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Development and Pilot Evaluation of Smartphone-Delivered Cognitive Behavior Therapy Strategies for Mood- and Anxiety-Related Problems: MoodMission

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Given the ubiquity and interactive power of smartphones, there are opportunities to develop smartphone applications (apps) that provide novel, highly accessible mental health supports. This paper details the development of a smartphone app, "MoodMission," that aims to provide evidence-based Cognitive Behavior Therapy (CBT) strategies for mood- and anxiety-related problems, contributing to the prevention of clinically significant depression and anxiety disorders and serving as an adjunct to therapeutic interventions delivered by trained health professionals. MoodMission was designed to deliver strategies in the form of real-time, momentary responses to user-reported low moods and anxiety. The development process involved: (a) construction of a battery of strategies, (b) empirical evaluation, (c) a software and behavioral plan design and testing process, (d) user feedback, and (e) a public launch. A pilot study of 44 participants completed the Mobile Application Rating Scale (MARS; Hides et al., 2014) for usability testing and feedback. MoodMission was rated significantly higher than standardized health app norms on the majority of the domains, including Entertainment, Interest, Customization, Target Group, Graphics, Visual Appeal, Quality of Information, Quantity of Information, Visual Information, Credibility of Source, Recommendation to Use, Estimated Frequency of Use, and Overall Rating (Hedges' s g range 0.57–1.97, $p < .006$). Case examples illustrate the practical uses of the app. In addition to clinical applications, MoodMission holds promise as a research tool either as an augmentation to clinician-delivered therapy, or as a vehicle for standardizing client access to specific CBT strategies (e.g., in studies intending to study different change processes).

Given the exponential growth in smartphone use (Deloitte, 2016b), there is a potential to increase access to and create novel delivery of mental health interventions. Data collection capability for the expressed purpose of evaluating the stated health aims and objectives of smartphone applications (apps) designed for mental health (MHapps) is an important ethical and practice consideration (Luxton, McCann, Bush, Mishkind, & Reger, 2011). Despite this opportunity to significantly transform behavioral health care, recent reviews have found a significant number of MHapps have been developed without an empirical base or evaluation capacity (Bakker, Kazantzis, Rickwood, & Rickard, 2016; Donker et al., 2013; Jones & Moffitt, 2016). For the continued advancement of MHapps, there is a need for careful evaluation that includes user feedback on intended benefits, as well as the overall interface and design of the platform.

Keywords: mobile; app; self-guided; depression; anxiety; cognitive behavior therapy

Cognitive behavior therapy (CBT) is an effective treatment for depression (Cuijpers et al., 2013) and anxiety (Bolognesi, Baldwin, & Ruini, 2014), and has been translated successfully for delivery via the Internet for a range of clinical disorders (Andrews & Williams, 2014; Dèttore, Pozza, & Andersson, 2015; Kuester, Niemeyer, & Knaevelsrud, 2016; Newby, Twomey, Yuan Li, & Andrews, 2016). Many Internet CBT (iCBT) programs have been designed to include techniques that can be flexibly applied to a range of disorder groups (Păsărelu, Andersson, Nordgren, & Dobrean, 2017), through their emphasis on core dimensions in psychopathology and treatment processes, including: attention and other processes of cognition (e.g., acceptance, tolerance), cognitive reappraisal (e.g., decentering, defusion), behavior change (e.g., activation, exposure), and emotional dysregulation (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Hayes & Hofmann, 2017, 2018; and see Kazantzis, 2018, for outline of technique-process links). For example, common treatment processes in iCBT for anxiety and depression (Ellard, Fairholme, Boisseau, Farchione, & Barlow, 2010) can be reliably facilitated through psychoeducation, self-monitoring of thoughts and emotions, emotion regulation skills, and relapse prevention (Newby

et al., 2016). By enabling individuals to learn broadly relevant skills, such as the ability to identify emotions and evaluate unhelpful thinking patterns, iCBT has the potential to be broadly beneficial, both as an augmentation to therapy, and standalone prevention and therapeutic modality.

In traditional delivery of CBT, a therapist would guide a patient to a shared understanding of their problems using a generic cognitive model illustrating the interactive patterns of cognition, behavior, emotions, and physiology in problematic situations (Layard & Clark, 2014; Westbrook, Kennerley, & Kirk, 2011). The basic CBT components involve the construction of individualized emotion rating scales (e.g., SUDS) for the evaluation of specific interventions focused on behavior change, and interventions focused on cognitive change. Cognitive change is posited as the main change mechanism within standard CBT (Beck, 2011), traditionally facilitated by techniques that involve cognitive reappraisal or reframing, but can also include techniques that focus on acceptance, building tolerance, decentering, and defusion, among others (Mennin, Ellard, Fresco, & Gross, 2013; Petrik, Kazantzis, & Hofmann, 2013). Interventions focused on behavioral exposure (e.g., in various anxiety disorder treatments) and activation (e.g., in various mood disorder treatments) can also facilitate cognitive change processes. Similarly, there is attention to the process of cognition, such as noticing themes in content of underlying assumptions and core beliefs, as well as the information processes that strengthen maladaptive beliefs and accompanying behavioral strategies. Between sessions, clients practice strategies to consolidate cognitive and behavioral changes, but ensuring engagement can pose unique motivational and practical challenges (Kazantzis, Deane, & Ronan, 2005).

Despite the conceptual clarity of and empirical support for CBT, delivery in community settings can often suffer from low levels of engagement and high treatment dropout (Fernandez, Salem, Swift, & Ramtahal, 2015). These factors may relate to the significant lifestyle and other behavioral changes required by CBT. Thus, maximizing engagement is necessary to reach the full potential of CBT (Ballegooijen et al., 2014). Technology can play a helpful role in enhancing client experience of treatment (Andrews & Williams, 2014), improving engagement and, in turn, accelerating treatment response. For example, the between-session practice of therapeutic skills (or homework) can be recorded, tracked, and reviewed on an app, and mapped against recordings of symptom severity and improvement (Reger et al., 2013), though the evidence suggests there is currently an untapped potential for apps to support monitoring (Kazantzis, Brownfield, Mosely, Usatoff, & Flighty, 2017). When apps are used, they provide both a memory aid to complete homework and have the potential to improve motivation to experience the benefits of task completion.

A growing literature demonstrates that mobile applications may be useful adjuncts or modes for the delivery of psychological interventions (Firth et al., 2017a, 2017b). For example, Titov et al. (2015) compared four different variants of iCBT for depression, including either self-guided or clinician-guided, and transdiagnostic or disorder-specific. All variants were effective at reducing depressive symptoms and comorbid anxiety, and there were no significant differences in effectiveness between the variants, suggesting that self-guided, transdiagnostic iCBT can be just as effective as clinician-guided diagnosis-specific iCBT. Dear et al. (2016) replicated these findings for participants with social anxiety disorder, noting effects on comorbid depression, generalized anxiety disorder, and panic disorder. Meta-analyses have found strong effect sizes for iCBT programs over both waitlist and active control conditions (i.e., self-monitoring, discussion groups) with an overall superiority in effect size across anxiety and depressive disorders (i.e., g = .88, 95% CI = .76–.99 in Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010), and in transdiagnostic iCBT programs (i.e., g = .84, 95% CI = .67–1.01 for depression; g = .78, 95% CI = .57-398 for anxiety, : and g = .48, 95% CI = .35–.61 for quality of life in Newby et al., 2016). A meta-analysis of 13 studies comparing iCBT to face-to-face CBT found equivalence between the two modes of therapy (g=-0.01, 95% CI =-0.13, 0.12). However, iCBT programs are typically designed for use on personal computers, and may not be well suited to delivery via smartphones.

Individuals interact with smartphones and with personal computers in different ways. For example, a person's interaction with a therapy intervention delivered by computer in the privacy of their own home is very different from their public use of a smartphone in transit from one location to another. Smartphone use generally involves a greater number of shorter, more momentary interactions than personal computer use, across a greater number of situations and settings (Deloitte, 2016c). Available data suggest Americans may check their phone 46 times a day (Deloitte, 2016a) and engage with their smartphone more than computers (i.e., in Google, 2016— 170 min through the day; 12 min in the evening). Accordingly, there are design and feasibility issues for both the therapeutic intervention being delivered via Internet or smartphone, and the way the user interface is designed (Wendel, 2013). Although some evidence suggests that CBT programs can be delivered effectively and equivalently via either computer or smartphone (Watts et al., 2013), further evaluating the extent to which CBT interventions can be effectively delivered via smartphone applications is one of the important ways in which the evidence base for technology-augmented and -delivered CBT can be enhanced.

Few available MHapps have been specifically evaluated for their effectiveness as a mode of delivery, even if their techniques and strategies are based on a body of evidence

(Bakker et al., 2016; Donker et al., 2013; Van Ameringen, Turna, Khalesi, Pullia, & Patterson, 2017). It is possible, for example, that some CBT strategies are effective when completed under the guidance of a therapist, but when incorporated into an MHapp, unique challenges to smartphone apps may limit their utility. Similarly, smartphone apps may afford some CBT strategies greater flexibility and enhance their effects. For example, behavioral activation strategies and scheduling pleasant activities may be more accurately self-monitored when tracked using a self-guided MHapp, but recording and reappraising negative automatic thoughts may require initial introduction and skill acquisition in a private learning environment or therapy setting. Thus, as with iCBT, there is a need for research to address the gap that exists regarding CBT delivered via MHapps.

This paper will outline the development and pilot evaluation of a new MHapp, called "MoodMission," for the delivery of CBT strategies for managing mood- and anxiety-related problems. Details are given to aid practitioners in their understanding and use of the app with clients, and to inform the development of future apps by practitioners.

Current Evidence for Smartphone Delivered CBT

Compared to other modes of delivery, such as group, phone, or Internet-delivered CBT, there is currently a scarcity of published experimental evidence investigating the outcomes of MHapps using CBT strategies (Donker et al., 2013; Grist, Porter, & Stallard, 2017; Olff, 2015). While several studies have found evidence for the efficacy of MHapp interventions in the acquisition of specific CBT skills (e.g. Franklin et al., 2016; Kauer et al., 2012; Roepke et al., 2015), their limitations suggest the need for more research.

Studies that have investigated MHapps have tended to focus on relatively narrow clinical applications, or have used methods that do not represent typical smartphone use. For example, Roepke et al. (2015) found that the use of two different versions of the MHapp "SuperBetter" decreased depression symptoms in participants experiencing depression, compared with a waitlist control condition. However, the exclusion of participants who were not experiencing clinical distress obstructed investigation of preventative utility. Similarly, Kauer et al. (2012) found that the use of an app to track mental-health-related variables increased emotional self-awareness (ESA) and reduced depressive symptoms in depressed participants when compared to a control group. However, participants did not download the app to their own phones, but instead were given a device with it installed, and they reviewed the self-monitoring data they had collected with their doctor at several time points. While this suggests that MHapps can have impacts on depression and ESA, it does not demonstrate the effectiveness of MHapps in naturalistic self-guided applications.

Franklin et al. (2016) designed a therapeutic evaluative conditioning (TEC) MHapp which was effective at reducing self-cutting episodes, suicidal behaviors, and suicide plans. While this suggests an efficacious intervention, it was for a narrow clinical purpose and 76% of participants reported a history of psychiatric treatment. A publicly available MHapp like this would have significant barriers to access, as the vast majority of smartphone users would not consider downloading it, let alone using it outside of a research study context. There is a need to study MHapps designed for nonclinical populations, as these represent the target of the majority of MHapps available. The present study aimed to fill this gap in the literature by developing a publicly, freely available MHapp that was useful for individuals of all mental health statuses, adhered to latest evidence-based guidelines, and was capable of collecting data for further experimental evaluation.

Many existing MHapps have been designed for adolescent and young adult users (e.g., Ray's Night Out [Hides et al., 2015], WorryTime [ReachOut, 2016]). This is understandable given the high ownership rates in these demographics, with up to 98% of 18- to 24-year-olds owning a smartphone (Nielsen, 2016). However, high ownership rates are observed in other age demographics, with 97% of 25- to 34-year-olds, 96% of 35- to 44-year-olds, and 89% of 45- to 54-year-olds owning a smartphone. Furthermore, in a survey of 100 psychiatric outpatients, those aged 30–45 were more likely to want to use MHapps (81%) than those under 30 years of age (78%; Torous, Friedman, & Keshavan, 2014), and a significant proportion of patients aged 45–60 years also expressed interest in using a MHapp (71%). To meet this demand, future MHapps should be designed for smartphone owners of all ages.

It is important for MHapps to undergo usability testing before public release (Dubad, Winsper, Meyer, Livanou, & Marwaha, 2017). The technical justification for usability testing is to ensure that the intervention works reliably across multiple unique devices and under a variety of usage scenarios (Jaspers, 2009). Furthermore, novel self-guided CBT interventions require prerelease testing to ensure that their therapeutic aims are being achieved through the hypothesized mechanisms (Kinderman et al., 2016). This is to mitigate against the risk that the MHapp is used in an unintended manner and gives the developers the opportunity to adjust the intervention to realign its usage patterns with the therapeutic aims.

The MoodMission Smartphone Application

Reviewing the MHapp marketplace and literature, a gap was noted that could be filled by an app that would meet all 16 of Bakker et al.'s (2016) recommendations. This app would be designed for both clinical and nonclinical users, and help give direction to the question, "I'm low/anxious, what can I do right now to help?" The designed app was

intended to provide individuals with discrete, "mission"-based coping solutions for mood problems, so was given the name "MoodMission." MoodMission was designed to be an easy-to-use and engaging application to enhance mental health and well-being for smartphone users of all ages, adolescents and older, and all mental health statuses. It was a crowd-funded project specifically designed to be a noncommercial product and included comprehensive data collection strategies to facilitate evaluation. Research using this app could investigate the utility of various, discrete strategies for reducing specific types of distress, and, more broadly, the utility of similar MHapps across a range of clinical and nonclinical contexts.

CBT Strategies

MoodMission was designed with three primary aims: (a) to provide self-administered prevention and self-help strategies to reduce the risk of clinically significant mood and anxiety disorders; (b) to support stepped-care interventions (Vogl, Ratnaike, Ivancic, Rowley, & Chandy, 2016; White, 2010) as a platform for access to low-intensity intervention for low-level clinical symptoms or subclinical symptoms of depression and anxiety; and (c) as an adjunct to psychotherapy or other face-to-face treatments for mood and anxiety disorders. The strategies, called "Missions," contained within MoodMission originate from behavioral activation (Dahne, Kustanowitz, & Lejuez, 2017; Mazzucchelli, Kane, & Rees, 2009), relaxation (Manzoni, Pagnini, Castelnuovo, & Molinari, 2008), mindfulness (Hofmann, Sawyer, Witt, & Oh, 2010; Shipherd & Fordiani, 2015), physical exercise (Cooney et al., 2013), cognitive reframing (Butler, Chapman, Forman, & Beck, 2006), and other activities promoted or supported by CBT. Missions are designed specifically to be appropriate for a self-guided smartphone app, and due to the user-friendly interface, do not require introduction by a therapist. Time and environment constraints are also considered, with each Mission achievable within 5–10 minutes and in most public or private spaces. Missions were only included if they were suitable for adolescents as well as older users. Example Missions can be seen in screenshots presented in Figure 2.

Researchers aim to pursue controlled trials for empirical validation of MoodMission, so the app has built-in data collection, which will be collated and analyzed in time. The current paper reports on the development process and usability testing, presenting app functionality and data on user experience.

Interface Design and Engagement

A central consideration to the design of an MHapp is its appeal to the individual using it, which may transfer to how engaged they are in the intervention. Engagement may be defined in different ways; for example, many iCBT studies report retention rates as a measure of how many participants did not complete all the interventions' stages. Studies in face-to-face CBT have assessed the amount of therapeutic interventions completed by clients, also referred to as "homework" (Kazantzis et al., 2016). However, engagement is a broader concept than adherence or compliance and takes into consideration the degree of difficulty and obstacles experienced by the individual in attempting the intervention (Holdsworth, Bowen, Brown, & Howat, 2014). MHapps may facilitate engagement, not only through ease of access to information, automated recorded and tallying of responses, but through their interface, and the potential for improved assessment of engagement that would not be possible through paper-and-pencil worksheet completion (Kazantzis et al., 2017).

Game-inspired mechanics, sometimes referred to as gamification, can improve user engagement and understanding in eHealth interventions (Comello et al., 2016). This can be as simple as tracking the number of minutes spent meditating (example apps include Headspace, 2015; Smiling Mind, 2015). Gamification can be understood using self-determination theory (SDT), which emphasizes the roles of perceived autonomy and mastery on intrinsic motivation (Ryan & Deci, 2000). For example, the MHapp SuperBetter (SuperBetter Inc, 2014) awards users "resilience" points for completing short activities, helping users quantify and reflect on achievements (Roepke et al., 2015). SDT principles have previously been considered when improving client engagement and therapeutic outcomes in CBT (Tee & Kazantzis, 2011). Gamification harnesses the same principles to improve engagement with an app, but of the 27 MHapps in the Bakker et al. (2016) review, only 19% included gamification.

Recently published recommendations (Bakker et al., 2016) informed the development of MoodMission. Care was taken to keep MoodMission's design simple, easy to use, and with a distinct purpose so smartphone users, including adolescents and older adults, would be able to understand how to engage with it. Inclusive design cues were taken from broadly accessible apps, such as those that come standard on smartphone operating systems, as these apps are designed to be used by all potential users.

The formation of a behavioral plan for MoodMission was a dynamic process to accommodate as many recommendations as possible without overcomplicating the users' engagement. The Hook model of user-centered design proposed by Eyal (2014) was used to establish triggers for engagement, the actions involved in engagement, variable rewards, and generation of investment. As outlined in Table 1, a pre-intervention engagement plan was formulated to cover the pathway towards engagement with the intervention. Table 2 lists how MoodMission's behavioral plan accommodated Bakker et al.'s (2016)

Table 1
Preintervention Engagement Plan for MoodMission

Stage	Details
Promotion—user learns of MoodMission	Potential avenues included: *1. Web search* is likely to be used by individuals looking for self-guided mental health support. A well-designed website, search engine optimization, and options such as Google AdWords (Dirmaier, Liebherz, Sänger, Härter, & Tlach, 2016) may increase the visibility of MoodMission in these searches. *2. Healthcare providers* such as general practitioners, psychologists, social workers, or community health organisations, may suggest self-guided support options when they have contact with clients or patients suffering from preclinical or clinical psychological disorders (Bower & Gilbody, 2005). MoodMission can be promoted to healthcare providers, who can then make professional recommendations to suitable clients and patients. *3. Users promoting via their own online social networks* on sites like Facebook and Twitter can provide dissemination of products and ideas, especially ones that are highly viral (Weng, Menczer, & Ahn, 2013). Curation of official Facebook and Twitter pages can enable sharing. *4. Crowdfunding supporters* pledged money in return for rewards to raise the funds for the initial development of MoodMission. Pledgers are invested in the success of the projects they support and are likely to promote them among their own communities (Belleflamme, Lambert, & Schwienbacher, 2014).
Access—user downloads MoodMission	Considerations included: 1. Platform: iPhone development was more efficient to complete, so Android development was postponed until it could be financed. 2. App Store Category: The vast majority of MHapps can be found in *Health & Fitness* rather than *Medical*, *Lifestyle*, or others. 3. Price: Apps that are free to download are more likely to be accessed than ones that require an initial payment, even if it is a very small fee (Garg & Telang, 2014). There are models of revenue that do not rely on payments for downloads, including the subscription models, freemium models, and in-app purchases (Lambrecht et al., 2014). Adopting these free-to-download revenue models at a later date can help cover ongoing development and maintenance costs, while keeping accessibility high.
Onboarding—introducing MoodMission's interface and purpose	The onboarding process can enhance the user's understanding of the app and hence their engagement (Sian Morson, 2015). Five screens of images and text were devised to orient users to the triggers, actions, and rewards associated with MoodMission's use, and emphasize that MoodMission does not replace professional help and users should consult a GP, psychologist, or mental health professional for more support.
Completion of pre-intervention surveys	While compulsory completion of these surveys was predicted to be a potential barrier to further engagement with the app, collection of the survey data was necessary for experimental validation. A rationale was provided to users to encourage persistence through the surveys, emphasizing the short time that each survey would take, and the contribution the user would be making to important research.

recommendations, and the phases of the behavioral plan are displayed in Table 3. The end goal of the behavioral plan was to encourage repeated use of MoodMission so a positive habit of use forms. This is important for MoodMission to achieve its goal of enhancing an individual's repertoire of useful strategies for overcoming low moods and anxiety in a variety of contexts. It is expected that repeated use will lead to more learning opportunities. The pre-intervention surveys mentioned in Table 1 are detailed in Table 4.

Following formulation of a behavioral plan, the plan was converted into a series of diagrammatic "wireframes" that set out exactly how the individual would interact with the app through the various screens. Figure 1 shows one of the initial wireframes generated for MoodMission. These were used to approach app development firms and collect proposals and quotes. Spark Digital was the firm chosen to build and launch the app, based on their proposal and experience developing the MHapp Smiling Mind (2015).

Table 2
How MoodMission's Features Adhere to the Recommendations Made by Bakker et al. (2016)

Recommendation from Bakker et al. (2016)			Use in MoodMission
1	Cognitive behavior therapy (CBT) based	Start with an evidence-based framework to maximize effectiveness.	Uses a CBT-based system for categorization of Missions. Many Missions have origins in CBT.
2	Address both anxiety and low mood	Increases accessibility and addresses comorbidity between anxiety and depression. Also compatible with transdiagnostic theories of anxiety and depression.	Trigger for access is when users feel low or anxious. Treats anxiety and low mood as two different types of emotional distress.
3	Designed for use by nonclinical populations	Avoiding diagnostic labels reduces stigma, increases accessibility, and enables preventative use.	No diagnostic labels used. Emphasizes the normality of low moods and anxiety.
4	Automated tailoring	Tailored interventions are more efficacious than is rigid self-help.	MoodMission learns users' coping styles by noting which categories of Missions reduce distress for each category of problems.
5	Reporting of thoughts, feelings, or behaviors	Self-monitoring and self-reflection to promote psychological growth and enable progress evaluation.	Users select whether they are experiencing distressing thoughts, feelings, behaviors, or physiological responses. They then rate their distress on a scale 0-10.
6	Recommend activities	Behavioral activation to boost self-efficacy and repertoire of coping skills.	Five activities are suggested based on the user's report.
7	Mental health information	Develop mental health literacy.	Missions contain a "Why This Helps" section, providing psychoeducation and a rationale for doing the Mission.
8	Real-time engagement	Allows users to use in moments in which they are experiencing distress for optimum benefits of coping behaviors and relaxation techniques.	Trigger for engagement is real-time distress. Missions are designed to be real-time coping strategies, achievable in a wide variety of situations.
9	Activities explicitly linked to specific reported mood problems	Enhances understanding of cause-and-effect relationship between actions and emotions.	Missions are selected for specific mood problems and rationale is explained in "Why This Helps" section.
10	Encourage nontechnology-based activities	Helps to avoid potential problems with attention, increase opportunities for mindfulness, and limit time spent on devices.	Missions are designed to be nontechnology-based.
11	Gamification and intrinsic motivation to engage	Encourage use of the app via rewards and internal triggers, and positive reinforcement and behavioral conditioning. Also links with flourishing.	Badge-based rewards structure for completing certain achievements. Rank-based rewards for completing more Missions.
12	Log of past app use	Encourage use of the app through personal investment. Internal triggers for repeated engagement.	Mission Log documents all past Missions attempted in detail.
13	Reminders to engage	External triggers for engagement.	Push notifications alert users when they have incomplete Missions or when they have not engaged with MoodMission recently.
14	Simple and intuitive interface and interactions	Reduce confusion and disengagement in users.	Behavioral plan designed to be linear and intuitive. Clean graphic design reduces confusion.
15	Links to crisis support services	Helps users who are in crisis to seek help.	Link to Lifeline and other supports available throughout app.
16	Experimental trials	It is important to establish the app's own efficacy and effectiveness before recommending it as an intervention	Randomized controlled trial planned to compare MoodMission against waitlist and other MHapps.

The researchers' wireframes were clarified and expanded upon by the developers, and once confirmed by all parties, MoodMission's screens were graphically designed to be attractive and engaging. Design inspiration was taken from several other successful apps, such as the bright color gradients of Vent (2017), and the simple home screen of

Table 3
Outline of MoodMission's Behavioral Plan

Phase	Details	MoodMission key information
Trigger	How the user will be motivated to open MoodMission for mental health purposes	Triggered by distress associated with low mood or anxiety
Action	What the user will do within MoodMission once they open it and start engagement	User inputs information about their distress and is provided with a list of coping activities ("Missions") to choose from
Rewards	What reinforcements will incline the user to maintain their engagement with MoodMission	Gamified rewards are issued based on completion of Missions. User gains a sense of accomplishment and autonomy, and their overall distress is decreased
Generation of investment	How the reinforcements will lead to repeated engagements with MoodMission over time	Only five Missions are presented with every engagement, drawn from a much larger database. This keeps each engagement fresh and the user is constantly discovering new content. MoodMission learns a user's coping style so more engagements will lead to better Mission selections. Users pair MoodMission's use with trigger and will seek to engage with MoodMission under future episodes of distress.

Table 4
Outcome Surveys Administered in MoodMission

Construct Measured	Name of Measure	Reference	Rationale
Emotional Self-Awareness	Emotional Self-Awareness Scale	(Kauer et al., 2012)	Assess how reflection-focused MoodMission is (see Bakker et al., 2016)
Mental Health Literacy	Mental Health Literacy Questionnaire	No appropriate standardized MHL measure exists, so this questionnaire has been developed by the researchers.	Assess quality of psychoeducation and how education-focused MoodMission is (see Bakker et al., 2016)
Coping Self-Efficacy	Coping Self-Efficacy Scale	(Chesney, Neilands, Chambers, Taylor, & Folkman, 2006)	Assess how goal-focused MoodMission is (see Bakker et al., 2016)
Emotional Mental Health	GAD-7 PHQ-9	(Spitzer, Kroenke, Williams, & Löwe, 2006; Kroenke, Spitzer, & Williams, 2001)	Assess anxiety and depression symptomatology
Positive Well-being	Warwick-Edinburgh Mental Well-being Scale	(Tennant et al., 2007)	Assess positive psychological functioning and flourishing
Demographics [a]	(self-devised)	(self-devised)	Collect information about users' gender, age, education, and employment status for the benefit of analyses
App Feedback and Engagement [b]	Feedback Questionnaire	Adapted from the Mobile Application Rating Scale (MARS; Hides et al., 2014) by Rickard, Arjmand, Bakker, & Seabrook (2016)	Assess how engaged users are with the app, enabling analyses that correlate engagement with mental health and wellbeing outcomes

[a] Administered only in the initial surveys.
[b] Administered only in the 30 day follow-up surveys.

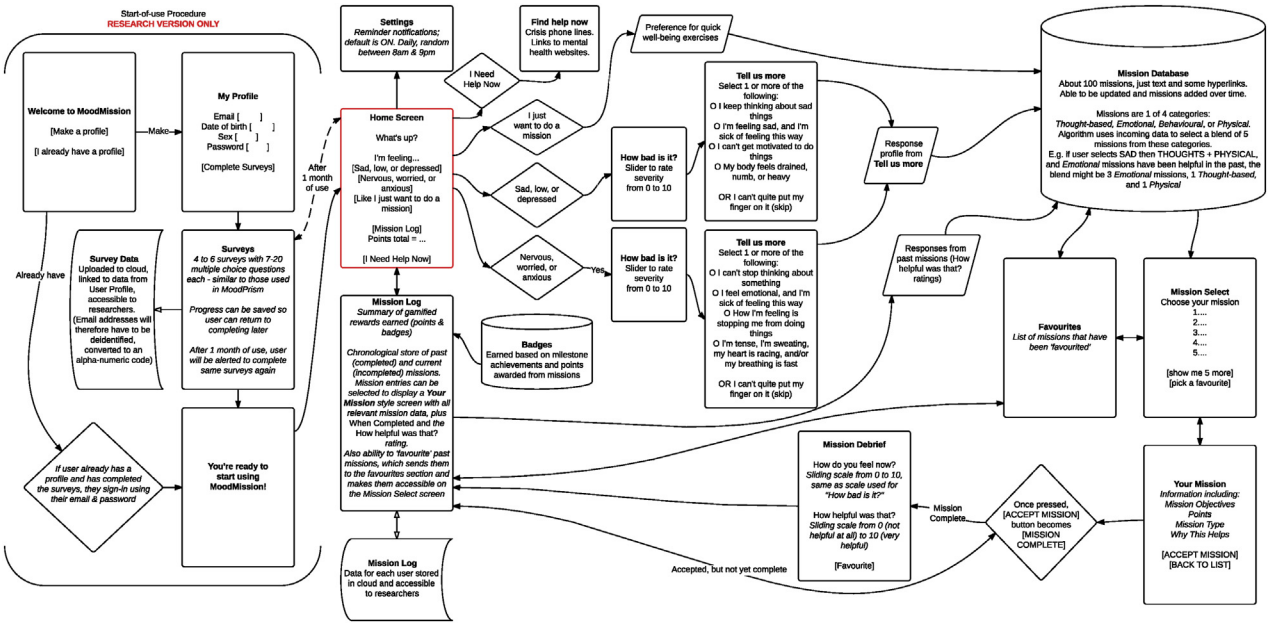

Figure 1. MoodMission early development wireframe

Pacifica (2016). Several design iterations were made before the researchers and developers confirmed each screen for the prototyping stage. Figure 2 illustrates several screens from MoodMission that demonstrate these designs.

MoodMission Usability Evaluation

Once the app's designs were confirmed, a prototype of the app was coded and made available to the developers for initial testing. This process included ensuring that all components from the designs were included, that the interactions proved pleasant and congruent, and that no significant bugs or errors were present. To test the app before it was launched on the App Store, a group of 60 "beta-testers" were recruited to use a prerelease version of MoodMission and provide feedback.

MoodMission was designed to be used in-vivo as participants experienced low moods or anxious feelings throughout their daily lives. This limited the utility of any laboratory-based usability testing methods, in which users engage with the intervention under studied laboratory settings (Jaspers, 2009). Collecting qualitative user reflections and responses on validated self-report usability measures about their experiences using the app was a highly scalable and intervention-appropriate option for informing MoodMission's initial development and ongoing improvements.

The Mobile Application Rating Scale (MARS; Hides et al., 2014; Stoyanov, Hides, Kavanagh, & Wilson, 2016), which was developed to rate mobile health applications, was used as a guide and foundation to determine usability. The guidelines for mobile health (mHealth) evidence reporting and assessment (mERA) checklist (Agarwal et al., 2016) was consulted to ensure that the app's implementation was rigorous and transparently reported.

Method

Participants and Recruitment

A total of 44 participants provided feedback about their use of MoodMission. Of these, 13 were beta-testers who were given access to the app before its public release, and 31 were participants in a randomized controlled trial (RCT) who had downloaded MoodMission from the iTunes Store. The beta-testers consisted of individuals who had pledged funds to the crowd-funding campaign that supported the initial development of the iOS app. The RCT participants had voluntarily opted in to a study on MHapps by providing their email address on an online form that had been advertised widely on social media. Like the beta-testers, RCT participants were asked to use MoodMission for the next 30 days before providing feedback as part of an online survey assessment. Participants were not drawn from clinical sources. Ages ranged between 18 and 62 years ($M = 36$, $SD = 13$), and 82% were female.

Materials

The User Version of the MARS (uMARS; Stoyanov et al., 2016) is a 26-item measure designed to rate mobile health applications in a standardized, multidimensional way, and is designed for end users rather than experts. Items are rated on a 5-point scale from Inadequate to Excellent, and are classified under six subscales, including Engagement (e.g., is the app interesting to use? Does it present its information in an interesting way compared to other similar apps?),

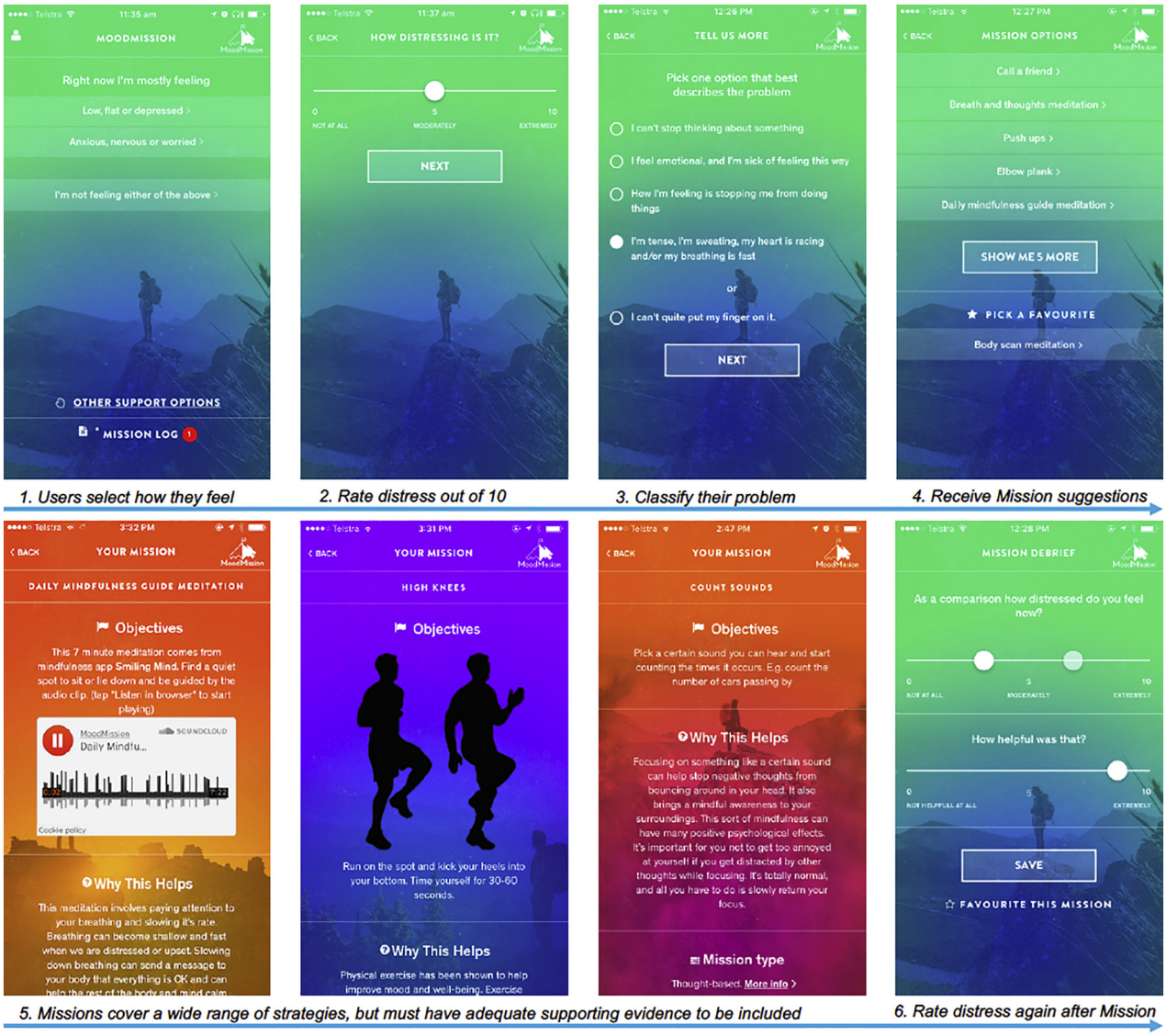

Figure 2. MoodMission sample screens displaying the app's behavioral plan

Functionality (e.g., How easy is it to learn how to use the app? How clear are the menu labels, icons and instructions?), Aesthetics (e.g., How good does the app look?), Information (e.g., is the information within the app comprehensive but concise?), Subjective Quality, and App-Specific. Norms for the MARS were developed by analyzing ratings for 50 mental health and well-being apps from two expert raters (Hides et al., 2014). Comparing obtained MARS ratings to these scores enables comparison to existing standards for MHapps. The uMARS has high internal consistency, Cronbach's α = .90, and good test-retest reliability, interclass correlation coefficient = .70 after 3 months.

The Homework Rating Scale–Mobile Application Version (HRS-MA; Bakker & Kazantzis, 2017) is a 12-item self-report scale designed to assess engagement and theoretically derived appraisals of CBT strategies used or recommended by MHapps. The HRS-MA contains 12 items (e.g., Quantity: I was able to do the activities; Rationale: The reasons for doing the activities were clear to me), closely modeled on the original HRS (Kazantzis et al., 2005), rated on a 5-point Likert scale from 0 (*not at all*) to 4 (*completely/extensive/ extremely*). In the present study, the HRS-MA achieved acceptable levels of internal consistency, Cronbach's α = .77, comparable to the original (i.e., Cronbach's α = .85; Hara, Aviram, Constantino, Westra, & Antony, 2017).

App Design and Content—mERA Checklist

Access of Individual Participants

The use of nonclinical language in MoodMission is designed to increase the accessibility of the app to individuals

who do not identify with having a diagnosed mental illness. However, to be motivated to download the app individuals still have to identify that they have occasional low moods or anxious feelings, and that strategies can help. These are potential barriers to access, so promotional efforts are aimed at reducing them by conveying the normalization message that "everyone has low moods and anxious feelings" and there are interventions that can help. For example, flyers for the app featured the slogan "change the way you feel," and social media posts used inclusive, normalizing language to encourage a "me too" reaction and sharing of posts within individuals' social networks.

Cost Assessment

MoodMission is free to download. The costs of maintaining the app, including server fees and developer updates, equate to about AUD$150 per month. Zero equity funding from a start-up accelerator program has been secured to cover these costs for the next 12–24 months. This funding will also support the development of additional features, which will be released as discrete, affordable in-app purchases to secure a self-sustaining revenue stream.

Adoption Inputs/Program Entry

MoodMission is designed to be used by novice, untrained users after downloading directly from the App Store. A series of "onboarding" screens educates the individual on the uses of the app. The app was promoted through social media channels, featured online articles, radio interviews, communications from Monash University, and blog posts. Care was taken to ensure that MoodMission's website was well designed and made downloading the app very simple, as this was the site linked to from other online promotions. Sending users notifications based on depression-screening measures can enable help-seeking in individuals who would not otherwise seek help (BinDhim et al., 2016), so a notification system was used to suggest mental health contacts and services to individuals who scored above clinical cut-offs on the depression and anxiety measures. These notifications were also delivered when individuals attempted three Missions at high distress and their distress did not significantly decrease following the Mission.

Limitations for Delivery at Scale

As a completely automated platform, MoodMission is highly accessible at scale. The main limitation to truly global scale is the use of written language and currently only English is supported. As the intervention garners support, the developers and researchers hope that translations can be achieved and multiple languages supported.

Contextual Adaptability

The Missions recommended by MoodMission are designed to be achievable across many settings and contexts, and they each take about 5–10 minutes to complete. However, many Missions may not be suitable for contexts where behavior is restricted; for example, when an individual is unable to practice a quick yoga move or go for a walk around the block. Offering a choice of 5–10 Missions overcomes this.

Replicability

Please refer to Figures 1 and 2 for a detailed account of the intervention, which may aid in replicability.

Data Security

All data collected by MoodMission are deidentified. Login details, including an email address and password, are stored unlinked to other user data, including survey answers and Mission data. User data are stored using a Firebase backend and hosted on Google's infrastructure. The app WordPress backend is hosted on an Amazon Web Services ec2 server with Linux.

Compliance With National Guidelines or Regulatory Statutes

At the time of writing, there is no regulatory system for MHapps. MoodMission's design has endeavored to follow all current evidence-based recommendations (e.g., Bakker et al., 2016).

Fidelity of the Intervention. Dummy accounts were created throughout the testing process to ensure that interactions with the app were being accurately recorded in the backend database. The results presented in this article provide evidence for the utility of MoodMission.

Infrastructure (Population Level). MoodMission is aimed at engaging typical smartphone users over the age of 12, and 77% of the U.S. population (comScore, 2015), 79% of Australians (Deloitte, 2016b), and 81% of adults in the U.K. (Deloitte, 2016c) use a smartphone. A survey of Australians revealed that 76% of adult smartphone owners were interested in using MHapps if they are free to download (Proudfoot et al., 2010).

Technology Platform. MoodMission was initially developed as an iPhone app for iOS 9 and above. It was coded using hybrid mobile app development and uses a WordPress backend, enabling more streamlined cross-platform development than using native coding. Development of an Android version of the app occurred after the successful launch of the iOS version. MoodMission is now available on both iOS and Android platforms.

Interoperability/ Health Information Systems (HIS) Context. The current version of MoodMission offers no

direct integration into existing health systems. However, future proposed developments for the app include a platform for psychologists and mental health practitioners to engage with patients and clients through the app.

Intervention Delivery. Individuals access MoodMission when they identify that they are feeling low or anxious. They report how they are feeling and are supplied with 5–10 Mission options. They can review the objectives and rationale for each Mission before accepting it. Following completing the Mission, they again rate how they feel. See Figure 2 for an illustration of this process. While it is possible that individuals may not experience a reduction in distress following a Mission, several design choices were made to help prevent a loss of confidence and subsequent disengagement. Firstly, Missions are not framed as definitive solutions, and are instead suggested as activities that may help out. Second, the large diversity of Missions is intended to give individuals hope that there are many options for coping. Third, care was taken to avoid impressions of expected results, so for example, badges and ranks are awarded for completing Missions rather than experiencing decreases in distress. Finally, push notifications are sent to individuals who have stopped using the app after a few days to encourage them to reengage.

Intervention Content. All Missions included in MoodMission have been taken from evidence-based psychotherapies, including but not limited to CBT, acceptance and commitment therapy (ACT; Brown, Glendenning, Hoon, & John, 2016), and dialectical behavior therapy (DBT; Kliem, Kroger, & Kosfelder, 2010). For a Mission to be included, it was required to have at least two good quality sources that established it as an effective strategy for decreasing anxious or depressive symptoms. For example, some Missions are drawn from behavioral activation, which has substantial evidence as an effective treatment for depression from a meta-analysis of 34 studies (Pooled effect size = 0.78, Mazzucchelli et al., 2009). Another meta-analysis of 20 studies found significant effects on improving psychological well-being (Pooled effect size = 0.52; Mazzucchelli, Kane, & Rees, 2010). Behavioral activation is made up of many strategies which could be appropriately translated into the MoodMission format, so reliable therapy resources were consulted to extract individual Missions from lists of behavioral activation strategies (e.g., G. Bakker, 2008; Dobson & Dobson, 2009). Missions in the database were classified as either anxious or depressive, depending on what evidence was available. Classification of Missions determined which were offered when individuals selected their current problem; e.g. only Missions classified as anxious were offered when the individual reported that they were anxious, nervous, or worried.

Procedures

Beta-testing participants downloaded MoodMission to their personal iPhones using app-testing software, before the public release of the app. The other RCT participants downloaded MoodMission from the iTunes Store. Participants were not instructed how to use MoodMission by the researchers, in order to replicate the circumstances by which individuals would naturally access the app throughout their daily routines. They were encouraged to email the researchers if they encountered technical difficulties, such as the app freezing or buttons being unresponsive. Care was taken to be responsive to these emails, and participants were updated about their reported issues and the subsequent software updates that fixed them. Several updates were released for the app throughout both beta-testing and public release phases, but these fixed small technical errors and none altered overall design or functionality. Thirty days after downloading MoodMission participants were emailed with a link to complete a feedback survey, administered by online platform Qualtrics. No identifying information was provided in this survey and because it was administered separately to the app-based surveys, data collected via MoodMission was unable to be paired to online survey responses. The online survey contained the uMARS, the HRS-MA, and several optional text-entry questions relating to the app's specific features. Following completion of the survey, participants were thanked for their time and were encouraged to provide any additional feedback via online form or email.

Results

Quantitative Results for Usability Analysis

Scores obtained on the MARS from 44 users, including 13 beta-testers and 31 study participants, were compared to the established norms (Hides et al., 2014). MoodMission scored higher than the MARS norms across multiple items, as seen in Figure 3 and Table 5.

Twenty Bonferroni-corrected two-way independent samples *t*-tests ($\alpha = .0025$) were performed for each comparison to establish significance, and Table 6 displays the results. Hedges's *g* was used as a measure of effect size, given the unequal sample sizes between the normative data and the collected data (Cumming, 2011). MoodMission scored significantly higher than the norms on the following items: Entertainment ($g = 0.89$), Interest ($g = 1.26$), Customization ($g = 0.57$), Target Group ($g = 0.75$), Graphics ($g = 0.97$), Visual Appeal ($g = 1.02$), Quality of Information ($g = 0.94$), Quantity of Information ($g = 1.14$), Visual Information ($g = 1.93$), Credibility of Source ($g = 1.97$), Recommendation to Use ($g = 1.19$), Estimated Frequency of Use ($g = 0.63$), and Overall Rating ($g = 1.10$). No significant differences from the norm ratings were observed in the remaining items.

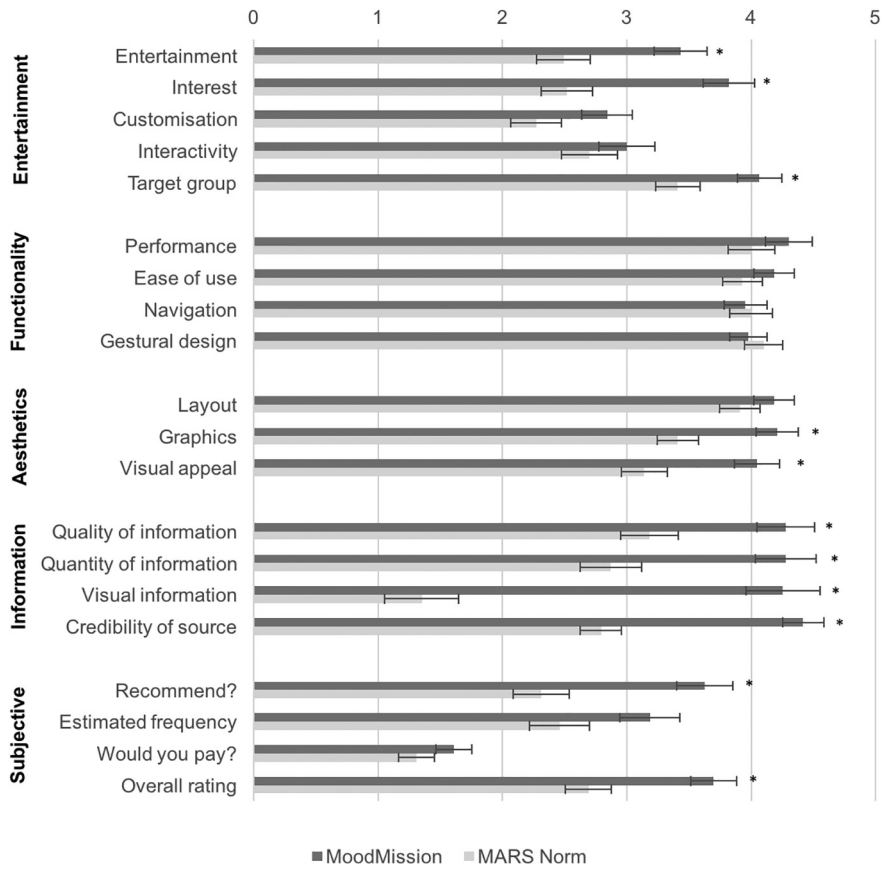

Figure 3. MoodMission MARS scores compared to norms. Error bars represent pooled SD, giving an estimation of 95% confidence intervals with within-subject variance removed. *$p < .0025$ (Bonferroni corrected p value)

Twenty-three participants completed the HRS-MA following the MARS: 96% reported that they were able to do some or more of the activities; 91% reported that they were able do the activities moderately well or better; 65% found the activities not at all or somewhat difficult, and 26% rated them as moderately difficult; 70% reported that they had no or little obstacles in doing the activities, and 22% had some obstacles; 96% reported that they understood the activities a lot or completely; 61% understood the rationale for the activities very or completely, with the remaining 39% understanding the rationale moderately; 78% reported that they had some, a lot, or extensive collaboration in planning the activities; 61% reported that the guidelines for carrying out the activities were very or extremely specific, and a further 30% reported that they were moderately specific; 43% agreed a lot or completely that the activities matched their goals for using the app, 30% agreed somewhat, and 22% agreed a little; 43% enjoyed the activities a lot or extremely, 30% enjoyed them somewhat, and 13% enjoyed them a little; 66% reported that the activities helped them somewhat, a lot, or extensively gain a sense of control over their problems, and 22% reported a little gain in control over their problems; and 78% reported that the activities helped somewhat, a lot, or extremely with their progress in using the app.

Qualitative Results

Of the 44 participants, 20 (12 beta-testers and 8 RCT participants) provided qualitative feedback via text-entry responses on the online surveys or email. Several themes from these messages were noted, and feedback-informed improvements were made to the app.

Surveys

Participants commented on the length of the surveys and the difficulty they had in feeling motivated to complete them. Some participants also had problems with the interface, as sliders and buttons behaved unpredictably. The interface issues were tuned and priority was given to removal of the surveys following the research phase of the app's development.

Missions

Participants reported that they enjoyed the Missions, particularly their speed, ease, and emotional relevance.

Table 5
Means (SD) of MARS scores for MoodMission and Norms

MARS Item and *Subscale*	MoodMission (n=44)	MARS Norm (n=50)
Entertainment	3.43 (0.81)	2.49 (0.81)
Interest	3.82 (0.78)	2.52 (0.78)
Customization	2.84 (0.80)	2.27 (0.80)
Interactivity	3.00 (0.96)	2.70 (0.96)
Target group	4.06 (0.81)	3.41 (0.81)
Total (Engagement)	3.43 (0.83)	2.67 (0.83)
Performance	4.30 (0.88)	4.00 (0.88)
Ease of use	4.18 (0.69)	3.93 (0.69)
Navigation	3.95 (0.72)	4.00 (0.72)
Gestural design	3.97 (0.67)	4.10 (0.67)
Total (Functionality)	4.10 (0.74)	4.00 (0.74)
Layout	4.18 (0.69)	3.91 (0.69)
Graphics	4.20 (0.70)	3.41 (0.70)
Visual appeal	4.04 (0.87)	3.14 (0.87)
Total (Aesthetics)	4.14 (0.75)	3.48 (0.75)
Quality of information	4.27 (0.70)	3.18 (0.70)
Quantity of information	4.27 (0.76)	2.87 (0.76)
Visual information	4.25 (0.87)	1.35 (0.87)
Credibility of source	4.41 (0.66)	2.79 (0.66)
Total (Information)	4.3 (0.75)	2.54 (0.75)
Recommend?	3.62 (1.02)	2.31 (1.02)
Estimated frequency	3.18 (1.20)	2.46 (1.20)
Would you pay?	1.6 (0.77)	1.31 (0.77)
Overall rating	3.69 (0.70)	2.69 (0.70)

Table 6
Results of *t*-Tests Comparing MoodMission MARS Scores to MARS Norms

	t	*p*	Hedges's *g*
Entertainment	4.39	<0.001	0.89
Interest	6.27	<0.001	1.26
Customization	2.81	0.006	0.57
Interactivity	1.33	0.187	0.27
Target group	3.65	<0.001	0.75
Performance	1.61	0.110	0.33
Ease of use	1.58	0.117	0.32
Navigation	-0.27	0.787	-0.06
Gestural design	-0.82	0.416	-0.17
Layout	1.70	0.092	0.35
Graphics	4.75	<0.001	0.97
Visual appeal	4.93	<0.001	1.02
Quality of information	4.74	<0.001	0.94
Quantity of information	5.72	<0.001	1.14
Visual information	9.75	<0.001	1.93
Credibility of source	9.73	<0.001	1.97
Would you recommend the app?	5.82	<0.001	1.19
Estimated frequency of use	3.02	0.003	0.63
Would you pay for the app?	2.08	0.040	0.44
Overall rating	5.48	<0.001	1.10

Note. $df = 92$ for all comparisons.

Participants who had experience with mental health services reported that the app helped them discover new mental health strategies or reinforced existing ones. Suggestions were noted to make the Missions more interactive and illustrative (e.g., on-screen animations to guide breathing exercises).

Design

Participants reported that they liked the visual and interface design of the app. The Achievements and Stats features were not well understood, so plans were made to make these features more accessible. Some persisting bugs were noted and plans made to rectify them in future versions.

Overall Impressions

Participants reported that using the app made them more conscious of their mental health, and using nonclinical language was helpful in making the app's messages accessible. However, others suggested that the lack of clinical language avoided addressing the stigma surrounding psychiatric or medication terms, and including psychoeducation about biological and chemical components of mental health problems may help individuals. One participant left the following feedback: "It is really comforting to know that I have MoodMission on my phone as a resource when things get tough. I know it's not connecting me with a real professional/someone to actually talk to in real time but it serves the equally valuable purpose of just being able to find some helpful strategies to approach challenging times without bothering friends at 1am in the morning; an app doesn't have "bed time" nor is it judgmental. Oddly, in that respect, you can trust an app and feel free to use it anytime. I want to keep using it and finish my goals."

Case Examples

Two constructed case examples are presented below, based on participant reports and the vignettes that informed the app's design process. Each reflects how the app can be used in a different context, but it should be noted that the app can be used in many more contexts than just these listed. For example, the app could be used in group therapy contexts, in hospitals, or in workplaces.

Case 1: Use in Individual Therapy

"Jake" is a 25-year-old male undergoing CBT for anxiety. Jake and his therapist decide that it would be useful for Jake to practice progressive muscle relaxation, and Jake's therapist coaches him through the exercise in therapy so Jake can continue practicing at home. However, at the next session, Jake admits that he did not practice the relaxation strategy for a number of different reasons, including his lack of alone time, feeling too anxious to begin the exercise, and ultimately his

skepticism that it would work. The therapist could troubleshoot these issues with Jake and develop a new plan for relaxation, or they could coach him through the downloading and use of MoodMission.

Jake uses apps on his phone regularly so is receptive to the idea of using MoodMission. While in the therapy session, he downloads the app and his therapist points out the app's features and uses. Leaving the session, Jake opens MoodMission when he's feeling anxious. He rates his anxiety 7/10, chooses "I can't stop thinking about something" to indicate his anxiety is mainly thought-based, and the app provides a tailored list of suggested strategies. The list gives Jake a choice, so he chooses the one that he feels is most achievable and suits his circumstances. This is the "This situation won't last forever" Mission, which involves him repeating the phrase in his head, applying it to his current situation, and writing it down as a reminder. He feels like this is a little helpful, and when finished rates his distress as slightly lower at 6/10.

The second time Jake uses MoodMission he reports feeling anxious at 8/10, again with anxious thoughts, but this time chooses the "Sit ups" Mission, which involves him doing 20 sit ups. After completing this he rates his distress as 5/10, as performing a short burst of physical exercise was particularly helpful for him to shake his anxious thoughts. The third time Jake uses MoodMission he reports 7/10 thought-based anxiety. The app suggests a few more physical-based Missions than the other categories, as past success indicates that these were helpful for Jake.

When Jake returns to his therapist, he opens MoodMission and shows his therapist his Mission Log. They review each Mission completed and Jake's therapist asks him a few questions about his experiences performing each Mission. Jake has discovered new coping options for him to reduce his anxiety, and his therapist has discovered that physical strategies, such as exercise, will be particularly useful for Jake progressing in therapy.

For Jake, using an app like MoodMission helped him discover a range of alternative coping options that were more achievable than progressive muscle relaxation. Jake's failure in completing the progressive muscle relaxation homework may have increased his sense of hopelessness, reinforcing the belief that relaxing is "too hard." Even if some of the Missions attempted by Jake were not successful at reducing his anxiety, the broad range of strategies on offer increase the likelihood that Jake will be hopeful to find something that works for him. MoodMission provided him psychoeducation about each strategy, giving him a rationale to engage. Reviewing his progress in the Mission Log, alone and with his therapist, enabled him to gain more self-insight and motivation to continue making therapeutic change.

Case 2: Use Outside of Therapy

"Annabel" is a 19-year-old female who has just started an undergraduate university degree. She has no history of mental health issues and does not know when or how she would seek help if she had a mental health related problem. She has moved away from her hometown and is now living in a residential college on campus. As she settles in to her new routine, she realizes that some of the things she used to enjoy doing are no longer available to her. She used to look forward to dinner table discussions with her siblings and parents at the end of the day, and she used to play sport on the weekends. Combined with the new stresses of college social life, starting a degree, and being in an unfamiliar place, she starts to feel quite down on herself. A flyer in her orientation pack mentions MoodMission as something that may help, so she downloads the app and reports feeling low. MoodMission suggests a list of strategies that she tries out and after a few she discovers that doing a short productive chore, like a load of laundry or cleaning her room, helps her feel better about herself. In this example, MoodMission has engaged Annabel in light mastery-based behavioral activation.

As the semester progresses Annabel is doing OK, but she experiences a particularly bad episode of low mood and anxiety in the week following exams. She attempts a few Missions on MoodMission, and due to her persistently high distress scores the app suggests that she visit her doctor about getting support. She sees her doctor who refers her to a therapist for treatment. With this therapist she is able to review her progress with MoodMission, so therapy can be efficiently tailored to her demonstrated strengths. In this example, Annabel is introduced to concepts of mental health self-care, she discovers new context-appropriate strategies for improving her mood, she is prompted to seek clinical support when it would be useful, and the start of her therapy is enhanced by her Mission Log data.

For Annabel, the mere promotional flyer for MoodMission serves as an acknowledgment that mental health is "real," and self-care is a helpful skill to develop. Using the app, she is able to reframe "boring" chores as important self-care achievements. This improves her understanding of the relationship between mood and activity levels. During her depressive episode, she struggles to experience improvements from the Missions, but is encouraged to seek help early, providing an earlier intervention therapeutic advantage. The app improves her help seeking by reducing barriers of uncertainty (e.g., "Should I see a therapist?" "How do I even arrange therapy?"), and reviewing her Mission Log improves the efficiency of the therapist's assessment.

Discussion

The purpose of this paper was to outline the development phases of a CBT-based MHapp for managing low moods and anxiety, and recommend future applications of this tool. The app development drew on recently published recommendations (Bakker et al., 2016) to optimize tailoring for individual users, incorporation of data collection capacity, and the use of validated CBT principles. The resulting app, MoodMission, successfully achieved this aim, with the delivery of an engaging CBT-based MHapp based in evidence-based principles. This app was successfully developed, tested, and released on the Apple iTunes Store. Preliminary testing revealed that MoodMission was rated superior to other health apps in terms of entertainment, aesthetics, and information. MoodMission has several anticipated applications across both clinical and research domains.

MoodMission could have many applications in both public and private health sectors as a clinical and preventative tool. MoodMission is an easily accessible, intuitive tool that does not require introduction by a health practitioner. General practitioners, counselors, social workers, and other professionals are able to recommend the use of MoodMission to at-risk populations. The flexibility of MoodMission allows it to cover most kinds of low mood and anxious distress, and built-in alerts recommend accessing professional mental health support if an individual's responses indicate sufficient severity.

Tang and Kreindler (2017) outline features of MHapps that can be used for the tracking, encouragement, and compliance of homework activities in CBT. MoodMission has features that meet each of the six recommendations: congruency to therapy, fostering learning, guiding therapy, building connections, emphasizing completion, and population specificity. Future work will focus on ways of integrating MoodMission into the practices of CBT clinicians so the app can be used collaboratively to set and review homework.

A firm evidence base establishing the effectiveness and efficacy of MoodMission is required to enable adoption by health professionals. At the time of writing, MoodMission has one RCT in progress investigating its efficacy in improving mental health, positive well-being, emotional self-awareness, mental health literacy, and coping self-efficacy. MoodMission also collects effectiveness data from every individual who completes the in-built assessment surveys. Using frequency of use as a variable allows controlled investigation of the app's effects on mental health and well-being, as described by Carpenter et al. (2016) for analysis of data from the well-being app Happify. It is anticipated that future publication of the RCT and the effectiveness data will support MoodMission and other similar MHapps as efficacious and effective self-guided mental health tools.

MoodMission also holds promise as a way of investigating research questions beyond the effects of the app itself. In addition to outcome data collected via surveys, MoodMission collects data that can be used to investigate the effectiveness of specific Missions. Comparing the pre-mission and post-mission distress scores for specific Missions may reveal how effective they are at reducing specific types of distress. This would enable objective comparison between two similar psychological techniques for the same type of distress. Findings could inform therapeutic work done by clinical psychologists and guide them to encourage the most effective evidence-based techniques for their clients' unique distress.

A distinct benefit that MoodMission can afford researchers of different psychological therapies is component analysis. Therapies are made up of collections of techniques and strategies (Mennin, Ellard, Fresco, & Gross, 2013). For example, CBT interventions for panic disorder may include components of exposure, relaxation, and cognitive restructuring (Craske & Barlow, 2014). However, evidence for specific strategies within evidence-based interventions is lacking. This is in part due to methodological limitations, as most studies of CBT treat large groups of participants with different intervention variants, and variation is on the macro level rather than the micro, strategy-based level. MoodMission enables ecologically valid comparisons between each of these components to identify those with the greatest impact on distress and anxiety symptomatology. Furthermore, strategies can be assessed on their preventative power, and their effects on individuals without identifiable clinical disorders. In the case of panic disorder, data from users' anxious thought-based problems could be parceled out and distress score differences could be compared between a mindfulness body scan meditation and a similar simple relaxation exercise. Component analysis research is often confined to strictly controlled situations in which participants receive slightly adjusted versions of the same therapy (e.g., Borkovec, Newman, Pincus, & Lytle, 2002; Jacobson et al., 1996; Linehan et al., 2015). Such research is resource intensive and is only able to compare two or three different techniques at a time. MoodMission allows easier component analysis across a wide range of very different therapeutic techniques to find the most efficient, effective treatments of low mood and anxiety.

The artificial or controlled settings of many laboratory- or clinic-based studies may reduce the ecological validity of findings concerning the effectiveness of certain distress-reduction strategies. For example, recall biases may limit participants' ability to accurately recall levels of distress or the effectiveness of coping strategies hours or days after experiencing the distress (Shiffman, Stone, & Hufford, 2008). MoodMission allows participants to record their distress in the moment that they are

experiencing it and rate the effectiveness of strategies immediately after they are used. This reduces recall biases and provides participants with immediate feedback on the helpfulness of the strategies.

Most studies that use therapists to deliver different modes of therapy are inherently influenced by a practitioner's skill level for particular modes of therapy (Lambert, 1989; Westen, Novotny, & Thompson-Brenner, 2004). For example, one therapist may prefer cognitive restructuring over imaginal exposure in their own practice, so when they are involved in a study that compares the two therapeutic modes, they are likely to present cognitive restructuring with more skill than other experimental conditions. MoodMission bypasses these presentation biases by presenting all therapeutic techniques in a consistent fashion.

While MoodMission was designed to be appropriate for all smartphone users over the age of 12, some specific age groups and demographics may derive more benefit than others. For example, the needs of undergraduate university students aged 18–25, like Annabel from Case 2, are particularly compatible with MoodMission's features. These young adults are often exposed to new, stressful situations, and relied upon coping mechanisms may have recently become inconvenient or inappropriate. Teaching flexible, evidence-based coping strategies may have a protective effect for this demographic, potentially preventing the onset of mental health issues at this critical life stage. This age group also has a high rate of smartphone usage, making MoodMission suitable for both clinical and research applications.

Research that investigates models of therapy often uses clinical samples made up of individuals who qualify for some sort of diagnosis or achieve a certain score on a measure of symptoms (Henry & Crawford, 2005). MoodMission allows for inclusion of both clinical and nonclinical samples, as individuals do not need a diagnosis to engage with the intervention. MoodMission is therefore capable of investigating both the clinical and preventative utility of mental health interventions, as well as how different individuals engage with these interventions.

This study was limited by the relatively small sample size and the noninvasive assessment methods used. However, this was a pilot evaluation to prepare MoodMission for public release, and planned future studies aim to collect data from much larger and more representative samples of participants who are using the app in a wider variety of situations. Future studies will also aim to collect in-depth user cases, increasing the resolution and comprehensiveness of the assessments to collect richer data about individuals' experiences using the app.

There is a balance in app development between: (a) releasing a prototype app and making fixes as user feedback is received, and (b) conducting extensive in-house testing before releasing it to the public. The risk with option (a) in the above is that provoking frustration in users who are expecting a fully functional product, while the risk with option (b) is the public may disagree with many of the choices of the in-house team, and the app may need major adjustment. Traditionally, psychologists have designed CBT interventions with patient feedback informing changes after implementation. However, the self-guided nature of MHapps increases the utility of user feedback. This project aimed to achieve a compromise between options (a) and (b), but there is a possibility that more user involvement at the very early stages of design and development may have increased the utility of MoodMission.

In conclusion, MoodMission is a mental health smartphone app, built using evidence-based therapeutic techniques, that aims to build its own evidence base as an effective intervention. It was designed using recommendations from Bakker et al. (2016) informing a behavioral plan using a trigger, action, reward, investment loop (Eyal, 2014). There are many potential therapeutic and research uses for MoodMission, and it is anticipated that these applications will be developed and evaluated over the coming years.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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