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Computer-Aided Psychotherapy for Anxiety Disorders: A Meta-Analytic Review

Pim Cuijpers[1], Isaac M. Marks[1,2], Annemieke van Straten[1], Kate Cavanagh[3], Lina Gega[4] and Gerhard Andersson[5,6]

[1]*Department of Clinical Psychology, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands;* [2]*Institute of Psychiatry, King's College London, London;* [3]*School of Psychology, University of Newcastle and Northumberland, Newcastle-upon-Tyne, UK;* [4]*School of Medicine, Health Policy and Practice, University of East Anglia, Norwich, UK; and* [5]*Department of Behavioural Sciences and Learning, Linköping University, Linköping, and* [6]*Department of Clinical Neuroscience, Psychiatry Section, Karolinska Institutet, Stockholm, Sweden*

Abstract. Computer-aided psychotherapy (CP) is said to (1) be as effective as face-to-face psychotherapy, while requiring less therapist time, for anxiety disorder sufferers, (2) speed access to care, and (3) save traveling time. CP may be delivered on stand-alone or Internet-linked computers, palmtop computers, phone-interactive voice response, DVDs, and cell phones. The authors performed a meta-analysis of 23 randomised controlled studies (RCTs) that compared CP with non-CP in anxiety disorders: phobias, $n=10$; panic disorder/agoraphobia, $n=9$; PTSD, $n=3$; obsessive–compulsive disorder, $n=1$. Overall mean effect size of CP compared with non-CP was 1.08 (95% confidence interval: 0.84–1.32). CP and face-to-face psychotherapy did not differ significantly from each other (13 comparisons, $d=-0.06$). Much caution is needed when interpreting the findings indicating that outcome was unrelated to type of disorder, type of comparison group, mode of CP delivery (Internet, stand-alone PC, palmtop), and recency of the CP system and that effect size decreased when more therapist time was replaced by the computer. Because CP as a whole was as effective as face-to-face psychotherapy, certain forms of CP deserve to be integrated into routine practice. *Key words: Computer-aided psychotherapy; anxiety disorders; Internet therapy; meta-analysis.*

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Correspondence address: Pim Cuijpers, Department of Clinical Psychology, Vrije Universiteit Amsterdam, Van der Boechorststraat 1, 1081 BT Amsterdam, The Netherlands. Tel: +31 20 598 8757; Fax: +31 20 598 8758. E-mail: P.Cuijpers@psy.vu.nl

Anxiety disorders affect about one in six people during their lifetime (Somers, Goldner, Waraich, & Hsu, 2006). The disorders often cause marked impairment in the quality of life of patients and their family (Angermeyer, Kilian, Wilms, & Wittmund, 2006; Mendlowicz & Stein, 2000; Wittmund, Wilms, Mory, & Angermeyer, 2002) and incur major costs (DuPont et al., 1996; Greenberg et al., 1999). Anxiety disorders are estimated to cost, directly and indirectly, about half a billion dollars per year per 1 million adults (Smit et al., 2006).

The burden of anxiety disorders may be eased substantially by effective brief psychotherapy (National Institute for Clinical Excellence [NICE], 2004). Psychotherapy has even been effective when therapist contact was minimal, with most of the therapy tasks being delegated to a self-help book (Hirai & Clum, 2006) or computer-aided cognitive behavioural therapy (Marks, Cavanagh, & Gega,

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2007). However, most anxiety disorder sufferers do not seek professional help (Bijl, Ravelli, & van Zessen, 2002; Haaga, 2000). When they do, they are commonly put on long wait lists (Lovell & Richards, 2000), and the treatment that they eventually receive is often not evidence-based (Andrews, Issakidis, Sanderson, Corry, & Lapsley, 2004). It is, therefore, important to develop evidence-based help that patients can access easily and that requires little time from a therapist (Hirai & Clum, 2006).

These requirements are met by some computer-aided psychotherapies (CPs). CP systems use patient input to guide some, and at times even most, treatment decisions (Marks et al., 2007; Marks, Shaw, & Parkin, 1998). CP may be delivered on all kind of devices, such as stand-alone or Internet-linked computers, palmtop computers, smartphones, phone-interactive voice response (IVR), CD-ROMS, DVDs, USB sticks, cell phones, and virtual reality equipment (Marks et al., 2007).

CP is becoming increasingly easy to access on the Internet. Some CP systems are as effective as face-to-face care despite requiring far less therapist time (e.g. Carlbring et al., 2005; Ghosh, Marks, & Carr, 1988; Kenardy, McCafferty, & Rosa, 2003; Marks, Kenwright, McDonough, Whittaker, & Mataix-Cols, 2004). They may also speed access, allow patients to work at their own pace, and abolish the need to schedule appointments with a therapist (Carlbring & Andersson, 2006). Further, they may save travel time and reduce stigma incurred by going to a therapist, increase confidentiality, and ease access to help for the hearing impaired when CP, as is usually the case, uses more visual than auditory information (Marks et al., 2007). Certain CP systems can also automatically report patient progress and self-ratings, have the potential of raising motivation by presenting attractive audiovisual information with voice-overs in whichever gender, age, accent, language, and perhaps game format the client prefers, enhance confidentiality, and speed research into which ingredients of psychotherapy are effective; every keystroke made by users can be recorded for subsequent analysis (Marks et al., 2007). CP also has disadvantages: technophobic patients may avoid it; it cannot answer all possible questions users may ask; it cannot detect subtle nonverbal and verbal clues to clients' misunderstandings; it may stimulate clients to cherry-pick from a range of homework options presented; and not all clients find CP acceptable (Marks et al., 2007).

In the past decade, many randomised controlled trials (RCTs) for anxiety disorders examined the effects of CP (e.g. Cavanagh & Shapiro, 2004; Marks, Shaw, & Parkin, 1998; Newman, Erickson, Przeworski, & Dzus, 2003). Very few were meta-analyses, and they focused on only certain kinds of CP studies, such as Internet-based CP (Spek et al., 2007) or on economic outcomes, and included only a handful of studies (Kaltenthaler et al., 2006; Kaltenthaler, Shackley, Beverley, Parry, & Chilcott, 2002). This meta-analysis differs from currently available reviews in that it pools together not only all different types of CP programs and delivery systems (Internet, stand-alone PC, IVR, palmtop computer) but also all different types of anxiety disorders (panic disorder/agoraphobia, social phobia, specific phobia, obsessive–compulsive disorder [OCD], posttraumatic stress disorder [PTSD], generalized anxiety disorder [GAD]). It builds on a comprehensive naturalistic review by three of the authors concerning English-language reports of CP for all mental health problems (Marks et al., 2007). This meta-analysis questions whether CP effectively improved symptoms and work/social function for anxiety disorder sufferers irrespective of type of computer system used or type of anxiety disorder treated.

Method

Identification and selection of studies

The studies were traced in several ways by Marks et al. (2007), who described their search methods in detail. First, the bibliographic databases Cochrane Library, Cinahl, Medline, PsychInfo, Social Sciences Citation Index, and Embase were searched with key and text words indicating the presence of any mental health problem, psychological treatment, and computers. This review concerns only anxiety disorders. Second, known experts in CP and members of the International Society for Research on Internet Interventions (Ritterband, Andersson, Christensen, Carlbring, & Cuijpers, 2006) were e-mailed invitations to send relevant manuscripts

under review or in press, conference papers, and dissertations and were asked if they knew any other work in the field. Third, key relevant journals (e.g. *International Journal of Human-Computer Interaction, Computers in Human Behavior, CyberPsychology and Behaviour*) were hand-searched for gray literature, which may not appear in medical databases. Fourth, the programs and abstracts of many conferences and the reference lists of further relevant papers were scanned to find studies that met Marks et al.'s inclusion criteria. Fifth, the references of retrieved studies and earlier reviews were searched. The main searches were closed in May 2006 (Marks et al., 2007), but we conducted an extra literature search (closed March 2008) to locate additional studies reported since then.

Studies were included in this meta-analysis if they (1) compared the effects of CP with a contrast group or a face-to-face psychotherapy, (2) covered anxiety disorders (panic disorder, agoraphobia, social phobia, specific phobia, OCD, PTSD, GAD), (3) used adult participants, and (4) had a randomised design. Only English-language studies were included. We excluded studies that compared two active CP treatments with one another (e.g. Fraser, Kirby, Daniels, Gilroy, & Montgomery, 2001; Newman et al., 1997; Schneider et al., 2005), as well as studies that also included patients with subclinical or nondiagnostic anxiety and stress-related problems (Dolezal-Wood, Belar, & Snibbe, 1998; Wagman & Kerber, 1984; Zetterqvist, Maanmies, Ström, & Andersson, 2003), studies that were aimed at children or adolescents (Dewis et al., 2001; Spence, Holmes, March, & Lipp, 2006), and studies that were not clearly aimed at patients with anxiety disorders (Jacobs et al., 2001; Slack, Porter, Balkin, Kowaloff, & Slack, 1990).

Quality assessment

At least 25 scales have been used to assess the validity and quality of RCTs (Higgins & Green, 2006), but evidence of their reliability and validity is lacking. We adopted three of the four *Cochrane Handbook* criteria (Higgins & Green, 2006) to assess study validity: (1) randomization to conditions done by an independent (third) party; (2) blinding of assessors to outcome; (3) completeness of follow-up data. We did not check for the fourth criterion for validity (adequacy of random allocation concealment to respondents) because it was not possible in these studies to conceal the randomization to patients.

Analyses

We calculated effect sizes (ESs; Cohen's *d*) by subtracting (at posttest) the mean score of the control group (M_c) from the mean score of the experimental group (M_e) and dividing the result by the pooled standard deviations of the experimental and the contrast groups (SD_{ec}). An ES of 0.5 thus indicates that the mean of the experimental group is 0.5 *SD* larger than the mean of the contrast group. ESs of 0.80 and higher can be assumed to be large, whereas ESs of 0.50 to 0.79 are moderate, and lower effect sizes are small or zero (Cohen, 1977).

We examined outcome on three types of measure—anxiety, depression, and quality of life—doing all analyses separately for each. These instruments could be administered during a clinical interview, as a self-report paper-and-pencil questionnaire, or as a self-report instrument through the Internet.

If any of the three types of measure were rated on more than one scale, then the mean of the ESs of all relevant scales for each specific type was calculated. This resulted in one mean ES for anxiety, one for depression, and one for quality of life.

We also tried to examine ESs for each scale used but found that no scale was used in more than four studies, and we considered this number to be too small to do specific analyses. When means and standard deviations were not reported, we used other statistics (*t* value, *p* value) to calculate ESs.

To calculate pooled mean effect sizes, we used the computer program *Comprehensive Meta-Analysis* (version 2.2.021; Biostat 2007), developed for support in meta-analysis. Both the random- and the fixed-effects models were used to see whether any differences would emerge. The fixed-effect model assumes that all studies in the meta-analysis are replications of each other. The random-effects model makes the more relaxed assumption that the studies included are a sample drawn from a "population" of studies, and each primary study is allowed to introduce its own amount of heterogeneity into the meta-analysis. This is reflected, for instance, in the broader 95%

confidence intervals usually observed with the random-effects model and its more conservative test results. In the presence of significant heterogeneity that cannot be explained by observed moderators, the safer choice is to rely on the random-effects model (Hedges & Vevea, 1998).

As indicators of heterogeneity of pooled ESs, we calculated (1) the Q statistic and (2) the I^2 statistic, which yields heterogeneity in percentages (0%=no, 25%=low, 50%=moderate, 75%=high heterogeneity of ES). We performed subgroup analyses using the mixed-effects procedures from *Comprehensive Meta-Analysis* version 2.2.021. In these analyses, studies within subgroups are pooled with the random-effects model and the significance of differences between subgroups is tested with the fixed-effects model.

Publication bias was tested by inspecting the funnel plot on the primary outcome measures (effects on anxiety at posttest) and by Duval and Tweedie's (2000) trim-and-fill procedure, which yields an estimate of the pooled ES after taking publication bias into account (as per *Comprehensive Meta-Analysis*, version 2.2.021). We also calculated Orwin's fail-safe N to show how many studies with an ES of 0 should be found to reduce the ES to a smaller value (e.g. 0.20). A larger N indicates that the ES found can be generalized further.

Finally, we compared dropout rates with CP versus face-to-face psychotherapy. We assumed dropout rate to be a dichotomous variable, although, in fact, it can have widely varying meanings across studies, from not even entering the RCT postrandomisation to entering the RCT but not completing various stages of the RCT. We calculated the odds ratio (OR) of dropout rates with CP versus face-to-face psychotherapy (instead of a standardized ES). Again, we performed all meta-analyses with both the fixed-effects model and the random-effects model, using the *Comprehensive Meta-Analysis* (version 2.2.021) program, and calculated the Q and the I^2 statistics to estimate heterogeneity.

Results

Description of included studies

All inclusion criteria were met by 23 RCTs. These tested the effects of 14 CP systems. Selected characteristics of the 14 systems are presented in Table 1 and of the 23 RCTs in Table 2. Of the 14 CP systems, four were for panic/agoraphobia, seven for other phobias (two spider phobia, two social phobia/social anxiety disorder, one flight phobia, two mixed phobias), two for PTSD, and one for OCD. All the systems used cognitive behavioural therapy including or limited to guided self-exposure. Access was by Internet (n=6), stand-alone computer (n=5), palmtop computer (n=2), or IVR (n=1). One of the systems was tested in four studies, another system in three, and five systems in two. Each of the remaining seven systems was studied in only one RCT.

In 19 studies, participants were recruited openly; the remaining four studies took clinical referrals or did not report the recruitment method. Ten studies were aimed at participants with a phobia (spider phobia, n=3; social phobia, n=3; flight phobia, n=2; all phobias, n=2), nine at participants with panic/agoraphobia, three at participants with PTSD, and one at participants with OCD. In 21 of the 23 studies, the presence of the anxiety disorders met the *Diagnostic and Statistical Manual of Mental Disorders* or *International Classification of Diseases* criteria. Six of the studies were conducted in Sweden, five in Australia, four in the United States, three in the United Kingdom, and four in other European countries (the Netherlands, Switzerland, Spain), and one was a multicenter trial in the United Kingdom and Australia. More than half of the RCTs (13 studies; 57%) were published in 2003 or later.

Quality of included studies

The quality of studies varied. Only eight reported allocation to conditions by an independent party. Blinding of assessors was reported in seven studies (Bornas, Tortella-Feliu, & Llabrés, 2006; Carlbring et al., 2005, 2006; Ghosh et al., 1988; Greist et al., 2002; Klein, Richards, & Austin, 2006; Marks et al., 2004). Dropout ranged from 2 to 29% (two studies did not report dropout; Bornas, Tortella-Feliu, Llabrés, & Fullana, 2001; Hassan, 1992). In 11 studies (Andersson et al., 2006; Carlbring, Ekselius, & Andersson, 2003; Carlbring, Westling, Ljungstrand, Ekselius, & Andersson, 2001; Carlbring et al., 2005, 2007; Greist et al., 2002; Kenardy et al., 2003; Klein et al., 2006; Knaevelsrud et al., 2007; Marks et al., 2004;

Table 1. *Computer-aided psychotherapy systems for the treatment of anxiety disorders*

Name	Disorder	Intervention	System	Homework	Format	Therapist support	Effect studies
Panikprojektet	Panic	Web-based CBT self-help on cognitive restructuring, exposure, relaxation (depending on version)	6–10 web modules (depending on version) with information and exercises + discussion forum	Yes	Internet	Weekly feedback on homework through e-mail	Carlbring et al., 2001, 2003, 2005 2006
CAVE	Spider phobia in adults or children	Stepwise exposure	3 exposure sessions (40–45) or 1 session (3 hr)	No	PC stand-alone	Therapist stays with patients during the first 5 min of first session to answer questions	Fraser et al., 2001; Gilroy et al., 2000; Heading et al., 2001
CAFFT	Flight phobia	Stepwise exposure	6 exposure sessions (50 min)	No	PC stand-alone	Therapist is present during treatment sessions	Bornas et al., 2001, 2006
No name	Panic	Exposure + standard cognitive and behavioral techniques	6 FTF sessions (1 hr); palmtop used for help in homework assignments	Yes	Palmtop computer	FTF treatment, with palmtop as help (5 times/day help in breathing control and exposure	Newman, 1997; Kenardy et al., 2003
SOFIE	Social phobia	Web-based self-help on cognitive restructuring and exposure	9 web modules with information + exercises, discussion forum	Yes	Internet	Study 1: 2 live FTF sessions + weekly feedback on homework (e-mail) Study 2: weekly telephone calls	Andersson et al., 2006; Carlbring et al., 2007
Panic Online 2	Panic	Web-based CBT	6 web modules (controlled breathing, cognitive restructuring, exposure)	Yes	Internet	Feedback and support by e-mail	Klein et al., 2006; Richards et al., 2006
Interapy	PTSD	CBT (self-confrontation; cognitive reappraisal; sharing + farewell ritual)	10 structured writing assignments (45 min; 2 per week)	Yes	Internet	7 times feedback on writing assignments through Internet	Lange et al., 2003 Knaevelsrud, 2007

Table 1. (*Continued*)

Name	Disorder	Intervention	System	Homework	Format	Therapist support	Effect studies
No name	Phobia/panic	Stepwise exposure	8 sessions	Yes	PC stand-alone	5–10 min contact with psychiatrist at each session	Ghosh et al., 1988
FearFighter	Phobia/panic	Stepwise exposure	6 sessions (1 hr), 9 modules (steps)	Yes	PC stand-alone	5 min before + 15 min after each session (coaching, reviewing progress, advice)	Marks et al., 2004
BT steps	OCD	Stepwise exposure with ritual prevention	9 IVR steps (17 weeks access to system)	Yes	IVR computer system	9 therapist-initiated phone calls at set appointments over 17 weeks	Greist et al., 2002
No name	Social phobia	Exposure, cognitive restructuring, generalization	8 FTF sessions (2.5 hr); palmtop used for homework assignment help	Yes	Palmtop computer	FTF treatment, with palmtop as help in cognitive restructuring before entering fearful situation	Gruber et al., 2001
CBSM	Spider phobia	Exposure	5 sessions	No	PC stand-alone	Therapist receives patient and briefly describes program/how to work with it	Hassan, 1992
Panic Online 1	Panic	2 web-based modules with information on panic and coping with it	NR	No	Internet	None	Klein & Richards, 2001
SHTC	PTSD	Information, relaxation, cognitive restructuring; exposure	8-week Internet sessions with writing assignments	Yes	Internet	No contact with therapist	Hirai & Clum, 2005

Note. *CAVE=computer-aided vicarious exposure; CAFFT=computer-assisted fear of flying treatment; CBSM=computer-based symbolic modeling; NR=not reported; SHTC=self-help program for traumatic event-related consequences; SBT=cognitive behavioural therapy; PTSD=posttraumatic stress disorder; OCD=obsessive–compulsive disorder; FTF=face to face; IVR=interactive voice response.*

Table 2. *Selected characteristics of included studies*

Study	Target group	Disorder	Recr	Diagnosis	Conditions	*N*	Sys	Measurements	Measures[a]	Country
Andersson et al., 2006	Adults (⩾18)	Social phobia	Com	DSM-IV/SCID	1. CP+2s FTF 2. WL	32 32	5	Pre, post, 1 yr	LSAS, SPS, SIAS, SPSQ, PRCS, BAI	Sweden
Bornas et al., 2001	Adults (⩾18)	Flight phobia	Com	DSM-IV/ADIS	1. Computer-aided exposure 2. FTF+CP 3. WL	15 18 17	3	Pre, post, 6 mo	FFQ	Spain
Bornas et al., 2006	Adults (⩾18)	Flight phobia	Com	DSM-IV/ADIS	1. Computer-aided exposure 2. Nonexposure	19 21	3	Pre, post, 6 mo	FFQ, FFS	Spain
Carlbring et al., 2001	Adults (18–60)	Panic	Com	DSM-IV/ ADIS+CIDI-SF	1. CP 2. WL	21 20	1	Pre, post BAI	Diary, BSQ, MI,	Sweden
Carlbring et al., 2003	Adults (18–60)	Panic	Com	DSM-IV/SCID	1. CP 2. CP-relaxation	11 11	1	Pre, post	Diary, BSQ, MI, BAI	Sweden
Carlbring et al., 2005	Adults (18–60)	Panic	Com	DSM-IV/SCID	1. CP 2. FTF	25 24	1	Pre, post, 1 yr	BSQ, MI, BAI	Sweden
Carlbring et al., 2007	Adults (⩾18)	Social phobia	Com	DSM-IV/SPSQ/ SCID	1. CP 2. WL	29 28	5	Pre, post, 1 yr	LSAS, SPS, SIAS, SPSQ, BAI	Sweden
Carlbring et al., 2006	Adults (18–60)	Panic	Com	DSM-IV/SCID/ ADIS	1. CP 2. WL	30 30	1	Pre, post, 1 yr	BSQ, MI, BAI	Sweden
Ghosh et al., 1988	Adults (16–60)	Phobia/panic	Clin	ICD-9	1. CP-FF 2. FTF 3. Book	28 19 24	8	Pre, post, 1, 3, & 6 mo	FQ	UK
Gilroy et al., 2000	Adults (16–60)	Spider phobia	Com	DSM-IV/CIDI	1. CP 2. FTF exposure 3. Relaxation CTR	15 15 15	2	Pre, post, 3 mo	BAT, SQ, FQ, PP, PT	Australia
Greist et al., 2002	Adolescents adults (15–80)	OCD	Com	DSM-IV/SCID	1. CP 2. FTF 3. Rel CTR	74 69 75	10	Pre, post	YBOCS, PGI, CGI	US
Gruber et al., 2001	Adults (25–60)	Social phobia	Com	DSM-III-R/ADIS	1. CP-PT 2. FTF-CBT 3. WL	18 18 18	11	Pre, post, 6 mo	FNE, SPAI, SPS	US

Table 2. (*Continued*)

Study	Target group	Disorder	Recr	Diagnosis	Conditions	*N*	Sys	Measurements	Measures[a]	Country
Hassan, 1992	Adults	Spider phobia	Com	DSM-III-R	1. CP 2. Exposure 3. Live modeling 4. WL	10 9 11 8	12	Pre, post	BAT, FS, SPQ, FA	UK
Heading et al., 2001	Adults (16–65)	Spider phobia	Com	DSM-IV/CIDI	1. FTF exposure 2. CP 3. WL	14 13 13	2	Pre, post, 1 mo	BAT, SPQ, FQ, PT	Australia
Hirai & Clum, 2005	Adults (⩾18)	PTSS	Com	Traumatic event	1. CP 2. WL	18 18	14	Pre, post	STAI, IESR, SRQ	US
Kenardy et al., 2003	Adults (18–60)	Panic	Clin -GP/com	DSM-IV panic disorder	1. CBT 12 sess. 2. CBT 6 sess. 3. CBT 6 s+PT 4. WL	42 39 41 41	4	Pre, post, 3, 6 mo	FQ, MIA, BSQ, STAI-T	Australia/ UK
Klein & Richards, 2001	Adults	Panic	NR	DSM-IV	1. CP 2. Self-monitored CTR	11 12	13	Pre, post	Prime MD, PARF, DRF, ASI	Australia
Klein et al., 2006	Adults (18–70)	Panic	Com	DSM-IV/ADIS 2. Self-adm CBT 3. Info CTR	1. CP 18 18	19	6	Pre, post, 3 mo DASS	PAQ, PDSS,	Australia
Knaevelsrud 2007	Adults (18–68)	PTSD	Com	Symptoms of PTSD	1. Internet CBT 2. WL	49 47	7	Pre, post, 3 mo	IES, BSI, SF-12	Switzerland
Lange et al., 2003	Adults (⩾18)	PTSD	Com	Symptoms of PTSD	1. CP 2. WL	69 32	7	Pre, post, 6 wk	IES, SCL-90	NL
Marks et al., 2004	Adults	Phobia/panic	Clin referral	DSM-IV; FQ-GP⩾4	1. CP–FF 2. FTF 3. CP-relaxation	37 39 17	9	Pre, post, 3 mo	MPG, FQ-GP	UK
Newman, 1997	Adults (18–65)	Panic	Com	DSM-IV/SCID	1. CP 2. FTF	10 10	4	Pre, post, 6mo	MI, PA, FQ-A, FQ-T, BSQ	US
Richards,	Adults 2006	Panic (18–70)	Com	DSM-IV/ADIS	1. CP-CBT 2. CP-CBT+SM 3. Info CTR	12 11 9	6	Pre, post, 3 mo	C-PD, PDSS, ASP, DASS, BVS	Australia

[a]*Only the instruments measuring anxiety are reported.*

Note. *Recr=recruitment; Sys=system (as described in Table 1); com=community recruitment; clin=clinical recruitment; GP=general practice; CP=computer-aided psychotherapy; FTF=face-to-face treatment; WL=wait list; CTR=control; CBT=cognitive behavioural therapy; sess=sessions; PT=palmtop; self-adm=self-administered; info=information; DSM-IV*=Diagnostic and statistical manual of mental disorders*, 4th edition. For the abbreviations of the measurement instruments, the reader is referred to the original reports.*

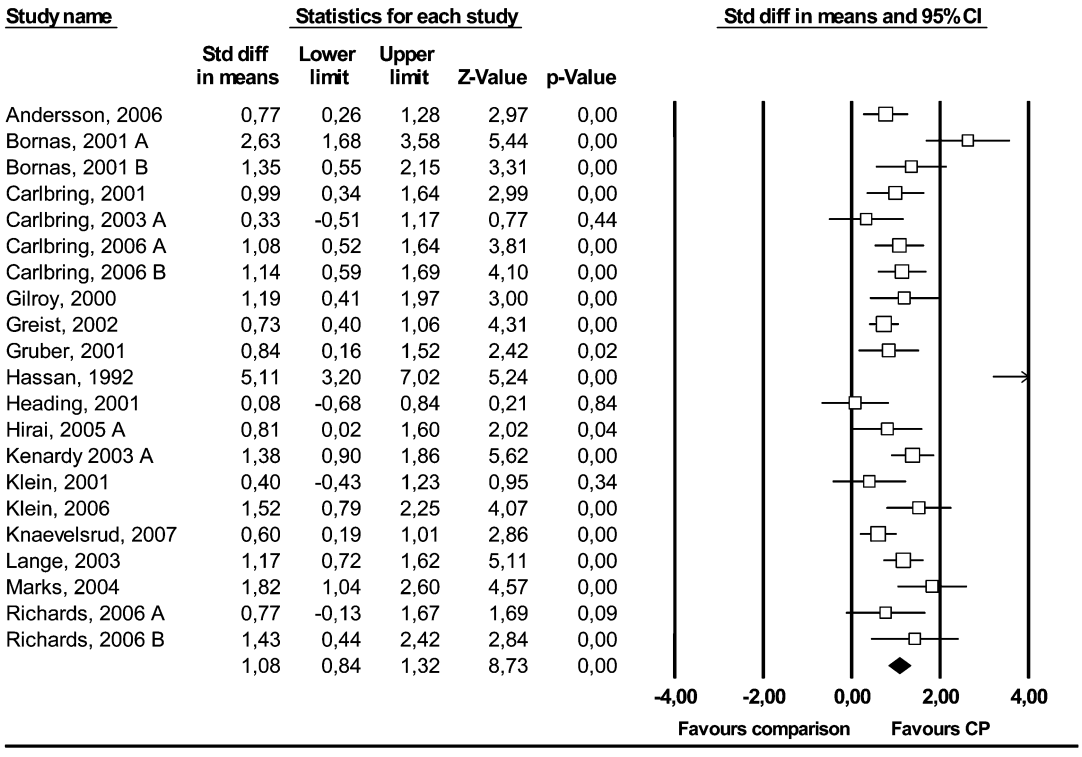

Figure 1. Standardized effect sizes of computer-aided psychotherapy for anxiety disorders compared with control conditions at posttest. Distinguishing letters refer to different comparisons within each study.

Richards et al., 2006), intention-to-treat analyses were made using all patients who were randomized, whether or not they dropped out from the intervention or study; the remaining RCTs reported only analyses of completers, which may distort the results considerably (Clark, 2005).

Effects of CP compared with contrast conditions at posttest

The mean ES indicating the difference in anxiety between CP and contrast conditions at posttest was $d=0.99$ (95% confidence interval [CI]: 0.86–1.13) according to the fixed-effects model and $d=1.08$ (95%CI: 0.84–1.32) according to the random-effects model. Heterogeneity was moderate to high ($I^2=65.59$). We show the ESs and 95%CIs of the individual control groups in Figure 1.

Visual inspection of Figure 1 suggests that the studies by Hassan (1992) and Bornas (2001) were possible outliers. On removing these two studies from the analyses, the ES dropped somewhat ($d=0.94$; 95%CI=0.80–1.08 in the fixed-effects model), but heterogeneity fell considerably to a low to moderate level ($I^2=36.22$). Both studies had a therapist present throughout the CP sessions and used as much therapist time as face-to-face care, which may explain why they were outliers.

We had included four studies in our analyses in which relaxation was used as a contrast condition. However, it is not clear whether relaxation is an active treatment or not. Relaxation has been used as a control condition in a considerable number of studies, whereas others have used it as an active treatment (Manzoni, Pagnini, Castelnuovo, & Molinari, 2008). There is also evidence that relaxation is an effective treatment for anxiety disorders in itself (Manzoni et al., 2008). This is especially true for applied relaxation (Ost, 1988; Ost & Breitholtz, 2000), although this is not supported by all studies (Arntz & van den

Hout, 1996). We conducted sensitivity analyses to examine whether the inclusion of relaxation as a contrast condition influenced our results. First, we conducted a subgroup analysis to examine whether studies with relaxation as a contrast condition had a different outcome than other studies. We found no indication that studies with relaxation as a contrast group ($N=4$; $d=0.99$; 95%CI: 0.43–1.55; $Z=3.51$, $p<.001$; $Q=8.61$, $p<.05$; $I^2=65.17$) differed significantly ($p>.1$) from those in which a wait list was used ($N=11$; $d=0.95$; 95%CI: 0.74–1.15; $Z=9.02$, $p<.001$; $Q=14.22$, *ns*; $I^2=29.69$) or in which another contrast condition was used ($N=4$; 1.03; 95%CI: 0.49–1.58; $Z=3.72$, $p<.001$; $Q=4.91$, *ns*; $I^2=38.87$).

We also examined what happened when we removed the study in which applied relaxation was compared with Internet-based CBT (Carlbring et al., 2003). Removal of this study did not result in a considerably smaller or larger effect size (the resulting effect size of the three remaining studies: $N=3$; $d=1.17$; 95%CI: 0.51–1.84; $Z=3.49$, $p<.001$; $Q=6.82$, $p<.05$; $I^2=70.69$).

Because we found no indication that the relaxation studies were systematically different from the studies in which other contrast conditions were used, we decided to conduct the subsequent analyses with all studies (including those with relaxation as contrast group).

Orwin's fail-safe *N* (number of studies with an ES of zero that would reduce the mean ES to 0.20) was 71. The mean ES indicating the difference in quality of life between CP and contrast conditions at posttest (12 comparisons) was $d=0.46$ (95%CI: 0.30–0.62) with zero heterogeneity. The effects of CP on depression was $d=0.56$ (95%CI: 0.41–0.71, fixed-effects model), but in this analysis heterogeneity of ES was moderate to high ($I^2=61.93$).

Publication bias

Neither the funnel plots nor Duval and Tweedie's (2000) trim-and-fill procedure pointed to significant publication bias. The ES indicating the difference in anxiety between the CP and contrast groups did not change after adjustment for possible publication bias (the observed and adjusted ESs were the same).

Subgroup analyses

We performed several subgroup analyses with the ESs indicating the difference between experimental and contrast conditions on anxiety at posttest (Table 3). Subgroups we examined included type of contrast group (wait list, relaxation, other), type of disorder (panic/agoraphobia, social phobias, other phobias, other), type of computer system (Internet, stand-alone PC, palmtop computer), and recency of CP system (before 2005, 2005 and later). None of these subgroup analyses found significant differences in ES (see Table 3).

We also tried to examine the effects of the CP systems as described in Table 1, but only one of these systems was examined in three studies (with a contrast condition), and three systems were examined in two studies. In a subgroup analysis, the systems did not differ significantly in ES (see Table 3).

CP versus face-to-face psychotherapy

We analysed CP and face-to-face care in 13 comparisons (Table 4). The resulting ES was −0.06 (95%CI: −0.22 to 0.10, fixed-effects model), indicating a small, nonsignificant difference favouring face-to-face care. Heterogeneity was low to moderate ($I^2=35.53$). When we removed the two outliers, the mean difference remained small and nonsignificant ($d=-0.13$; 95%CI: −0.29 to 0.04, fixed-effects model), while heterogeneity dropped further ($I^2=22.46$).

We analysed subgroups for type of disorder (panic/agoraphobia, other phobias, other), system used (stand-alone PC, palmtop computer, other), and recency of the system (before 2005, 2005 and later). No significant differences between subgroups were found (see Table 4).

In a meta-regression analysis, we tested whether ES related to reduction in time patients spent with a therapist in CP versus face-to-face care by calculating the time ratio (time spent with a therapist in CP divided by the time spent with a therapist in face-to-face care). We could calculate this time ratio in 10 comparisons of CP versus face-to-face care (the two outliers were excluded). The time ratio related significantly to ES ($p<.05$). The point estimate of the slope was 0.48 (95%CI: 0.04–0.92). Figure 2 shows the scatter plot of ES as a function of the time ratio (the size of

Table 3. *Results of meta-analyses: posttest effects on anxiety of computer-aided psychotherapy versus comparison condition*

Variable	N_{comp}	Model	*d*	95%CI	*Z*	Q	I^2	*p*
			All studies					
Anxiety	21	FEM	0.99	0.86–1.13	14.57***	58.12***	65.59	
		REM	1.08	0.84–1.32	8.73***			
Two outliers excluded	19	FEM	0.94	0.80–1.08	13.60***	28.22 o	36.21	
		REM	0.96	0.78–1.14	10.54***			
			Subgroup analyses					
Contrast group								
Wait list	11	MEA	0.95	0.74–1.15	9.02***	14.22 (*ns*)	29.68	*ns*
Other	8	MEA	1.00	0.64–1.36	5.44***	13.96 o	49.87	
Disorder								
Panic/agoraphobia	8	MEA	1.05	0.76–1.34	7.07***	9.60 (*ns*)	27.07	*ns*
Social phobia	3	MEA	0.90	0.57–1.22	5.34***	0.68 (*ns*)	0	
Other phobias	4	MEA	1.11	0.37–1.84	2.95**	10.70*	71.97	
Other	4	MEA	0.81	0.56–1.05	6.45***	3.69 (*ns*)	18.62	
Type								
Internet	12	MEA	0.92	0.73–1.11	9.65***	12.04 (*ns*)	8.63	*ns*
Stand-alone	5	MEA	1.00	0.48–1.52	3.77***	12.61*	68.29	
Palmtop	2	MEA	1.17	0.65–1.68	4.42***	1.61 (*ns*)	37.82	
Recency of system								
Before 2005	11	MEA	0.96	0.68–1.23	6.90***	20.78*	51.88	*ns*
2005 and later	8	MEA	0.93	0.71–1.15	8.26***	7.40 (*ns*)	5.35	
System[a]								
Panikprojektet	3	MEA	0.91	0.48–1.34	4.15***	2.56 (*ns*)	21.72	*ns*
CAVE	2	MEA	0.63	–0.46–1.72	1.14	4.03*	75.21	
SOFIE	2	MEA	0.91	0.5–1.29	4.76***	0.65 (*ns*)	0	
Interapy	2	MEA	1.08	0.80–1.36	7.63***	15.24 o	40.93	
Other	10	MEA	0.88	0.32–1.44	3.08**	3.37 o	70.28	
Other outcomes								
Quality of life	12	F/R	0.46	0.30~0.62	5.64***	10.68	0	
Depression	12	FEM	0.56	0.41~0.71	7.23***	31.52**	61.93	
		REM	0.61	0.35~0.87	4.59***			

Note. N_{comp}=*number of comparisons; CI=confidence interval; FEM=fixed-effects model; REM=random-effects model; MEA=mixed-effects analyses; CAVE=computer-aided vicarious exposure; F/R=results for the fixed- and random-effects model were the same.*

[a]*See Table 1.*

o *indicates* $p<0.1$. *$p<0.05$. **$p<0.01$. ***$p<0.001$.

the circles indicate the weight of each study in the overall analyses).

In eight studies (nine comparisons), we compared the dropout rate in CP versus face-to-face care. Dropout rates did not differ across CP versus face-to-face care (OR=1.28; 95%CI: 0.81–2.03; Z=1.04, *ns*) in either the random- or the fixed-effects models, with no heterogeneity of ES (Q=3.17, *ns*; I^2=0).

Outcomes at follow-up

We could compare the effects of CP with a control condition at 1 to 3 months follow-up in only two studies (Table 5); all three were with the CAVE system (see Table 1). Both in the random-effects and the fixed-effects models, the ES was small and did not differ significantly from zero.

Three comparisons of CP with face-to-face care yielded no significant differences at 1 or 3 months follow-up (d=−0.29; 95%CI: −0.73 to 0.15 in the random-effects model, low heterogeneity) or at 6 months follow-up (0.17; 95%CI: −0.35 to 0.69 in the random-effects model, high heterogeneity).

Thirteen comparisons of ESs of differences between anxiety at posttest versus 1 to 12-month follow-up (see Table 5) found no significant ES, indicating that after the end

Table 4. *Results of meta-analyses: CP versus face-to-face care at posttest (effects on anxiety only)*

Variable	N_{comp}	Model	*d*	95%CI	*Z*	*Q*	I^2	*p*
CP vs. FTF	13	FEM	−0.06	−0.22–0.10	−0.78 (*ns*)	18.61 (*ns*)	35.53	
		REM	−0.06	−0.27–0.14	−0.89 (*ns*)			
Two outliers excluded	10	FEM	−0.13	−0.29–0.04	−1.49 (*ns*)	11.61 (*ns*)	22.46	
		REM	−0.14	−0.33–0.06	−1.37 (*ns*)			
Subgroup analyses								
Disorder								
Panic/agoraphobia	4	MEA	−0.04	−0.25–0.33	0.27 (*ns*)	3.60 (*ns*)	16.65	*ns*
Other phobias	5	MEA	−0.30	−0.62–0.03	−1.77 o	4.99 (*ns*)	19.87	
Other	1	MEA	−0.21	−0.54–0.12	−1.25 (*ns*)	0	0	
System								
Stand-alone	4	MEA	−0.29	−0.70–0.13	−1.35 (*ns*)	4.81 (*ns*)	37.60	*ns*
Palmtop	4	MEA	–0.06	−0.43–0.31	−0.32 (*ns*)	5.17 (*ns*)	41.95	
Other	2	MEA	−0.15	−0.44–0.13	−1.04 (*ns*)	0.48 (*ns*)	0	
Recency of system								
Before 2005	9	MEA	−0.16	−0.38–0.06	−1.43 (*ns*)	11.32 (*ns*)	29.30	*ns*
2005 and later	1	MEA	0.02	−0.54–0.58	0.07 (*ns*)	0	0	

Note. *CP=computer-aided psychotherapy; FTF=face to face;* N_{comp}*=number of comparisons; CI=confidence interval; FEM=fixed-effects model; REM=random-effects model; MEA=mixed-effects analyses.*
o *indicates* $p<0.1$.

of treatment anxiety remained stable at subsequent follow-up.

Discussion

In patients with anxiety disorders, CP was effective for level of anxiety and moderately effective for level of depression and quality of life. We found no indication that face-to-face treatment was more or less effective than CP. CP effects did not differ either across various anxiety disorders or across various types of CP delivery system (Internet, stand-alone PC, or palmtop computer).

The results should be considered with caution because of limitations. First, the number of studies was relatively small. Second, several studies were included with

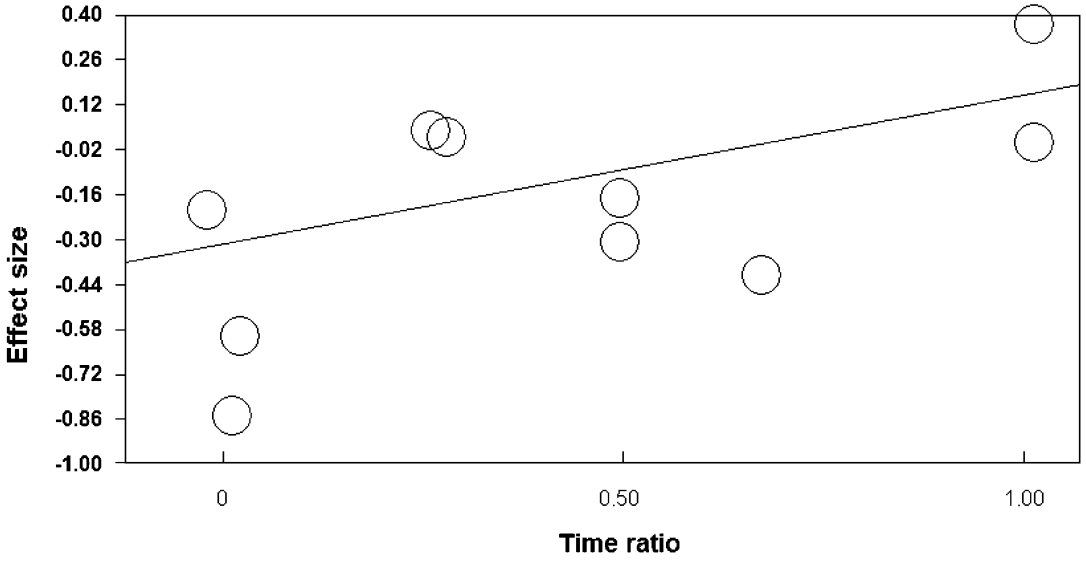

Figure 2. Relation of effect size to time ratio (the time the patient spent with the therapist in the computer-aided psychotherapy condition divided by the time the patient spent with the therapist in the face-to-face condition).

Table 5. *Results of meta-analyses: effects of CP on anxiety symptoms at follow-up*

Variable	N_{comp}	Model	*d*	95%CI	*Z*	*Q*	I^2
CP vs. control at FU[a]	2	F/R	0.55	0.02–1.08	2.03*	0.57 (*ns*)	0
CP vs. FTF							
1–3 months FU	3	FEM	−0.27	−0.66–0.12	−1.36 (*ns*)	2.46 (*ns*)	18.54
		REM	−0.29	−0.73–0.15	−1.28 (*ns*)		
6 months FU	6	FEM	0.05	−0.18–0.28	0.45 (*ns*)	23.30***	78.54
		REM	0.17	−0.35–0.69	0.63 (*ns*)		
CP at posttest vs. CP at FU[b]							
1–3 months FU	6	FEM	0.09	−0.15–0.33	0.70 (*ns*)	1.68 (*ns*)	0.00
		REM					
6 months FU	4	FEM	−0.02	−0.34–0.30	−0.12 (*ns*)	1.22 (*ns*)	0.00
		REM					
12 months FU	3	FEM	0.03	−0.27–0.32	0.17 (*ns*)	0.83 (*ns*)	0.00
		REM					

Note. N_{comp}=*number of comparisons; CP=computer-aided psychotherapy; FU=follow-up; FEM=fixed-effects model; REM=random-effects model; FTF=face to face; F/R=results for the fixed- and random-effects model were the same.*

[a]*Follow-up periods ranged from 1 to 3 months.* [b]*A positive* d *indicates further improvement from posttest to follow-up.*

****p*<0.001.

small sample sizes. Twelve studies included fewer than 50 respondents and only three studies included more than 100. Third, the quality of the included studies varied. Fourth, no study compared CP with anxiolytic or antidepressant medication. Fifth, most studies used samples recruited from the community, and few used clinical populations. Other major limitations are shared with those of many meta-analyses and are reviewed by Marks et al. (in the present issue).

Despite these limitations, the evidence that some forms of CP are effective for anxiety disorders is convincing. Based on this evidence, dissemination in routine practice should be considered. In England and Wales, a government regulatory body (NICE, 2006) recommends a CP system for anxiety disorders (*FearFighter*; see Table 1) as an evidence-based treatment for implementation in the National Health Service and recommends another CP system for mild to moderate depression (*Beating the Blues*; Proudfoot et al., 2004), and these systems are now widely used nationally. We can expect further CP systems to enter routine care in the future.

Our meta-analysis highlighted important research issues. Although CP effects were smaller when anxiety disorder sufferers had less therapist time, this may reflect less CP use that is directly proportional to therapist support. CP users might merely need very brief support given by a person face-to-face, by phone, e-mail, or text. The person may not need to be a therapist; perhaps an administrator could be briefly instructed on how to support users of a given CP system after having completed personal use of that system as a pretend patient. The optimal amount of support may also vary across different types of CP system. More research is needed to examine the trade-offs between costs and outcomes for different durations (e.g. brief vs. enhanced) and modalities (clinician vs. administrator, phone vs. face-to-face) of adjunct human support for CP.

We found that most CP systems tested in RCTs were aimed at panic/agoraphobia and other phobias, including social phobia/social anxiety disorder. Few were for other anxiety disorders such as PTSD and OCD. None were for GAD, although several were aimed at subclinical or nondiagnostic anxiety and stress-related problems. Some depression-specific systems are also marketed for general anxiety (e.g. *Beating the Blues*; Proudfoot et al., 2004), but no systems include evidence-based CBT interventions for GAD such as Borkovec, Wilkinson, Folensbee, and Lerman's (1983) stimulus control for worry. Although there has been much progress in recent years, it is important to develop new systems and improve existing ones.

Adherence and clinical outcome can vary with many factors, among them the source of referrals. CP users referred by mental health professionals did less well than those who were referred by GPs or who were self-referred (Mataix-Cols, Cameron, Gega, Kenwright, & Marks, 2006). This could have reflected the greater severity of referrals from mental health professionals, that such professionals may have given less encouragement to patients to take up the CP option (therapists may resist the introduction of CP) or that patients already on a wait list for face-to-face care by a mental health professional perhaps felt cheated and less motivated to complete a supposedly inferior CP care option. At the start of the referral process, casual unscreened visitors to CP Web sites who registered to try CP without any support had huge dropout rates, far greater than rates in RCTs (reviewed by Eysenbach, 2005). Screening for CP suitability (Gega, Kenwright, Mataix-Cols, Cameron, & Marks, 2005) and offering scheduled, albeit brief, phone support (Kenwright, Marks, Graham, Granses, & Mataix-Cols, 2005; Carlbring & Smit, 2008) could maximise efficiency and minimise dropout.

Future research issues deserving exploration include ''unpacking'' of the actively therapeutic components of CP by examining the extent to which patient improvement can be accounted for by the content and delivery of the CP system itself and by the duration, frequency, and expertise of any human support. In addition, although CP systems are intended for people with mental health problems, RCTs found that they successfully educated health professionals in how to recognise and treat anxiety disorders by going through the CP systems as ''pretend'' phobia/panic patients (Gega, Norman, & Marks, 2007; McDonough & Marks, 2002). Further research should explore how CP systems can enhance students', professionals', and caregivers' understanding of anxiety disorders and their treatment and help them develop skills to give brief support to CP users.

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