



The challenger app for social anxiety disorder: New advances in mobile psychological treatment

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ABSTRACT

Social anxiety disorder (SAD) is a common debilitating mental illness with large negative effects on quality of life and economic productivity. Modern psychotherapy treatments utilizing cognitive-behavioral theory are increasingly delivered over the Internet and more recently using smartphone applications. The Challenger App written natively for the Apple iPhone was developed at the Stockholm University Department of Psychology for the treatment of SAD and uses a number of advanced features not previously seen in past mental health applications; these include real-time location awareness, notifications, anonymous social interaction between users, a high-degree of personalization and use of gamification techniques. This paper explores design considerations for the various components of the app, their theoretical and evidence base, and research opportunities that exist for apps making use of these novel features.

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1. Introduction

Social anxiety disorder (SAD) is characterized by a pervasive and often disabling fear of social performance, the scrutiny of others, and a commensurate withdrawal from interpersonal encounters. Its lifetime prevalence in Europe and North America is one of the highest among mental health disorders at between 6.6 and 13.3% (Fehm et al., 2005; Kessler et al., 2012), with international lifetime prevalence rates in the vicinity of 3.6% (Somers et al., 2006). SAD has a high personal cost as well as serious economic implications for society (Bruch et al., 2003; Stein, 2000; Patel et al., 2002).

Individual cognitive-behavioral therapy (CBT) is considered the best intervention for the initial treatment of SAD and consistently shows large effect sizes (Mayo-Wilson et al., 2014). However, those accessing care for SAD are in the minority with only 50% consulting a medical professional after 16 years of suffering and just 3.4% in the year of onset (Wang et al., 2005).

Alternative methods for providing care for individuals with SAD have since the early 2000s included interventions such as Internet-based cognitive-behavioral therapy (ICBT; Tillfors et al., in press). ICBT interventions for SAD, as compared to other mental health issues, are especially well studied (Boettcher et al., 2013). A recent Cochrane Review found that ICBT for anxiety was more effective than wait-list and not different from face-to-face treatment in improving anxiety and

reducing symptoms (Olthuis et al., 2015). Another meta-analysis (Andersson et al., 2014) has also noted the equivalence between ICBT and face-to-face treatment for anxiety and other disorders. A systematic review of ICBT applications for the treatment of SAD, with 1801 socially anxious individuals in 21 separate studies evaluating 4 computer applications (Boettcher et al., 2013) concluded that effect sizes for these applications were generally strong. Large effect sizes ($d > 0.80$) were obtained in 15 studies, and in 2 unguided programs, small to medium effect sizes were noted.

The natural evolution of computer-based applications is towards mobile apps that can be used on a smartphone (Danaher et al., 2015). Smartphone-based mental health apps (mobile ICBT) may include many of the benefits of ICBT, such as cost-effectiveness (Musiat and Tarrier, 2014), plus they are always online, almost always with the individual and can collect location and other data through their integrated sensors (Chen et al., 2014). Many populations outside the West that would not otherwise own a computer are beginning to own smartphones. In China, for example, the proportion of users accessing the Internet with a mobile device by the end of 2013 surpassed those doing so with a PC (83 vs. 81%; Carsten, 2014). Text-based bibliotherapy can be readily translated to other languages (Choi et al., 2012), providing the ability to introduce new populations to mental health services (Andersson et al., 2013).

Mental health and healthy eating apps comprise over 30% of all health apps on the Apple App Store (West et al., 2012), however few have completed evaluations of clinical effectiveness (Powell et al., 2014). Donker et al. (2013) identified 8 studies ($N = 227$) describing 5 apps from a pool of 5464 abstracts that fit inclusion criteria. These apps targeting depression, anxiety and substance abuse had significant

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within-group effect sizes ranging from Cohen's $d = 0.29$ to 2.28 post-test and follow-up. [Torous and Powell \(2015\)](#) identified 14 studies of smartphone apps for major depression and bipolar disorder that fit inclusion criteria. While few of the studies drew clinical conclusions, evidence for the feasibility of using apps for collecting diagnostics information (actively and passively) and providing interventions (such as psychoeducation and medicine management) is encouraging. Further evidence for the potential impact of mobile ICBT is found in the interest levels of those asked whether they would use such software on their mobile phones. In Australia, a survey of the general public indicated that 76% would be interested in mobile apps for mental health monitoring and self-management if the service was free ([Proudfoot et al., 2010](#)). A geographically and socio-economically diverse group of American psychiatric outpatients responded to a questionnaire indicating that 70.6% would be interested in monitoring their symptoms using smartphones ([Torous et al., 2014](#)).

The present study provides an overview of a new mobile ICBT application from the Department of Psychology at Stockholm University called Challenger, that uses a number of advanced features not previously seen in past psychological treatment apps, including real-time location awareness, notifications, anonymous social interaction between users, a high-degree of personalization and use of gamification techniques. We explore design consideration for the various components of the app, their theoretical and evidence base, and research opportunities that exist for apps making use of these advanced features.

1.1. Theoretical design

The Challenger App was designed to help users overcome social anxiety by inviting them to complete increasingly challenging interactions with their environment. For those with severe symptoms the App may be used in conjunction with a psychotherapist as a means of systematic exposure to social situations and independently of a therapist for those with mild-to-moderate SAD symptoms. The following section describes a selection of novel features implemented in the Challenger App, how they function, and their evidence and relevance as therapeutic tools for treating SAD.

1.2. Gamification

The first view a new user has of the Challenger App, following a short instruction guide ([Fig. 1](#)), is a game board, in which the objective of moving from one end of the board to the other is implicit ([Fig. 2](#)). Users are free to select a unique avatar for their board piece. Each step that a user makes along the board indicates some form of personal achievement, either a new skill learned in the form of a package drop (parachute), or a challenge overcome (star). The more difficult a challenge the user succeeds in, the greater number of squares they move forward (up to 4 squares for the most difficult challenges). At the end of the game board view is a clearly marked yellow box entitled "Add a Reward." After clicking this box, the user has the option of adding a preloaded reward, such as go to a nice restaurant, enjoy some popcorn, take a bubble bath, visit a spa, or the user can create a unique personalized reward.

Serious games and gamification have typically referred to the use of game playing elements such as points and scores used for reasons other than play, normally with the goal of increasing motivation and developing skills ([Deterding et al., 2011](#)). [Prensky \(2005\)](#) reviewed some of the reasons why games are such productive learning tools. He noted that they give us: a. enjoyment (they are a form of fun), b. intense involvement (they are a form of play), c. structure (they have rules), d. motivation (they have goals), e. interactivity (they give us an opportunity to "do"), f. flow (they are adaptive), g. outcomes and feedback (they provide us learning), h. ego gratification (they have win states), i. adrenaline (they involve conflict, challenge and competition), j. creativity (they

involve problem solving), k. social groups (they involve interaction with others) and l. emotion (they are comprised of characters and a storyline).

In a psychotherapy context, it has been suggested that patients who strive after goals for intrinsic reasons (because of the fun and enjoyment that striving provides) rather than for external reasons (because someone else wants them to do this) have lower levels of psychopathology and more positive session outcomes ([Michalak et al., 2004](#)). Meaningful gamification requires designers to make a connection for the user between their natural goals and desires, and the non-game activity ([Nicholson, 2012](#)). One example noted, was the addition of piano keys attached to stairs in the Odenplan subway station in Stockholm, Sweden that encouraged 66% more pedestrians than normal to use stairs instead of ride the escalator ([Piano Stairs, 2015](#)).

Serious games designed for their psychotherapeutic properties have been used for, among others, the treatment of depression ([Merry et al., 2012](#)), impulse-control disorders ([Fernández-Aranda et al., 2012](#)), schizophrenia ([Bellack et al., 2005](#)), and anxiety disorders ([Difede et al., 2007](#)). [Horne-Moyer et al. \(2014\)](#) reviewed the use of electronic games in therapy and found them to be equivalent to, but not superior in efficacy to traditional treatments for a wide-range of medical and mental health issues. Their use may be particularly beneficial to younger populations reticent to seek out mental health services ([Giota and Kleftras, 2014](#)). Challenges identified for serious games in psychotherapy include ensuring that they are appropriately targeted to the user population in respect to culture, gender and socioeconomic status ([Goh et al., 2008](#)). Better evidence for improved retention rates or engagement as a result of gamification elements is warranted.

1.3. Self-selected goals

In the Challenger App, a user has the opportunity to select from 27 different skills (goals) they would like to develop. Skills are sorted between "personal skills" such as learning to be kind to oneself, creating a healthy distance from personal thoughts, and being home alone; "social skills" such as learning to talk to strangers, standing out from the crowd, talking to attractive people, or giving compliments; "physical activity" skills such as walking or doing daily exercise; as well as "miscellaneous skills" such as traveling by bus or train. Users that would like to add additional skills can make in-app recommendations that are sent to the research team as suggestions for future updates.

When a user selects a skill they are provided ratings for identifying their current level of ability with the problem area (from novice to expert) and what level they would like to eventually achieve ([Fig. 3](#)). This information is used to select challenges at the appropriate level of difficulty. For example, a user at a novice level working on the "standing out from a crowd" challenge might first be encouraged to wear two different colored socks as a behavioral experiment (cf. [Bennett-Levy et al., 2004](#)), but at an expert level to drop a large bag of apples on the floor of a supermarket in front of strangers. A user can track their progress with a graph of their initial level of skill ability, the intermediate challenges they accomplished (date/time and duration of activity), and their chosen goal level.

Goal-setting has a long tradition in psychotherapy practice ([Wollburg and Braukhaus, 2010](#)). Conscious goal-setting helps facilitate goal achievement ([Kolb and Boyatzis, 1970](#)). In one study, success rate of a self-directed behavior change exercise increased from 44 to 61% after being modified to emphasize goal achievement ([Kolb et al., 1968](#)). Goal achievement is partly affected by how people formulate their goals, whether they are specific or vague, challenging or modest, proximal or distal, an approach or an avoidance task ([Gollwitzer and Moskowitz, 1996](#)). Those who are more optimistic about achieving their goals are more likely to attain them ([Michalak et al., 2004](#)). In cognitive models of SAD, social apprehension is associated with deficiency in properly defining social goals and selecting specific, attainable behavioral strategies to reach them ([Hofmann, 2007](#)). Identifying and achieving discrete, increasingly challenging goals that are personally motivating may be

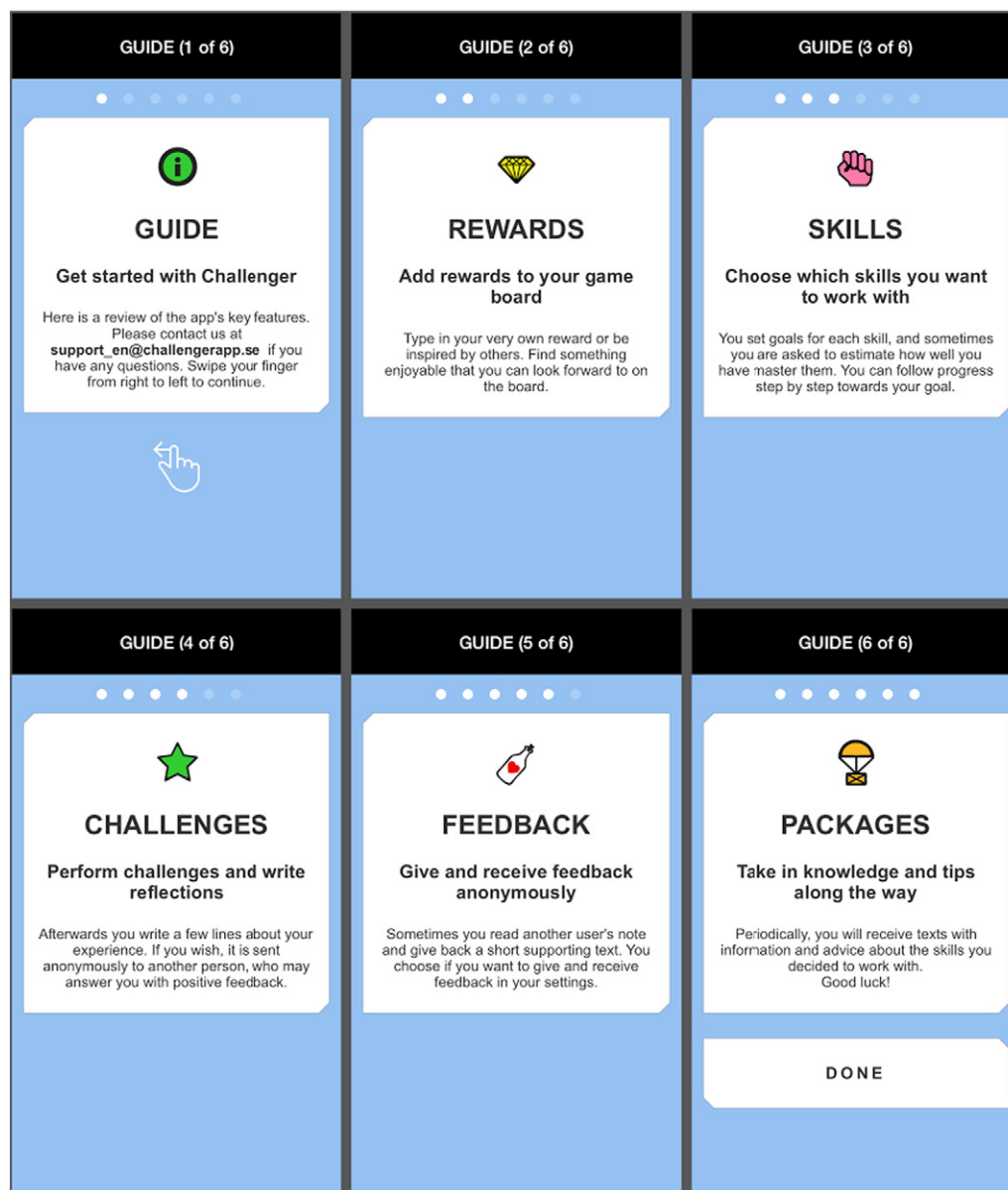


Fig. 1. Instruction guide for using the Challenger App.

important prerequisites to the eventual long-term success of a psychological intervention (Mausbach et al., 2010).

Technology has provided advantages to those seeking to reach their goals (Aguilera and Muñoz, 2011). Electronic activity monitors, such as pedometers, are now integrating behavior change techniques identified in social cognitive theory alongside their continuous monitoring ability. These include assistance formulating goals, identifying discrepancies between current and goal behavior, social comparison, rewards and a focus on past success (Lyons et al., 2014). Technologies may also be beneficial to goal success because partially automated action plans can reduce volitional demands on an individual who would otherwise have to decide when and how to accomplish their goal (Koestner et al., 2002).

The Challenger App emphasizes many of the behavior change techniques discussed in the literature (Lyons et al., 2014; Free et al., 2013), such as identifying specific goals, tailoring, barrier identification/problem solving, breaking long-term goals into short-term challenges, accomplishing easier challenges first, prompts/cues, emphasizing success, social support and tracking of personally valued information. Basic behavioral change techniques used in the Challenger App are likely to be useful when applied to mental health disorders other than SAD.

1.4. Customized challenges

Self-selected skill areas are used to systematically provide challenges to the user suited to the areas where they are having problems. These challenges are based on a series of user-selectable customizations, such as the location of their workplace, home or school. For example, if the user has difficulty speaking in meetings and the user is identified as being present at their office, a challenge in the form of “overcoming fears of speaking” may be suggested alongside psychoeducation about how to deal with the fear. The user has the option to indicate if the suggested challenge was useful and appropriate. Responses are saved for reference by the research team who continue to improve the app.

The use of real-time location data provides challenges appropriate to the user's current location. This feature relies on the Google Places API featuring over 95 million businesses and points of interest (Google Places API, 2014). For example, the user who has difficulty making phone calls and is challenged to call a local gym, is not only told the task but given a real business to call nearby as well as a “call now” button that provides instant access to the establishment. See Fig. 4 for an example. Following the call, the user has the option to indicate whether

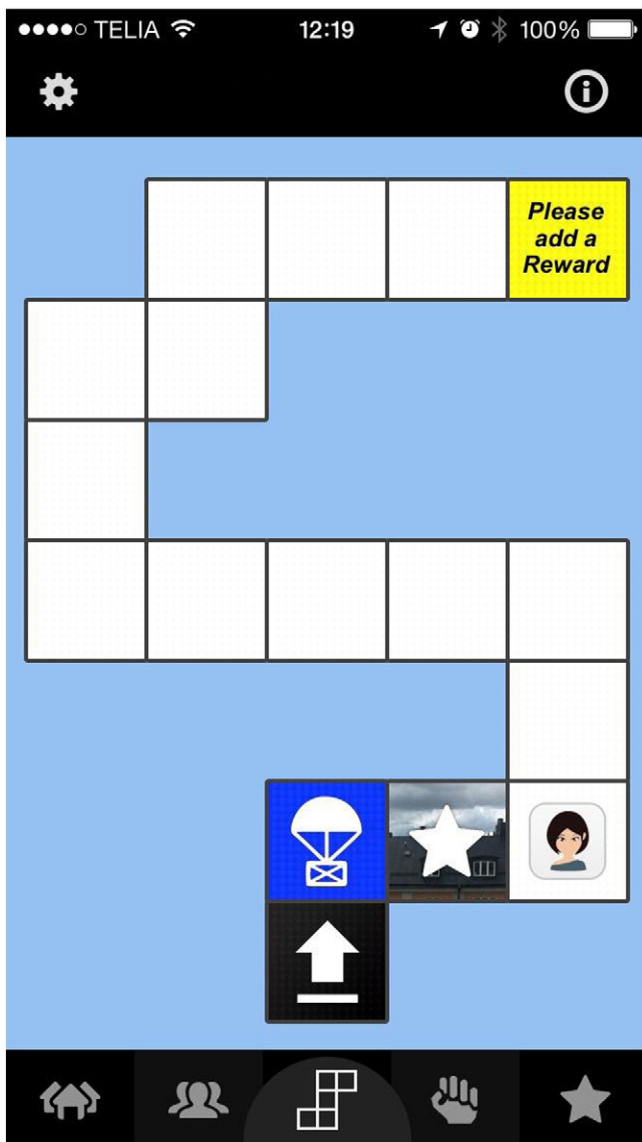


Fig. 2. The Challenger App game board.

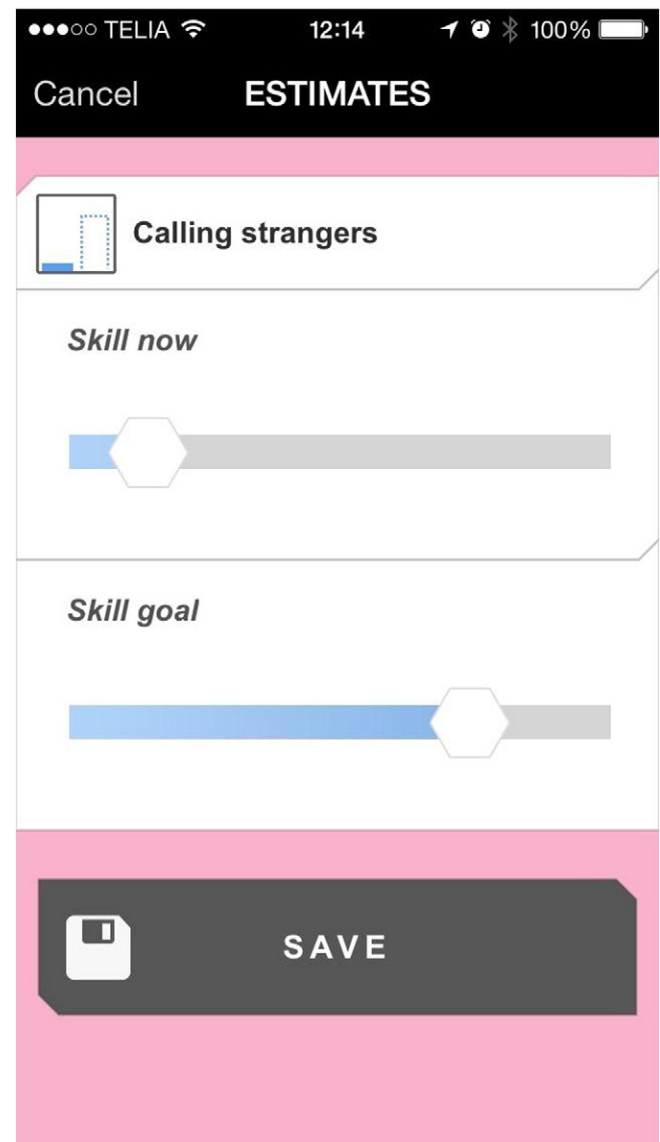


Fig. 3. Setting of self-selected skill difficulty levels.

the challenge was too easy or too difficult for them. If the challenge was too easy, next time the app will suggest an exposure with a greater level of difficulty or if the former, something a little easier.

In addition to location, challenges may be linked to real individuals. The user is encouraged to add persons they know to the application, including a photo and a name. A user is also encouraged to add self-ratings to indicate their level of comfort and safety acting spontaneously around that person. These ratings are used to select challenges at the appropriate level of difficulty for the user to engage in with their actual friends and family. For example, a user who has problems chatting with friends might be challenged to telephone a particular acquaintance and talk about what they did that day. In order to ensure security of personal information, like all data being sent to and from the Challenger servers and the user's phone, images are encrypted in the transfer process. Storage on secure servers ensures that old data, including images, can be moved if the app is reinstalled on a new device.

Behavioral experiments, a foundational theory for many of the customizable exposure challenges included, is considered a core CBT skill used in cognitive-restructuring, in which a patient's thoughts about feared situations and the beliefs that underlie them are examined and tested (McMillan and Lee, 2010). Evidence for cognitive-restructuring

is supported by a large body of experimental psychopathology research (Heimberg, 2002). In the popular and well-researched "Beck–Heimberg CBT" method for treating SAD (Hofmann, 2007), patients begin by confronting increasingly difficult feared situations simulated in the therapy office followed by identifying and agreeing on real-life behavioral experiments that can be performed outside of the office to challenge specific reactions to uncomfortable situations.

To be effective, the behavioral experiments should "violate the patient's perceived social norms and challenge the social cost estimates" (e.g., "walking around with toilet paper hanging out of the shirt, [or] buying and minutes later returning the same book...") (Hofmann, 2007, p. 204). Another type of behavioral experiments might involve a client entering a feared situation without engaging in "safety behaviors" (cf. Levy and Radomsky, 2014), which they inaccurately believe will enable them to manage their anxiety, but may actually prevent disconfirmation of cognitive beliefs (Heimberg, 2002). For example, speaking to an attractive individual without repeating a mantra in their head. Patients are encouraged to reflect on their experience, if something surprised them, and what they might do next time.

In addition to behavioral experiments, mindfulness-based exercises are incorporated into some challenges. SAD treatment studies using mindfulness techniques have noted reductions in low self-esteem,

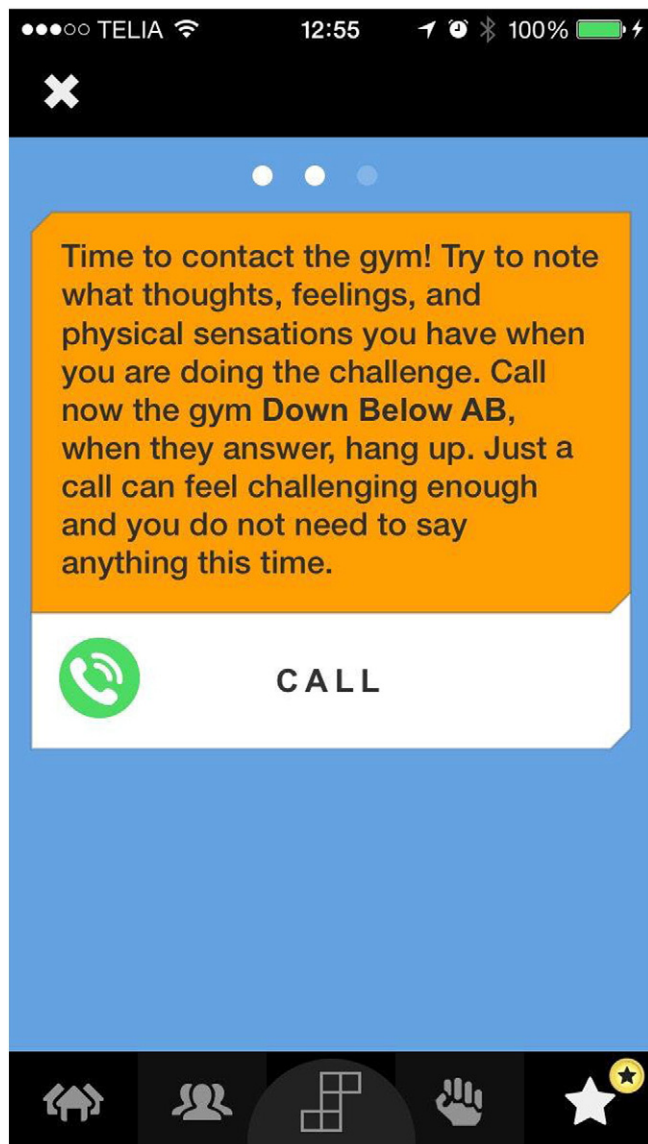


Fig. 4. Real-time location based “Calling Strangers” challenge.

emotional reactivity and improved functioning and quality-of-life (Goldin and Gross, 2010; Koszycki et al., 2007). An unguided mindfulness-based intervention has also demonstrated improvements on social anxiety and depression levels (Boettcher et al., 2014a). Goals emphasized in mindfulness-based SAD treatment programs include reducing experiential avoidance (using meditative and other interventions designed to enhance acceptance), improving non-judgmental awareness, and practicing the cognitive diffusion of thoughts, emotions and physical symptoms. Exercises may include (among others) body scanning, mindful meditation and mindful stretching, as well as homework on core mindfulness concepts (Kocovski et al., 2013).

Certain SAD therapies may be more suitable for online or mobile treatment. Evidence indicates that anxiety disorders using exposure are particularly responsive to self-administration (Marks, 1991). Omission of a therapist during administration did not negatively impact treatment as long as the exercises were carried out. A review of technology-assisted self-help and minimal contact therapies identified self-help tools as being effective (Newman et al., 2011). Virtual reality (VR) exposure treatment for fear of public speaking used as a self-help tool was found superior to wait-list for exposure therapy in a group with speech anxiety (Harris et al., 2002). Active VR exposures were found superior to neutral exposures (North 1997 in Newman et al.,

2011). However, improved results may be evident in self-help treatments that emphasize interacting with real-life situations. Such treatments, like the Challenger App may offer benefits not found in solitary computer-based therapies.

1.5. Psychoeducation notifications

Psychoeducation notifications in the form of “parachutes” are packages sent to users in order to support their momentum in reaching personal goals, guiding them through the application, as well as providing valuable psychological insights (Fig. 5). Parachute drops are initiated right from the user’s first interactions with the Challenger App, and unlike traditional CBT homework that may not be completed for a variety of reasons (Dattilio et al., 2011), they function as notifications on the smartphone lock-screen providing a helpful reminder to access the application. Among the suggestions provided in parachutes are information on formulating and setting realistic goals, overcoming fears, and increasing motivation. Once a goal is achieved, a parachute may be sent to the user outlining a plan on how to maintain the new skills and avoid falling back into old habits. After reading the parachute, users can elect to “like” the post, notifying the research team that this

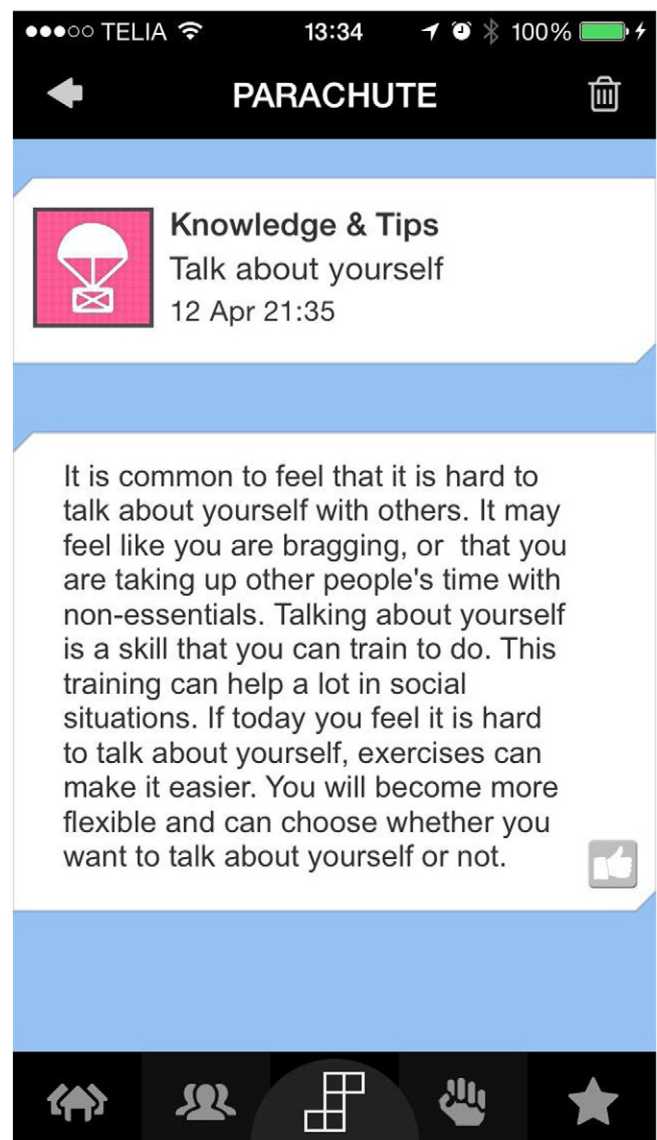


Fig. 5. An example of a psychoeducation parachute.

information was beneficial, and helping to improve future versions of Challenger.

Psychoeducation is also provided in connection with exposure challenges. As with parachutes, challenges are provided as notifications on the smartphone lock-screen. These notifications are intended to provide the user with guidance and support rather than simply an effort to draw them into the application. For example, a user with a fear of speaking during meetings, might be sent a challenge alongside information on overcoming a focus on self. The fear of speaking would be normalized for the individual, and they might be provided a mindfulness meditation designed to emphasize cognitive diffusion and acceptance of negative thoughts and feelings. Psychoeducation exercises may include a count-down timer that can be initiated by the user. This would indicate how long someone should spend on the exercise and helps provide focused attention for completing a session. Psychoeducation material used in the study is unique to the Challenger App and is inspired by previous Internet-based studies (Andersson et al., 2008).

CBT workbooks supplying education material including homework assignments have traditionally been used both as a supplement to psychotherapy (Kazantzis and Lampropoulos, 2002) and for self-directed use (Abramowitz et al., 2009; Furmark et al., 2009). Despite the acknowledged benefit of the material (Haug et al., 2012; Lewis et al., 2012; Nordin et al., 2010), dropouts may be high (Geraghty et al., 2010). This is particularly the case with self-directed online treatments without human contact or guidance (Eysenbach, 2005; Palmqvist et al., 2007). In one example, of 19,607 individuals from the public registering for an online CBT mood disorder application (Moodgym), 15.6% ($n = 3055$) completed 2 of 5 modules but just 0.5% ($n = 97$) completed the full course (Christensen et al., 2004). Attrition among certain groups is predicted to be high, such as men, the young, and those with low educational level, based on analysis from an online bipolar education program (Nicholas et al., 2010). The same results have been found in a recent individual patient meta-analysis for depression (Karyotaki et al., 2015). In a recent review of studies comparing ICBT to face-to-face treatment, however, dropout rates evaluated using meta-analytic logistic regression did not identify one modality as superior to the other (Andersson et al., 2014).

The use of notification reminders on a mobile phone may be of significant aid for those completing self-assigned CBT lessons. Numerous authors have discussed the potential benefits of this technology (Helgadottir et al., 2009; Aguilera and Muench, 2012; Mohr et al., 2013). Its primary use may be that reminders can be set to automatically “push” information to the user, rather than “pulling” data to make the app work (Helgadottir et al., 2009). Free et al. (2013) used a systematic review to evaluate the effectiveness of mobile-health technology-based health interventions for behavior change and disease management. Multifaceted text message interventions (including self-help materials, access to hotline advice or an SMS requiring a response) were found to increase adherence to anti-retroviral and smoking cessation, while simple reminders for adherence to medication regimes, for example, showed at best small effects. A study evaluating the efficacy of SMS messages for improving healthy behaviors in goal-impaired schizophrenia patients, identified that goal achievements increased with prompting, as did keeping appointments and carrying out leisure activities (Pijnenborg et al., 2010). Performance dropped in goal achievement when reminders were removed. Medication adherence and attendance at training sessions, however, remained unchanged notwithstanding reminders. Similar positive results have been found for individuals with Attention Deficit Hyperactivity Disorder using smartphones to help structure their life (Moëll et al., 2015).

1.6. Community support notes

Users are encouraged to write notes about their experiences after they complete a challenge so that they can deepen their level of understanding of what occurred (Fig. 6). These reflective messages can be shared anonymously with others, with the intention of creating a

supportive environment not unlike group therapy or online forums in ICBT (Thorén et al., 2011); a feeling of connectedness with others struggling with the same disorder, increased motivation levels for writing notes and, for the user replying to the message, an opportunity to provide encouragement to others (the same kind of encouragement they need to provide themselves).

To increase the level of personal contact between users and a sense of connection (without revealing personal identifiers), the distance of the writer of the message from the recipient is included (Fig. 7). Messages appear in the Challenger App as a “message in a bottle,” underlining that the message is a single interaction (one message sent, one returned), and is not intended to be a chat forum. Instead the messages are meant to encourage users to get back to the task of undertaking challenges. Users have the choice (in the settings menu) whether they want to send and receive messages from others or if they prefer the notes be just for themselves. They can also flag a message (“report for abuse”) if they feel something inappropriate has been sent in the feedback they receive and it will be identified for the research team to review.

Marks (1991) identified that due to advances in instruction for exposure focused therapies like cognitive restructuring, “the clinician hardly ever needs to actually go out into the exposure situation with the patient as part of treatment. Rather, the clinician’s job is to... praise

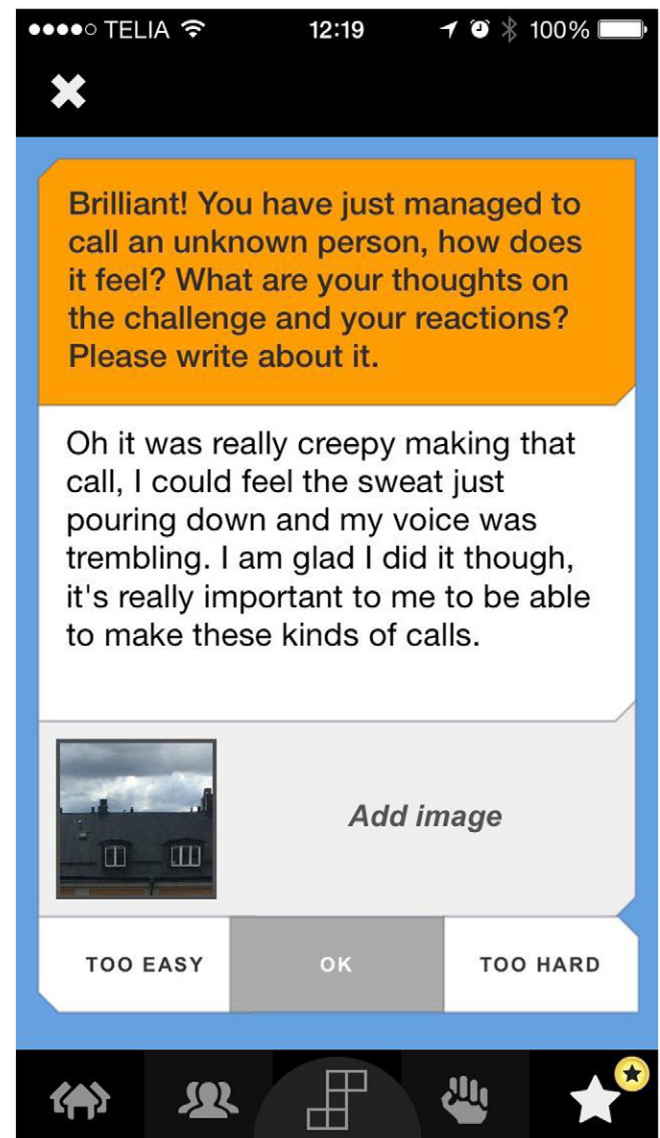


Fig. 6. A user note detailing their experience during and after a challenge.

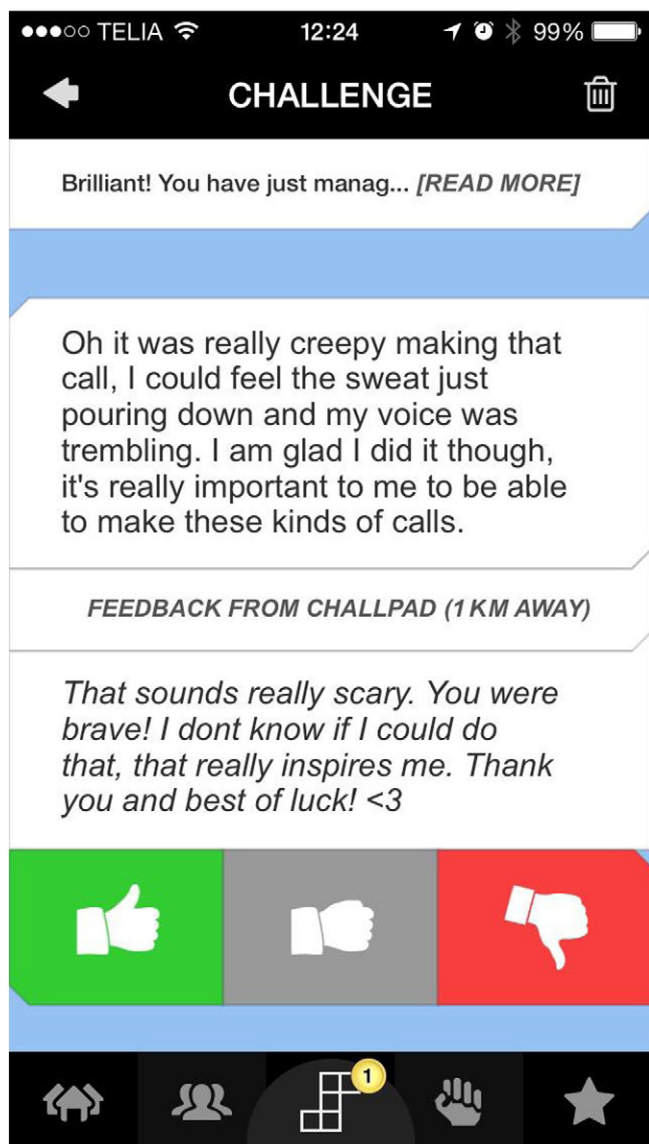


Fig. 7. An encouraging message from another anonymous user.

appropriate tasks completed and progress attained” and can function more as an “assessor, coach and monitor” (p. 44). Nevertheless, a consistent finding of more recent reviews of self-help treatments and technological solutions for anxiety disorders is that the amount of time a patient spends with their psychotherapist is the most important prognostic indicator of positive outcomes (Helgadottir et al., 2009). Unlike a psychotherapist, currently available technology still lacks the ability to provide corrective feedback to a user based on their behavior and responses.

ICBT apps that are intended to replace some of the functions of a psychotherapist often make use of chat forum-like interactions (Ljótsson et al., 2013). In a review of ICBT applications for SAD, Boettcher et al. (2013) identified that all but one program (3 of 4) included a chat forum. Berger et al. (2009) who evaluated a minimal-contact treatment for social phobia that made use of a forum, acknowledged that they may be a promising way of incorporating therapeutic factors typical of group therapies but within an individual setting. A study of an individually tailored, Internet-based treatment for anxiety disorders made use of a moderated online forum instead of wait-listed controls (Carlbring et al., 2011). The authors indicated that while it should not be considered an active treatment, it may be considered to have some beneficial effects.

A review of 45 publications that made use of peer-to-peer communities and electronic self-support groups used to discuss health related issues, found that most studies did not show an effect on depression or social support indicators (the most common outcomes) (Eysenbach et al., 2004). It should be noted, however, that many of the studies (32) were a complex design involving psychoeducational programs and one-on-one communication with health professionals, making determination of intervention effects difficult. Importantly, the authors found no evidence of harm arising from participation in the online forums.

Online interactions may be particularly important for users with SAD due to their fear of evaluation and other anxieties surrounding social interactions. Erwin et al. (2004) examined the implications of Internet communication for individuals with SAD, indicating that among socially anxious individuals who responded to an online survey, spending more time on the Internet was associated with perceived stronger social support and encouragement online. It was also associated with developing increased confidence and new face-to-face friendships. Individuals expressed that they found it easier to talk about their problems to people on the Internet and were more comfortable in general with interacting online than face-to-face. Nevertheless, there may be particular risks associated with online communities for individuals with SAD. As Erwin et al. (2004) suggests, users may distract themselves from doing the “active ingredient” of ICBT or the online community might facilitate the weakening of face-to-face social bonds. For those reasons, a more limited approach to online communication was implemented in the Challenger App, providing sufficient interaction to increase encouragement and confidence in undertaking exposure challenges, but insufficient interaction to become a communication portal for SAD users.

2. Technical design considerations

2.1. Technical development

The Challenger App was developed by multiple parties over an 18 month period with funding from the Swedish government for mental health smartphone applications. The inspiration for the app came from a Masters psychology student at Stockholm University. This student also developed and designed the app, using open-source tools for Apple's iOS platform, such as the Google Places API library and the Norwegian Weather Service API for providing weather validations such as “it seems like a nice day for a walk.” The generation of psychoeducation and challenge instruction content was led by the same student, with assistance from a psychologist with extensive experience developing psychological instruction material, as well as a number of other Masters psychology students. Translation of the material is being completed in conjunction with departments of psychology in other countries.

2.2. Installation and setup

The Challenger App setup process was designed to be straightforward for anyone with experience using an iPhone. The application is freely available on the Apple App Store. When used in a research context, users who are invited to join are sent an invitation letter with a link to the App Store. Once users have installed the application they are invited to sign-up by providing an email address and self-created username that can be as anonymous as the user wishes. The email address is used to send a unique password to complete the installation process. Requiring the user to receive a unique password by email ensures that they are a human, have a properly setup email account, and can be sent additional service information when necessary. The password typically needs to be entered only once into the application when the individual sets up their account, but will be needed again if the user uninstalls and reinstalls the app or is logged out due to a security concern (explained below). After completing the sign-up process

and entering the app, the user is greeted by a simple 6-page instruction guide for getting started. This guide walks the individual through the basics of interacting with the app, starting with how to contact the support team in case of questions, as well as information about the rewards, skills, challenges, feedback and parachute systems.

2.3. Security

Security was a top concern during development of the Challenger App due to the use of novel technologies such as location-based interactions, and the risk of personal psychotherapy related data being divulged to one or more parties. All passwords used in the application employed secure salted password hashing and all interactions between the user and servers, including GPS data, use 256-bit encryption. Every interaction between the user and the application results in a new token being created. If there is a discrepancy between user and server tokens, the user is logged out and is asked to re-enter their password. The Challenger App is hosted on the servers of Linköping University using the same physical setup as the iterapi-project (Vlaescu et al., 2015), making use of the stability and security of the university's government level implementation.

3. Novel research opportunities

3.1. Activity-tracking

One of the unique features of mobile apps are the research opportunities available when a device is carried throughout the day. The Challenger App was built with the intention of examining the relationship between activity and levels of SAD. For example, the percentage of time an individual spends at home or office may be indicative of SAD status. The percentage deviation of a person from familiar routes ("geographic flexibility") may similarly offer an indication of SAD treatment progression. The most recent versions of the Challenger App now include regular weekly emails with basic feedback about the percentage of time spent at work, home, school, and "other" locations, as well as recent challenges accomplished and skills practiced. Future versions of a Challenger App could be designed to offer alerts to an individual when they have reduced their level of activity from prescribed norms as well as a measure of their geographic flexibility.

Passive tracking of activity has been used with success in other mental health applications. Wang et al. (2014) tested an app called StudentLife to correlate and eventually predict depression and other outcome variables using automatic continuous sensing with an Android device accelerometer, microphone, light sensor, GPS and other data. Students ($N = 48$) from a single class during a 10-week term volunteered to participate in the study. In regard to depression, the authors found significant correlations with sleep duration (using light sensors, the accelerometer and microphone), colocation with others (GPS and Bluetooth encounters), and conversation frequency and duration (using the microphone). These findings were in line with other research on depression indicating that lack of sleep, low proximity with other individuals, and fewer and shorter conversations were correlated with depression.

Activity tracking outcome measures similar to what might be evaluated using Challenger, were also tested. The accelerometer was used to determine whether the student was stationary, walking, running, driving or cycling, GPS data was used to determine the distance the student traveled around campus during the day, and WiFi scan logs determined the time students spent in each of the campus buildings. Location was found to be correlated with various measures of loneliness. Activity duration during a 24 h period was negatively associated with loneliness ($r = -0.388$), as was indoor mobility during the day ($r = -0.332$), and distance traveled during the complete day ($r = -0.338$). The authors suggest that students who are less active, isolated, resigned to not seek out the company of others, may be more likely to be lonely.

Activity tracking and smartphone use was strongly related to depression symptom severity in recent study of 40 adult participants (Saeb et al., 2015). Participants completed a self-reported depression survey (PHQ-9) prior to a 2-week sensory data collection period using an Android app developed by the authors ("Purple Robot"). Depression was correlated using GPS data with regularity in 24-h rhythm ("circadian movement"; $r = -.63$), variability of time spent at favorite locations ("normalized entropy"; $r = -.58$), location variability ($r = -.58$), as well as phone usage duration ($r = .54$) and frequency ($r = .52$). Percent of time spent at home relative to other locations ("home stay") also correlated with depression but less strongly ($r = 0.49$). The authors report that their method can discriminate depression symptoms with a high degree of accuracy, sensitivity, and specificity. Evidence from these two studies indicate that the use of a mobile platform for correlating mental health status with activity may be a powerful tool for identifying and predicting negative health episodes.

3.2. Likes

In the Challenger App, many of the notifications and psychoeducation lessons include the ability to indicate a "like" (thumbs up). This is similar to what exists today within Google applications (YouTube, etc.) and on Facebook. Currently, this information provides researchers the ability to correlate "likes" with SAD status, to determine whether there were particular psychoeducation lessons that correlated with SAD, or to evaluate whether individuals who were active giving feedback (positive or negative) were more or less likely to have reductions in SAD symptoms. This information is not shared publicly and is only available for internal use and for the individual user who has liked/disliked content in the app.

4. Conclusion

The Challenger App is a modern tool for the treatment of SAD and makes use of the latest technologies available for mental health research, including real-time location, activity tracking, gamification, reminder notifications, up-to-date psychoeducation, anonymous social networks, and gathering of generic digital footprint information (e.g., likes), all within a single integrated app written natively for the Apple iPhone.

While mobile ICBT shows promise to reduce the burden of disease in SAD and other common mental health disorders, there are a range of challenges that must be addressed. Security of personal data is of paramount concern with all Internet activity, particularly in regard to mental health which is highly stigmatized in society, and where the credibility and reliability of research is involved (Bennett et al., 2010). Privacy and confidentiality issues may arise such as users (professional or patient) working with mental health apps in public areas (Tran et al., 2014) or the loss, theft or malfunction of a device with personal data (Giota and Kleftras, 2014). However, many of these problems can be mitigated with open, frank discussion about such risks and taking proper precautions (Price et al., 2014). While negative effects have been reported in internet-based treatments (Boettcher et al., 2014b) no negative outcome or adverse effects have yet been identified using smartphone applications for mood disorders according to a recent review of 14 mostly pilot and feasibility studies (Torous and Powell, 2015). However, monitoring such side-effects is important (cf. Rozental et al., 2014). Technical hurdles must also be adequately dealt with in mobile ICBT apps, such as buggy software, accessibility problems among some users, long-term maintenance issues, battery life, and the identification and timely management of mental health crises (Price et al., 2014, Donker et al., 2013).

Highlighting the importance of this sub-group of apps for Apple Inc. and other manufacturers, and perhaps anticipating potential problems related to security and functionality of health apps on mobile phones, Apple has released the HealthKit and ResearchKit developer toolkits. These will enable applications to track, manage and interact with a user's health while also providing a straightforward way for medical doctors and researchers to securely receive data (Apple Inc., 2015).

Mobile ICBT apps may also have non-technical design requirements specific to the condition they intend to treat. In the case of SAD, for example, while access to evidence-based treatment may have many benefits, the syndromes underlying disorder (a fear of social interactions) might be exacerbated if the app increases use of the smartphone to the exclusion of social contacts (Boettcher et al., 2013).

Research will need to determine the efficacy of the Challenger App as compared to ICBT on the computer and traditional psychotherapy, and eventually the effectiveness of the app when used in real-world settings. To support the further advancement of the platform, new features are continuing to be added. For example, recent updates include weekly e-mail reports, indicating what the user has achieved during the past 7 days, as well as advanced gamification techniques such as personal and group statistics (e.g., “the most popular skill of the week”). Future updates may employ the use of A/B testing, a convention within the software development industry, to identify what features return the best results. Those aspects of the Challenger App that result in the greatest reduction of SAD and other positive outcomes, along with user feedback, will help determine the future of the app and other mobile mental health interventions.

Conflict of interest

The first and last authors have no conflict of interest to report. The second author, Arvid Marklund has founded a company which develops and markets applications for mobile platforms.

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