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PSYCHIATRY IN THE DIGITAL AGE (J SHORE, SECTION EDITOR)

Computer-Assisted Cognitive-Behavior Therapy and Mobile Apps for Depression and Anxiety

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Abstract

Purpose of Review We reviewed research on computer-assisted cognitive-behavior therapy (CCBT) and mobile applications with the goals of assessing the effectiveness of these newer methods of delivering or augmenting treatment and making recommendations on the clinical use of computer tools in psychotherapy of depression and anxiety.

Recent Findings Research on CCBT has found solid evidence for efficacy when the use of a therapeutic computer program is supported by a clinician or other helping professionals. Lower levels of efficacy or ineffectiveness typically have been found when computer programs are used as stand-alone treatments. A large number of mobile apps have been created that claim to be useful for depression and/or anxiety. However, considerable caution is warranted in evaluating mobile apps and recommending them to patients. Research on mobile apps is still in an early stage of development.

Summary A number of well-established CCBT programs have been studied in multiple randomized, controlled trials and have been found to be effective. Such programs appear to have adequate quality, security, and efficacy to be used in clinical practice. Mobile apps offer easy portability and immediate access to coping strategies and may be useful for augmenting treatment. But clinicians need to select apps with integrity and reliable content for clinical use.

Keywords Computer-assisted cognitive-behavior therapy · Mobile applications · Depression · Anxiety

Introduction

The development of computer programs and mobile apps that can be used in psychotherapy or as self-help tools has been escalating at a rapid pace. In this article, we review work on two major initiatives, computer-assisted cognitive-behavior therapy (CCBT) and mobile apps, and evaluate the efficacy and clinical applicability of these tools in the treatment of depression and anxiety. Most CCBT programs involve a sequence of modules or lessons in which evidence-based treatments are delivered through the Internet on desktop, laptop computers, or tablets, often with the assistance of a therapist—either in person, by telephone, or by email [1•, 2, 3, 4••, 5•, 6•, 7••, 8•, 9••, 10••]. However, some programs for CCBT can be delivered via mobile devices [10••]. Typically, mobile apps do not provide an entire course of cognitive-behavior therapy or

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other therapies (as done with CCBT) but instead deliver a specific component of treatment, stress management, or skill (e.g., breathing exercises, relaxation, mindfulness, thought diaries, mood tracking). Considerable research has evaluated the efficacy of CCBT, but outcome studies on mobile apps have been sparse to date.

We first review CCBT for depression and anxiety and then examine the safety, security, and usefulness of mobile apps. We conclude with a set of recommendations on how clinicians might use these tools in treatment.

CCBT for Depression

The prospects of reduced cost of treatment and improved access to evidence-based psychotherapy have been major drivers of research efforts on CCBT [1•, 2, 3, 4••, 5•, 6•, 7••, 8•, 9••, 10••]. Although standard CBT has been shown to be effective for depression in a large number of studies [11–13], it typically requires 12 to 20 h of clinician time, and there are not enough fully-trained therapists to meet the needs of a large number of patients who could benefit from treatment [7••]. Other constraints on the delivery of standard CBT for depression include lack of access in underserved and rural populations, difficulties in scheduling and attending therapy sessions during work hours, and reluctance to receive mental health services in clinical settings [7••, 14, 15].

In addition to potential advantages in cost, access, and convenience for CCBT, this newer form of treatment can promote learning through interactive exercises, enrich the therapy experience with multimedia learning opportunities, provide extensive feedback to users, encourage homework completion, measure outcomes, and record and manage data [2, 7••]. While these features have appeal for enhancing treatment, currently available programs for CCBT of depression are not able to communicate with patients with the same empathy, wisdom, flexibility, and creativity as human therapists. Thus, many developers of CCBT have recommended a hybrid method of treatment delivery that blends a therapeutic computer program with support from a clinician or other helping professional.

Because CCBT is designed to be used for the treatment of psychiatric conditions, developers have given high priority to quality and integrity of program content (adheres to core tenants of CBT), security and confidentiality (Health Insurance Portability and Accountability Act [HIPAA] compliance for personal health information), and research to test effectiveness.

CCBT methods for depression have been investigated in a large number of randomized, controlled trials (RCTs), beginning in 1990 and rapidly increasing in the past decade. The most recent meta-analysis [7••] examined 40 studies and found that the overall effect size was moderate ($g = 0.50$) for CCBT compared with control conditions. However, investigations that utilized the hybrid method including clinician involvement (typically 1–5 h) had more robust effects ($g = 0.67$) than those which relied on the computer program alone or gave only minimal technical support ($g = 0.24$).

A variety of computer programs for CBT of depression have been developed in multiple formats and languages [7••]. Some use text only, while others employ multimedia and engaging interfaces with interactive learning exercises [7••]. Examples of multimedia programs for CCBT, written in English, and studied in more than one RCT include *Beating the Blues* [16–18], *Mood Gym* [18–22], and *Good Days Ahead* [1•, 23]. In an early study [16] of *Beating the Blues*, in which details of clinician support were not specified, CCBT led to a significantly greater reduction in depression than treatment-as-usual (TAU). However, a later study with a larger sample of patients who only received a very small amount of technical support found no advantage for CCBT over TAU [18]. Investigations of the hybrid delivery method for *Mood Gym* [21, 22] found better improvement in depression scores than those who provided unsupported CCBT [18–20].

The *Good Days Ahead* program has been distinguished by direct comparisons with standard CBT [1•, 23], in which drug-free patients with major depressive disorder were treated with supported CCBT (abbreviated contact with a clinician) or 50-min sessions of CBT. In perhaps the most rigorous trial of CCBT to date, CCBT was compared with up to 20 sessions of standard CBT [1•]. Although clinician contact was reduced by two-thirds in CCBT, no significant differences in outcome were found between CCBT and CBT, except for greater acquisition of knowledge about cognitive behavioral concepts in CCBT [1•]. Other studies of CCBT versus standard face-to-face CBT have reported similar findings [24••]. Table 1 lists several CCBT programs that have been studied in more than one randomized, controlled trial and are used in clinical practice.

CCBT for Anxiety Disorders

During the last decade, there has been a proliferation of computer programs for treating a wide variety of anxiety disorders using cognitive behavioral principles and techniques [39, 40]. Some CCBT methods for anxiety rely completely on self-help with no therapist involvement, while others include regular but limited contact with a therapist, such as a weekly email or phone call, or the treatment may primarily take the form of face-to-face contact and the computer program is used as an adjunct to therapy. The method of delivering CCBT may be through a desktop or laptop computer used in a clinic or at home or through the internet [39]. The cognitive behavioral principles and techniques employed in these programs may include psychoeducation about CBT, cognitive restructuring,

Table 1 CCBT programs with multiple randomized, controlled trials

CCBT program	Primary application	Link
Beating the Blues [16–18]	Depression	https://www.beatingthebluesus.com/
Deprexis [25, 26]	Depression	https://us.deprexis.com/
FearFighter [27, 28]	Anxiety – Panic/Phobia	http://fearfighter.cbtprogram.com/
Good Days Ahead [1•, 23]	Depression	http://www.empower-interactive.com/solutions/good-days-ahead/
Mood Gym [18–22]	Depression	https://moodgym.com.au/
Sadness Program [29–32]	Depression	https://www.c4tbh.org/program-review/the-sadness-program/
Shyness Program [33–35]	Social Anxiety	https://thiswayup.org.au/how-we-can-help/courses/social-phobia/
Worry Program [36–38]	Generalized Anxiety Disorder	https://thiswayup.org.au/how-we-can-help/courses/generalised-anxiety-disorder/

breathing training, relaxation techniques, graded exposure to feared stimuli, response prevention, and assertiveness training.

A burgeoning number of studies have investigated the effectiveness of CCBT for anxiety, and several meta-analyses and systematic reviews have been published [3, 8•, 10••, 39–45]. Although findings among individual studies tend to be heterogeneous, overall conclusions reached from these meta-analyses show that CCBT is significantly more effective than waitlist and other non-treatment or limited treatment control conditions, and has similar efficacy to face-to-face treatment. As with the treatment of depression, methods involving at least some therapist contact had better outcomes. Evidence also suggests that therapeutic gains achieved through CCBT are sustained for several months or longer and that patients tend to continue improving after treatment ends. Results were mixed as to whether disorder-specific interventions were more effective than transdiagnostic interventions. A concern raised in meta-analyses is that CCBT tended to be associated with greater dropout rates, particularly when the treatment involved no therapist contact.

Table 1 lists several programs for CCBT of anxiety disorders that have been studied in multiple randomized, controlled trials. One of these programs, *FearFighter*, has been approved by the National Institute for Health and Care Excellence (NICE) in the UK. It is an online program with nine treatment modules designed to treat panic and phobia [27, 28]. After learning coping techniques to help manage panic and phobic symptoms, patients gradually expose themselves to their triggering situations. In a study of *FearFighter* with no clinician assistance, *FearFighter* with clinical assistance, or a computer-guided self-relaxation condition, patients in both *FearFighter* conditions improved significantly [27]. However, those assigned to self-relaxation did not improve.

The *Shyness Program* is another example of an established CCBT method that has been investigated in multiple, controlled trials [33–35]. Designed for social anxiety disorder, the treatment involves six lessons with homework assignments, participation in an online discussion forum, and email contact with a therapist. The lessons tell an illustrated story about a young man with social anxiety whose aunt—a clinical psychologist—helps him learn about his social anxiety symptoms and eventually master them. The *Shyness Program* has been found to be more effective than waitlist control conditions [33]. However, clinician involvement appears to be a critical element for success [34]. In a recent investigation, the *Shyness Program* was effective in routine clinical practice, whether the participant was guided by a CBT specialist, primary care provider, psychiatrist, or other mental health practitioners [35].

Using CCBT in Clinical Practice

With multiple large-scale meta-analyses completed for both depression and anxiety [3, 4••, 5•, 6•, 7••, 8•, 9••, 10••, 41–45], we think that enough evidence has been collected to support the dissemination of CCBT in clinical practice. However, a number of questions will require further research and clinical experience. For example, how much and what type of clinician support is needed for effectiveness? What patient characteristics predict good outcomes, or poor outcomes, with CCBT? How does CCBT fare in disadvantaged populations and those with limited or no access to the internet? How can quality of programs be assessed? What methods could enhance adherence and completion rates for CCBT?

A recent meta-analysis of CCBT for depression described findings that addressed some of these questions [7••]. Face-to-face or telephone-delivered support was associated with higher effect sizes than email support. The severity of depression did not predict worse outcomes with CCBT. But patients from primary care settings did less well with CCBT than those from non-primary care settings. A strong association was found between completion rates and treatment response. Studies that did not report completion rates or those in the lowest quartile had the poorest outcomes [7••].

Although CCBT research is likely to continue to expand and provide additional information that can guide clinical practice, we recommend these practical steps for current implementation:

1. Use a CCBT program yourself before recommending it to patients. Check it out and learn its features.
2. Select CCBT programs that provide confidentiality and security of personal health information.
3. Utilize CCBT programs with demonstrated effectiveness.
4. Introduce patients to the CCBT program. Explain its core features and your recommendations for its use.
5. Use the CCBT program to educate patients about core principles of CBT and to help them learn skills such as modifying automatic thoughts, activity scheduling, graded exposure, and developing coping strategies.
6. If the program has a clinician interface, use this feature to track progress and gather information to help guide treatment.
7. Provide support either in face-to-face treatment sessions or by telephone, telemedicine video visits, or HIPAA-compliant secure email.
8. Use a comprehensive treatment method that integrates CCBT into clinical practice.

Mobile Apps for Depression and Anxiety

The widespread availability of touchscreen devices, especially smartphones, has led to a proliferation of mobile apps for depression and anxiety. In multiple surveys, a majority of psychiatric patients have expressed interest in apps to help treat their symptoms and offer healthcare support [46–49]. Though developed countries tend to see more usage of apps than developing countries [50], there is promise in disseminating mental health interventions in areas of the world with a paucity of mental health clinicians [51]. However, disparities in the availability of smartphones and access to the internet raise concerns about inequity in the use of apps for healthcare delivery [52, 53]. Ownership of smartphones among patients with severe mental illness in an Atlanta community clinic was 31.4%, less than half that of the US general public (72%) [50].

Another concern is that academia-driven innovations and developments can take almost two decades, if ever, to reach widespread dissemination. Scholarly work in academia is incentivized more for development and testing than dissemination and marketing [54]. The greatest concerns about using apps for depression and anxiety are lack of adequate quality, security, and evidence for efficacy.

Risks of Low-Quality, Unvalidated, or Unsecured Mobile Apps

Recent reviews have found substantial problems with most apps for mental health symptoms. For example, an analysis of mobile apps for CBT of depression [55•] identified 117 commercially available apps, only 10% of which included content that was consistent with basic CBT methods. The usability of the apps for depression was highly variable, and specific privacy and safety policies were rarely specified [55•]. In another study, 247 mobile apps for panic disorder were identified on the Google Play Store. However, only 52 met the researchers' criteria for including content potentially helpful for panic disorder [56•]. The overall quality of the included apps was poor, as were scores used to assess usefulness. In an evaluation of apps for suicide risk, only 25% included a discussion of crisis support services [57].

Reviews of other apps that may be used for persons with depression and anxiety have found similar problems [58, 59]. An evaluation of apps on alcohol found that a majority were for entertainment and to encourage drinking [58]. One app ostensibly developed to promote moderation of drinking—by providing estimated blood alcohol concentration feedback—instead was associated with increased frequency of drinking episodes [58]. An evaluation of nicotine cessation apps discovered that several claimed to change users' "brain waves" with sounds, while others were merely virtual cigarettes or smoke [59].

Commercial fraud and commercial surveillance also can occur with low-quality apps. Apps can ask the user's permission to access the phone's contacts, call logs, messages, camera, microphone, running apps, and full access to the user's keystrokes. Both Android and iOS prompt users to enable access, but earlier versions of Android OS, many of which are still deployed in modern phones, gave apps full access to data stores. The culture for developing apps is to hold data permanently, transmit data, and have data pass through many hands and service providers, with little regard to protecting the privacy of those with mental illness [60].

Few apps have received the rigorous scientific testing that has characterized research on CCBT [7••, 55•, 56•], and thus much less is known about whether they are effective for specific psychiatric disorders. Lack of research has been linked, in part, to the requirements of the long cycle of conducting a traditional randomized, controlled trial, which often may take 7 or more years for design, funding, execution, and publication of results. There has been a call for researchers to evaluate "micro-interventions" (i.e., smaller components and features of an app) in the place of evaluating a more comprehensive treatment method, as has been done with CCBT [61]. This strategy was used in research on Intellicare, a suite of 14 different apps, in addition to apps developed by the United States Department of Defense that are reviewed here [62•, 63•, 64].

Effectiveness of Mobile Apps for Depression and Anxiety

When apps for depression and anxiety have been evaluated in research studies, they have generally found to be helpful [65••, 66••]. However, most investigations were not conducted in carefully diagnosed samples of persons with major

depressive disorder or anxiety disorders [55•, 56•, 65••, 66••]. A meta-analysis of 18 studies of a variety of participants (including self-reported mild depression or anxiety, persons from the general population, and US veterans), in which a depression outcome measure was used, found an overall moderate effect size ($g = .38$) for the mobile apps compared with control conditions [65••].

Research on Intellicare, a suite of eclectic apps (some based on CBT) developed at Northwestern University, along with 8 weeks of coaching, found significant reductions in depression and anxiety measures [62•]. However, there was no control group for this study, so conclusions on effectiveness await further investigation. One of the United States Department of Defense mobile apps, Virtual Hope Box, includes breathing exercises, diversions, inspiring quotations, relaxation training, and methods for displaying photos that may inspire hope [63•]. In a study with US service veterans, this app was found to be significantly better than a control condition for increasing coping skills for unpleasant emotions and thoughts as measured by the Coping Self-Efficacy Scale [63•]. Use of another Department of Defense app, PTSD Coach, was associated with improved PTSD symptoms when compared with users on a waitlist [64].

Mobile apps designed primarily for anxiety disorders can contain several elements of CBT (e.g., cognitive restructuring, relaxation, breathing exercises, exposure) and other treatments (e.g., acceptance, mindfulness, and hypnosis-guided imagery) [67•]. In a recent meta-analysis of 1837 participants in nine randomized clinical trials [66••], use of mobile apps was associated with significant reductions (effect size, $g = .325$) in anxiety symptoms versus control conditions. However, these apps were not generally available in commercial markets [66••]. A review of the apps available in such markets, encompassing 361 iPhone apps that claimed to decrease anxiety or worry, found that only 13% of such apps were consistent with CBT [67•]; thus, nearly all apps available to the public do not incorporate evidence-based best practices [67•].

Evaluating Mobile Apps and Selecting Them for Clinical Use

Choosing apps that have adequate usefulness and safety is a tricky process. Apps can supplement or augment traditional psychotherapy. However, they typically leave little room for variation or personalization. And, unlike printed books, apps can be changed at any time, with updates pushed from a central app store to users' devices, regardless of clinical or scientific need. Often, they are dynamic and changing, making them difficult to study or review.

The UK Medicines and Health Regulatory Agency and the US Food and Drug Administration have distinguished mental health apps from medical devices, which are subject to stringent regulations. However, there is a movement toward government agencies providing evaluation guidelines and even an approval process in an effort to promote higher-quality apps and potentially obliging developers to report adverse events [68].

In addition to clinical utility, the safety of data stored and transmitted from the app has been suggested as a criterion for evaluation. The European Commission published a voluntary Code of Conduct for data safety of health apps, and the UK NHS National Institute for Health Research (NIHR) and the National Institute for Health and Care Excellence (NICE) have published Health Technology Assessment criteria using safety, effectiveness, and cost considerations [68]. The UK initially had issues with insecure apps present on the UK National Health Service (NHS) App Store, ultimately shutting down the website in 2015. Despite this setback, NHS strategy continues to work toward accreditation of digital services and apps to be implemented by the year 2020 [69].

Other proposals for systems to evaluate apps include *Enlight*, developed by Northwell Health's Feinstein Institute for Medical Research [70]. *Enlight* is a series of quality measures that assess usability, visual design, user engagement, content, therapeutic persuasiveness, therapeutic alliance, credibility, privacy, security, and evidence base [70]. Researchers from Queensland University of Technology have developed the Mobile Application Rating Scale (MARS) [71] and produced a version for users without technical expertise [72]. When the MARS was applied to mindfulness apps, shortcomings were identified in the apps' visual design, engagement, functionality, and information quality, and little evidence was found for the apps' efficacy [73]. An additional evaluation model has been proposed by the American Psychiatric Association to assess the business method, developer, security, evidence base, ease of use, and data interoperability of mobile apps [74].

Although evaluation systems, such as ones identified here, could help clinicians choose apps to recommend to patients, their potential has not been realized to date. Based on our clinical experience and evaluation of available studies, we recommend these steps in selecting mobile apps for clinical practice:

1. Use a mobile app yourself before recommending it to patients. Do you like the app and think that it would be useful to your patients? Does the app content fit with treatment methods you endorse and use?
2. If possible, assess the app for security and privacy. Is personal information collected and shared? Caution patients about data collection and sharing by mobile apps.
3. Select apps that have been produced by reliable sources. Apps produced by Governmental agencies, such as the United States Department of Defense, and through universities are likely to be reliable, although some commercial developers also produce apps that are suitable for clinical use. Have clinicians with expertise in the subject

Table 2 Mobile apps for depression and anxiety

Mobile app	Features	Source	Links/availability
Breathe2relax	Breathing exercises	United States Department of Defense	https://www.hprc-online.org/resources/breathe2relax-app
Calm	Soothing music and photos, meditations, calming stories	Calm.com	http://www.calm.com
Day to Day	Daily tips on CBT skills such as challenging negative thoughts and behavioral activation	Intellicare Northwestern University	https://intellicare.cbits.northwestern.edu/app/day-to-day
Headspace	Mindfulness	Headspace.com	https://www.headspace.com/headspace-meditation-app
My Mantra	Create a mantra	Intellicare Northwestern University	https://intellicare.cbits.northwestern.edu/app/mantra
Positive Activity Jackpot	Behavioral Activation	United States. Department of Defense	https://www.hprc-online.org/resources/positive-activity-jackpot-app
PSTD Coach	CBT methods	United States Department of Defense	https://mobile.va.gov/app/ptsd-coach
T2 Mood Tracker	Mood monitoring	United States Department of Defense	https://www.hprc-online.org/resources/t2-mood-tracker-app
Thought Challenger	Modifying negative thoughts	Intellicare Northwestern University	https://intellicare.cbits.northwestern.edu/app/thoughtchallenger
Virtual Hope Box		United States Department of Defense	https://www.research.va.gov/research_in_action/Virtual-Hope-Box-smartphone-app-to-prevent-suicide.cfm

area contributed to the design and development of the app?

4. Introduce patients to the app. Open the app on your smartphone. Explain its features and discuss how the app can be used.
5. Follow up on your recommendations by asking patients about their experiences using the mobile app.

Table 2 contains a list of mobile apps that we use in our own clinical practices.

Conclusions

The development and testing of CCBT programs and mobile apps for depression and anxiety have escalated dramatically in the past few years. But have CCBT and mobile apps entered the mainstream of contemporary psychiatric treatment? In some clinical practices, they are a regular component of comprehensive treatment plans. However, we suspect that most clinicians have not yet fully explored these options or incorporated them into their daily work.

With meta-analyses of large numbers of investigations of CCBT for both depression and anxiety [3, 4••, 5•, 6•, 7••, 8•, 9••, 10••, 41–45] showing efficacy, and research on CCBT expanding at a fast pace, we think that this method, particularly if offered in concert with support from a clinician, offers excellent opportunities to deliver psychotherapy with enhanced efficiency and convenience. The promise of CCBT for reducing cost and improving access to evidence-based treatment may be at hand. However, completion rates have been lower than desirable in some studies, and patient characteristics that predict success with CCBT are still unclear.

Further investigations of CCBT are clearly needed. And the development of programs that are more engaging and interactive and have mobile elements could promote increased use and better outcomes. Advances in artificial intelligence could make programs much more intuitive, personalized, and flexible. Yet solid advances already have been made with CCBT, and rigorously researched programs with strong security and privacy protection are now available.

A variety of mobile apps for depression and anxiety have been developed in the past decade, but many lack adequate security protection, data management policies, and scientifically tested content to be recommended as tools in clinical practice. Although two recent meta-analyses [65••, 66••] provided preliminary evidence that mobile apps can reduce symptoms of depression and anxiety, the small number of studies on patients with defined depressive or anxiety disorders limits ability to evaluate the effectiveness of apps for these conditions. Progress is being made in evaluating apps, performing outcome research, and creating apps that can assist clinicians and patients in treating depression and anxiety. With additional development and improved security, we expect that

this valuable technology will have a growing influence on psychiatric treatment.

Compliance with Ethical Standards

Conflict of Interest Jesse H. Wright is an author of the *Good Days Ahead* (GDA) program used in an investigation cited in this article and has an equity interest in Empower Interactive and Mindstreet, developers and distributors of GDA. He receives no royalties or other payments from sales of this program. His conflict of interest is managed with an agreement with the University of Louisville. He receives book royalties from American Psychiatric Press, Inc., Guilford Press, and Simon and Schuster, and he receives grant support from the Agency for Healthcare Research and Quality and the Oticon Foundation.

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- •• Of major importance

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