the conclusions that may be drawn about these treatments. Additionally, dismantling studies should determine the therapeutic and technological components of treatment that are required for optimal efficacy and client satisfaction. Finally, future studies should examine the effect of technology-based treatments on comorbid conditions. As technological innovations

continue to develop, the efficacy, portability, and feasibility of the use of technology should continue to grow, bringing with it new and exciting mental health applications.

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