ASSESSING THE EFFICACY OF A SELF-ADMINISTERED TREATMENT FOR SOCIAL ANXIETY DISORDER IN THE FORM OF A GAMIFIED MOBILE APPLICATION

A Thesis
by
DANIEL LEWIS GEORGE

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Abstract

ASSESSING THE EFFICACY OF A SELF-ADMINISTERED TREATMENT FOR SOCIAL ANXIETY DISORDER IN THE FORM OF A GAMIFIED MOBILE APPLICATION

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Social anxiety disorder (SAD) is not only a highly prevalent and impairing mental disorder, but it is also vastly undertreated. Because effective treatments exist for SAD but are not reaching many with the disorder, it is important to investigate and design novel treatment delivery methods. To this end, our study set out to determine whether such a treatment could be made more effective through two novel mechanisms: (a) delivery of the treatment on a mobile smartphone; and (b) the gamification of the treatment. Utilizing a single-subject multiple baseline across participants design, the efficacy of the treatment was evaluated on a sample of undergraduate students (N = 10) who endorsed significant social anxiety on a self-report measure. Participants completed assessments every four days during a 12-, 16-, or 20-day baseline phase and a 44-, 40-, or 36-day treatment phase. Seven of ten participants completed all measures and were used in the final analysis. At the study's conclusion, these participants showed a statistically significant mean decrease of 13,

95% CI [2.05, 23.94], $t(7) = 2.907$, $p = .027$, $d = 1.461$ on the BFNES, and a statistically significant mean decrease of 24.58, 95% CI [4.69, 44.46], $t(7) = 3.024$, $p = .023$, $d = 1.288$ on the LSAS-SR. Participants showed no statistically significant changes on the K10 ($p = .336$, $d = 0.379$) or WHOQOL ($p = .112$, $d = 0.450$). These results suggest that this application may be effective as a stand-alone treatment for SAD.

Keywords: social anxiety, mHealth, eHealth, mobile technology, gamification

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Finally, I would like to thank my brother, David George for programming the application that allowed this thesis to be a reality. He dedicated more than a year of his time to bringing this application to life and I am incredibly grateful to him for it. His programming expertise and creativity continue to astound me.

Dedication

This thesis is dedicated to my parents Mary and James George for their unwavering support, love, and encouragement over the years. They have stuck with me as I've traveled a circuitous path towards my values, allowing me to become the person that they believed I could be.

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Assessing the Efficacy of a Self-Administered Treatment for Social Anxiety Disorder in the Form of a Gamified Mobile Application

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Abstract

Social anxiety disorder (SAD) is not only a highly prevalent and impairing mental disorder, but it is also vastly undertreated. Because effective treatments exist for SAD but are not reaching many with the disorder, it is important to investigate and design novel treatment delivery methods. To this end, our study set out to determine whether such a treatment could be made more effective through two novel mechanisms: (a) delivery of the treatment on a mobile smartphone; and (b) the gamification of the treatment. Utilizing a single-subject multiple baseline across participants design, the efficacy of the treatment was evaluated on a sample of undergraduate students (N = 10) who endorsed significant social anxiety on a self-report measure. Participants completed assessments every four days during a 12-, 16-, or 20-day baseline phase and a 44-, 40-, or 36-day treatment phase. Seven of ten participants completed all measures and were used in the final analysis. At the study's conclusion, these participants showed a statistically significant mean decrease of 13, 95% CI [2.05, 23.94], $t(7) = 2.907$, $p = .027$, $d = 1.461$ on the BFNES, and a statistically significant mean decrease of 24.58, 95% CI [4.69, 44.46], $t(7) = 3.024$, $p = .023$, $d = 1.288$ on the LSAS-SR. Participants showed no statistically significant changes on the K10 ($p = .336$, $d = 0.379$) or WHOQOL ($p = .112$, $d = 0.450$). These results suggest that this application may be effective as a stand-alone treatment for SAD.

Keywords: social anxiety, mHealth, eHealth, mobile technology, gamification

Assessing the Efficacy of a Self-Administered Treatment for Social Anxiety Disorder in the Form of a Gamified Mobile Application

Social anxiety disorder (SAD) is both significantly impairing and highly prevalent, with 13% of the US population meeting diagnostic criteria for the disorder at some point in their lives (Rapee & Heimberg, 1997). Among U.S. adults, 12-month prevalence rates are 6.8%, with one-third of these cases classified as severe (Kessler et al., 2005). The essential feature of SAD is anxiety or fear associated with social situations in which the individual may be subject to the evaluations of others (American Psychiatric Association, 2013). Individuals with SAD fear that their anxiety symptoms and behaviors are visible and that they will be evaluated negatively by others. For such individuals, social situations almost always provoke intense anxiety that is out of proportion to any actual threat. This intense fear of scrutiny and negative evaluation can lead to avoidance behaviors that impair the individual academically, occupationally, and socially, leaving individuals with SAD less likely to graduate from college, less productive in the workplace, and more likely to be unmarried, single, or divorced (Stuhldreher et al., 2014; American Psychiatric Association, 2013). The disorder also exacts a significant economic burden, with both direct and indirect costs including outpatient, inpatient, and pharmaceutical treatment expenditure, increased workplace sick leave, and disability pension payments (Stuhldreher et al., 2014).

Despite the increased recognition in the last two decades of the disorder's individual and societal costs, SAD remains an undertreated psychiatric disorder, with only 40% of those with the disorder receiving any treatment at all (Stein & Stein, 2008; Wang et al., 2005). Even among those who do receive treatment, dropout rates are high, with research suggesting that up to 85% of those with the disorder do not attend follow up sessions after an initial

interview (Santana & Fontenelle, 2011). Additionally, SAD substantially increases risk for the development of depression and is associated with a more treatment resistant form of depression (Beesdo et al., 2007). In one study, a third of patients with SAD reported suicidal ideation within the last year while 12% reported a suicide attempt at some point in their lives (Cox, Direnfeld, Swinson & Norton, 1994).

Effective Treatments for SAD

Despite the potential severity of SAD, there are a number of effective treatments including exposure therapy and cognitive restructuring (Heimberg, 2002; Rodebaugh, Holaway, & Heimberg, 2004), social skills training (Bögels & Voncken, 2008), and applied relaxation (Rodebaugh et al., 2004), with pharmaceutical treatments considered a second-line treatment only for those not interested in therapy (National Institute for Health and Clinical Excellence, 2013). A review of five meta-analyses by Rodebaugh, Holaway, & Heimberg (2004) that examined the efficacy of various cognitive-behavioral therapy (CBT) techniques in treating SAD (including exposure, applied relaxation, cognitive restructuring, and social skills training) concluded that all four techniques achieved moderate to large effect sizes when compared to waitlist control conditions. Further, the meta-analysis showed moderate to large pre-to post-treatment effect sizes within each treatment group.

In addition to CBT treatments, more recent evidence suggests that mindfulness and acceptance-based treatments (MABTs) are effective in the treatment of SAD. A systematic review of MABTs for SAD found that SAD symptomatology improved following MABTs, although these reductions were equivalent to or less than CBT outcomes (Norton, Abbott, Norberg, & Hunt, 2015). Evidence suggests that mindfulness-based cognitive therapy (MBCT) may be particularly effective in the treatment of SAD. MBCT combines traditional

CBT strategies with mindfulness and acceptance techniques. Two studies examined MBCT for the treatment of SAD related symptoms, finding significant improvements in social anxiety symptomatology, functional impairment, and distress both post-treatment and at follow-up (Bogels, Sijbers, & Voncken, 2006; Mulkens, Bogels, de Jong, & Louwers, 2001).

Addressing Treatment Barriers

Though it is clear that there are a number of effective treatments for SAD, low treatment rates, high dropout rates, and the significant impairment and distress experienced by individuals with the disorder highlight the importance of developing novel delivery methods. Research in the past decade has examined a number of promising treatment delivery methods ranging from purely self-administered bibliotherapeutic treatments to internet-delivered CBT. Carlbring et al. (2006) showed that internet-based bibliotherapy that included minimal therapist contact through email led to significant social anxiety symptom reduction, with treatment gains maintained in a 6-month follow-up. Additionally, Carlbring et al. (2007) ran a similar study with internet-delivered CBT that was augmented by weekly short telephone support calls with a clinician. When compared to a waitlist control group, the treatment group participants showed significant reductions on measures of social anxiety and avoidance. Encouragingly—when considering the high rates of SAD treatment dropout—93% of participants in the study completed the entire treatment.

In addition to internet-delivered treatments, other researchers have looked at the use of more traditional bibliotherapy interventions, in the form of workbooks. Utilizing a social phobia workbook, Rapee, Abbott, Baillie and Gaston (2007) compared pure self-help with therapist-augmented self-help in the treatment of SAD. They found that both therapist-augmented and pure self-help were more effective than waitlist conditions, although the

therapist-augmented self-help was most effective. The authors reported that the pure self-help condition showed relatively modest results and had limited value in the treatment of SAD. However, when bibliotherapy was augmented by five group CBT sessions it showed no statistically significant difference in efficacy when compared to ten group CBT sessions. Rapee et al. (2007) admitted that the limited efficacy of the pure self-help condition may be related to their sample, in which severely phobic individuals and individuals with avoidant personality disorder were overrepresented. The authors concluded that a sample with a milder presentation might be more amenable to pure self-help. A more recent study showed more promising results for pure self-help, finding that bibliotherapy alone showed significant effects in reducing SAD symptomatology, reductions that were maintained at follow-up (Furmark et al., 2009). Although the research on purely self-administered bibliotherapy for SAD remains equivocal, a recent meta-analysis found guided self-help with only minimal support from therapists to be as or more effective than face-to-face treatments in reducing symptoms of depression and anxiety disorders (Cuijpers, Donker, van Straten, Li & Andersson, 2010).

One commonality in the majority of the aforementioned studies on self-administered treatments is their utilization of technology to deliver treatments, from email to custom-designed websites. Evidence suggests that technology-assisted psychotherapeutic interventions may have a number of benefits in general, including increasing access to treatment and reducing treatment costs (Newman, Szkodny, Llera & Przeworski, 2011). While much of the research in the last 20 years has focused on the use of internet-connected personal computers for the delivery of treatments, more recent research has begun to focus on the potential use of mobile smartphone technology. In 2013, nearly two-thirds of US

adults owned a smartphone (Smith, 2013). In addition to their ubiquity, mobile devices are typically always with the individual, with the ability to prompt the individual with reminders and alerts, a concept that I will hereafter refer to as presence. This presence not only simplifies the collection of real-time clinical data, including information about clinically relevant symptoms and behaviors (Clough & Casey, 2011), but it also has potential to facilitate and enhance the delivery of treatments.

In the last decade, mobile phones have been utilized in the treatment of both medical and mental disorders. A study by Grassi, Preziosa, Villani, and Riva (2007) used mobile phones to deliver relaxation exercises, with participants showing significant reductions in anxiety. In a follow-up study, Preziosa, Grassi, Gaggioli and Riva (2009) looked at the use of a mobile phone delivered stress management treatment and found a significant reduction in anxiety when compared to a video-based treatment or a no-treatment control group. In both studies, the researchers modified a stress inoculation training protocol in to an audiovisual narrative that could be presented on the participants' phones in situ. Evidence suggests that there are numerous potential mechanisms that may make mobile technologies clinically effective, such as the ability to present interventions in real world settings, allowing for easier application and practice, as well as the potential for "increased client interaction and enjoyment with therapeutic tasks" (Clough & Casey, 2011, p. 283). Additionally, the potential to dispense therapeutic interventions through mobile technologies to populations suffering from mental disorders is great, with a recent study finding that 72% of individuals with severe mental illness who were surveyed owned and used a mobile phone (Ben-Zeev, Davis, Kaiser, Krzsos & Drake, 2013).

Gamification

One result of the rapid rise in smartphone usage has been an explosion of mobile gaming, with worldwide mobile gaming revenue forecasts for 2018 set at $45 billion (Digi-Capital, 2018). The widespread adoption of mobile gaming has led to the emergence of a relatively new phenomenon wherein game mechanics are utilized to motivate individuals to engage in desired behaviors, a process known as gamification (Schoech et al., 2013). Although the term gamification is a fairly recent one, the concept of using similar mechanisms for behavior change has a long history in the behavioral health field in the form of token economies (Kazdin, 1982). Modern gamification techniques utilize motivational elements that have been discovered through the creation of video games. These elements include but are not limited to: (a) points: a representation of accrued credits for the completion of tasks; (b) levels: a graded system of achievement based on the accumulation of points; (c) characters: visual and often anthropomorphic representations of a player; (d) storylines: stories through which players progress from beginning to end; and (e) progress bars: visual representation of a player's progress through a certain task. By applying game design elements such as these to real-world contexts like health and financial behaviors, gamification allows practitioners to apply the strengths of games towards managing real-world problems. Studies reviewed by Schoech et al. (2013) suggest that evidence is mounting that games can be utilized to improve lives through modifying healthy behaviors, such as encouraging healthy eating and physical activity, aiding smoking cessation, and increasing adherence to cancer and diabetes treatments regimens.

A number of studies have utilized gamification to enact positive health behavior change with promising results. For example, one study successfully used an interactive video

game to increase self-care behaviors among children diagnosed with diabetes (Brown et al., 1997). Further, a 2003 study used a multimedia psychoeducational game to increase the consumption of fruit and vegetable juice among a large sample of elementary school students, with the finding that children who participated in the game significantly increased their consumption relative to a control group (Baranowski et al., 2003). Video game based interventions have also demonstrated efficacy in older populations. A literature review by McCallum and Boletsis (2013) concluded that a number of different games that encourage exercise were effective in increasing physical activity among elderly individuals. Although the potential for using gamification specifically for the treatment of mental disorders represents a nascent field of exploration, some existing studies show encouraging results. For example, a study that used a gamified "attention-bias modification training" application found that one session of the training reduced anxiety and stress reactivity when compared to placebo (Dennis & O'Toole, 2014).

While both mobile applications and gamified treatments have been used effectively in the treatment of a wide array of physiological and psychological disorders, there are a number of potential advantages in utilizing a gamified mobile application in the treatment of SAD specifically. As discussed previously, the majority of those with the disorder are untreated. Fear of the intense social interactions that accompany the psychotherapeutic process—from setting up appointments to prolonged evaluations—likely acts as a barrier to seeking treatment at all. High treatment dropout rates may also be a result of the intense discomfort those with SAD experience during initial therapy sessions. Self-administered treatments, whether bibliotherapeutic or technology-based, offer a potential alternative by allowing individuals with SAD to be exposed more gradually to social situations and at their

own pace. If those with SAD are able to find a competent therapist, undergo initial evaluations and stick with therapy, it is likely that they will benefit from exposure inherent in the process of therapy as well as the motivation and encouragement that the therapist provides. However, the evidence suggests that this ideal situation has not been a reality for those with SAD, with only a small percent of those with the disorder receiving even minimally adequate treatment. Although self-administered treatments may not be able to provide the personalized approach of a skilled therapist, gamified treatments in particular have the potential to provide comparable levels of motivation and encouragement. By providing such treatments on mobile phones, they may even have an advantage over traditional therapy by allowing the process of therapy to occur in real world contexts at any time rather than within the constraints of the 50 minute weekly or biweekly therapy session.

A Gamified Mobile Application

In the present study, we investigated the use of a gamified mobile application in the implementation and delivery of a set of empirically-supported interventions for the treatment of SAD. The interventions included psychoeducation, cognitive restructuring, mindfulness, acceptance, and exposure that were embedded within the framework of a mobile game with game mechanics that included points, levels, awards, and customizable characters. The application had the advantages of presence and interactivity while drawing on the proven efficacy of bibliotherapeutic interventions. Building on research that suggests a limited potential for purely self-administered interventions—in particular, the findings by Rapee (2007) that a pure self-help bibliotherapy treatment is less effective in the treatment of SAD than therapist augmented treatments—we endeavored to determine the effectiveness of a purely self-administered gamified mobile application. Our hypothesis that a gamified mobile

application might increase treatment effectiveness was partly based on previous findings that indicate that motivated clients benefit the most from self-administered interventions (Newman, Szkodny, Llera & Przeworski, 2011). Our supposition was that gamification might help to provide the additional motivation necessary for those less motivated clients, increasing the overall efficacy of purely self-administered treatments.

In this study, we measured the efficacy of a self-administered gamified mobile application (GMA) intervention in the treatment of SAD, as measured by pre- and post-treatment symptom reduction. We hypothesized that the GMA intervention would significantly decrease the participants' self-reported level of social anxiety on the Brief Fear of Negative Evaluation Scale (BFNES; Leary, 1983; Carleton, Collimore, McCabe & Anthony, 2011), a widely used measure of SAD symptomatology. In addition, a number of secondary measures were given pre- and post-treatment to determine changes in overall distress, quality of life, and social fear and avoidance, with the secondary hypotheses that each of these measures would reflect change in a beneficial direction.

Method

Participants

To be included in the study, the participants had to meet the following inclusion criteria: (a) be at least 18 years old; (b) and possess an iPhone 5 or more recent version of the iPhone. Participants were excluded from the study if they: (a) were undergoing current psychotherapeutic treatment; or (b) currently met the criteria for substance use disorder as indicated by a Drug Abuse Screening Test (DAST; Skinner, 1982) score of 7 or higher, indicating current substance use disorder. Both the inclusion and exclusion criteria were consistent with criteria used in previous studies that looked at self-administered treatments

for SAD including Rapee et al. (2007), Carlbring et al. (2006), Carlbring et al. (2007) and Furmark et al. (2009).

Participants consisted of 10 individuals (90% female; 100% Caucasian; M_{age} = 19, *SD* = 1.054) with elevated social anxiety symptoms on the BFNES. All participants were undergraduates at a moderately sized public university in the southern United States. Participants varied in employment status (60% unemployed; 40% employed part-time) and relationship status (60% single, 40% in a relationship). All but one participant reported that they felt that their iPhone was a necessary item and that they could not leave home without it and endorsed phone usage ranging from one to three hours of phone usage per day to more than six hours. In regards to self-reported previous mental disorder diagnoses, one participant reported comorbid diagnoses of social anxiety disorder, major depressive disorder, and generalized anxiety disorder, two participants reported generalized anxiety disorder diagnoses, and the remaining seven reported no formal diagnoses. This and other demographic information is presented in Table 1.

Materials

Gamified mobile application treatment. The mobile application was designed by the study's main author and programmed by his business partner who has expertise in programming applications for Apple's mobile operating system, iOS. The application was based on a modular approach to CBT and MBCT aimed at treating SAD. These treatments were dispensed through the participants' smartphones across different stages and levels. Throughout, gamified elements such as points, coins, and character customizations fostered motivation and engagement. The following subsections discuss the content and gamified

elements of the application in more detail. Each participant will hereafter be referred to as a "player."

Structure of the application. The first time the application is opened, the player was presented with a brief tutorial outlining how the application is used and the meaning of the screen elements. Each screen contained within the application is outlined below.

Gameboard screen. The gameboard screen (see Figure 1) was the main screen of the application and the first screen the player saw each time he or she opened the application. At the bottom of the screen there was a navigation bar that continuously displayed the player's avatar, number of points, and number of coins. Additionally, the navigation bar allowed the player to access his or her profile by touching the avatar image. The gameboard screen displayed a visual representation of the player's progress through the stages and levels of the game. As the player progressed, the next level was unlocked.

Character & character customization screen. The character screen showed the current state of the player's customized character. By touching a "customize" button, the player was taken to the character customization screen where they were able to purchase different character customizations such as hats, pants, or different facial features with earned coins (see Figure 2).

Settings screen. The settings screen was accessed through the navigation bar and included the ability to change account login information, to change the four-digit passcode for access to the app, and to set reminders.

Gem gallery and coins screens. The gem gallery was accessed through the navigation bar and allowed the player to see the current gems they had earned and the remaining gems

that they had not yet earned. The coins screen, which was also accessed through the navigation bar, allowed the player to view information about the utility of coins.

Progress. The progress screen was accessed through the navigation bar and allowed the player to see their overall app completion, in terms of percentage, as well as the time since they started the application, the total coins earned, and the gem gallery.

Help & contact screens. The help screen allowed the player to re-access the initial tutorial in addition to providing screen specific-help images. The contact screen allowed the player to contact the principal investigator by email or, in case of a crisis, contact the university Counseling Center's 24-hour crisis support line.

Levels. The application consisted of 28 levels that included psychoeducation, self-monitoring and journaling, cognitive restructuring, guided mindfulness and acceptance meditations, and exposure exercises (see Figure 3). To motivate players to complete more difficult levels (e.g. exposure, acceptance meditations etc.) in a timely fashion, time limits for level completion were provided. The total time limit allowed to complete different levels varied, and the player was allowed to finish the level in less time or more time. However, levels completed before the time limit had elapsed earned bonus coins while those that were completed after the time limit had elapsed did not. Customizable reminders were utilized to aid in the completion of levels within the time limits. When a level was completed, the player earned a gem and the next level was unlocked.

Level 0. The first level was a guided tutorial that took the player through the intricacies of using the app, explained the value of coins and gems, and showed the player how to customize their character.

Levels 1-6. The next six levels consisted of psychoeducational materials dispensed in the form of brief readings and quizzes. The quizzes tested the player's knowledge of the material that had been covered thus far, rewarding the player with extra coins for correct answers. Throughout these readings, short surveys continually assessed the player's specific presentation of social anxiety, information that was utilized to provide a tailored experience as the player progressed.

Levels 7-8. The next two levels sought to build treatment motivation through an exploration of the pros and cons of change as well as having the player engage in a week of self-monitoring through an in-app journal.

Levels 9-17. The next nine levels consisted of psychoeducation about and the practice of cognitive restructuring, including building awareness of "thinking traps" and engaging in the practice of challenging one's own cognitive distortions.

Levels 18-20. The next three levels introduced mindfulness and its importance to the process of psychological change followed by a series of six guided mindfulness meditations that focused on building attention and awareness skills.

Levels 21-23. The next three levels introduced the player to the concept of willingness (i.e. acceptance) and then took the player through a series of guided acceptance meditations.

Levels 24-27. The next three levels prepared the player for and encouraged the player to engage in in-vivo exposure exercises over a two-week period. When an exposure task was completed, the player was prompted to rate the level of anxiety he or she experienced and was rewarded with coins.

Level 28. The last level summarized the progress the player had made and congratulated them on a job well done.

Game mechanics. A number of game mechanics were used to provide feedback, motivation, engagement, and a sense of reward.

Gameboard. The player worked his or her way through the gameboard, with stars appearing over levels that had been completed.

Gems and coins. Coins were earned continuously based on set progress points in the completion of levels and tasks. For example, each page read in a psychoeducation level earned one coin while a multiple-choice quiz question earned two. More difficult or challenging tasks earned the player extra coins. Each completed level earned the player a gem.

Avatar. A character avatar was used for motivational purposes. The avatar was an anthropomorphic cartoon character designed to appear friendly and likeable. The avatar was customizable, although customizations required the spending of coins. Example customizations included changing the avatar's clothing or facial features. The purpose of the ability to customize the avatar was to provide player motivation to earn coins by completing tasks. Assigning a more tangible value to coins aimed to increase the reinforcement value of the coins. Additionally, each time the player earned a certain number of gems, he or she was provided with a wider range of possible customizations. Thus, both coins and gems were tied to the reward of avatar customization.

Reminders. At certain points in the app, the player was prompted to set reminders for level completion. The player was then allowed to program customized reminders that could be set to vibrate, make sounds, and/or display message boxes (see Figure 4). When reminders appeared, they could be dismissed, acted upon immediately, or delayed by the player.

Measures

Brief Fear of Negative Evaluation Scale. The BFNES was used as the study's primary outcome measure (Leary, 1983; see Appendix A). The BFNES is a 12-item self-report questionnaire designed to assess an individual's fear of negative evaluation within social situations. Eight of the twelve items consisted of statements that represented thoughts and beliefs common to those who experience social anxiety (e.g. "I'm afraid that people will find fault with me") with participants rating each item on five-point Likert scale ranging from one (*not at all characteristic of me*) to five (*extremely characteristic of me*). The remaining four items consisted of statements that represented thoughts and beliefs that are uncommon to those who experience social anxiety and thus were reverse-coded (e.g. "I am unconcerned even if I know people are forming an unfavorable impression of me"). The BFNES is utilized frequently in research and clinical settings and shows robust psychometric properties including strong internal consistency ($\alpha = .96$) and adequate to high convergent validity with other measures of social anxiety including the LSAS-SR, the Social Anxiety Interaction Scale (SIAS) and the Social Phobia Scale (SPS; Weeks et al., 2005). Additionally, the BFNES shows good test-retest reliability (.75; Leary, 1983).

Liebowitz Social Anxiety Scale, Self-Report Version. The LSAS-SR represented one of the studies secondary measures (see Appendix B). While the BFNES focused on the underlying cognitive factors that serve to maintain the disorder, the LSAS-SR focused on feared and avoided situational factors. It consisted of 24 items with approximately half of the items geared towards measuring performance-related anxiety while the remaining items were used to measure social interaction anxiety. These 24 items presented various social situations (e.g. writing while being observed; meeting strangers) and participants rated each situation

across two columns (*fear or anxiety* and *avoidance*). The *fear or anxiety* column was coded on a four point Likert scale ranging from one (*none*) to four (*severe*), while the avoidance column consisted of a four-point scale with one indicating *never (0%),* two indicating occasionally *(1-33%),* three indicating *often (33-67%),* and four indicating usually *(67-100%).* According to a review by Letamendi, Chavira, and Stein (2010), the LSAS is the most widely used scale for the assessment of social anxiety. It shows excellent internal consistency ($\alpha = .95$) and good convergent validity with other measures of social anxiety including SIAS and the SPS (Heimberg et al., 1999). Additionally, the self-report version of the LSAS demonstrates "indistinguishable psychometric properties from the clinician version" (Letamendi et al., 2010, p.16).

World Health Organization Quality of Life Scale-BREF. Overall quality of life was assessed pre- and post-treatment with the WHOQOL-BREF, a 26-item questionnaire that assessed quality of life across physical, psychological, social, and environmental domains (World Health Organization, 1996; see Appendix C). Responses were rated on five point Likert scales, with different questions utilizing different scales. These scales included a qualitative scale ranging from one (*very poor*) to five (*very good*), a satisfaction scale ranging from one (*very dissatisfied)* to five (*very satisfied),* an amount scale ranging from one (*not at all*) to five (*an extreme amount),* a frequency scale ranging from one (*never)* to five (*always),* and an ability scale ranging from one (*not at all)* to five (*completely).* The WHOQOL-BREF's psychometric properties were analyzed on a large, international sample (n = 11,830) and the measure was found to have good to excellent reliability and validity with moderate to high internal consistency scores (α = 0.65-0.87; Skevington, Lotfy, & O'Connell, 2004).

Kessler Psychological Distress Scale. Overall psychological distress was measured pre- and post-treatment with the Kessler Psychological Distress Scale (KPDS), a 10-question scale that assesses general, non-specific psychological distress (Kessler et al., 2002; see Appendix D). The items were rated on a five-point Likert scale ranging from one (*none of the time*) to five (*all of the time*). The KPDS shows strong psychometric properties across large sociodemographic samples with excellent internal consistency ($\alpha = 0.93$) and good convergent validity with other measures of symptoms and disability including the General Health Questionnaire and the Short Form Survey 12 (Andrews & Slade, 2001). Additionally, it discriminates well between those with and without DSM-IV definable disorders (Kessler et al., 2002).

Drug Abuse Screening Test 10. Severity of drug use in potential participants was measured during the initial screening process to rule out those that meet criteria for a substance use disorder using the Drug Abuse Screening Test 10 (DAST-10; see appendix E). The DAST-10 is a brief questionnaire that measures problems associated with substance use, such as medical and legal consequences, by presenting questions (e.g. have you had "blackouts" or "flashbacks" as a result of drug use?), which were answered by each participant with *yes* or *no*. The DAST-10 represents a reliable and valid screening measure for identifying problematic substance use with high internal consistency ($\alpha = .86$), and good reliability (ICC = .71; Cocco & Carey, 1998).

Demographic information questionnaire. A demographic questionnaire recorded basic demographic information, such as age, sex, and frequency of phone use for potential exploratory analyses (see Appendix F).

Procedure

Screening. Potential participants for the study were recruited through a pool of undergraduate students. In the recruitment materials, the study was described as an investigation into novel treatments for shyness and social discomfort. Students who had experienced any level of social anxiety were encouraged to participate. Three hundred potential participants were directed to an online Qualtrics survey that administered the screening measure. The screener began by obtaining informed consent and then proceeded through questions that were based on electronic versions of the LSAS-SR, BFNE, DAST-10, WHOQOL-BREF, KPDS, as well as a demographic questionnaire.

After screening 304 participants, 65 were excluded based on failure to meet inclusion criteria while two were excluded due to meeting exclusion criteria for presence of a substance use disorder. Those were not screened out were put into a pool of potential participants. Within this pool of 237 potential participants, participants were sorted by BFNES scores, with those with the highest scores sorted to the top of the list. Potential participants were then invited to participate in the study, with the top scoring 18 participants being contacted first. Six of the invited participants accepted and were provided a link to an initial assessment that included the study's primary and secondary outcome measures. After four days, another 12 participants were invited, with six accepting. One participant who accepted did not complete the initial assessment and was dropped from the study. Another participant completed the initial assessment but did not respond further so was also dropped from the study.

Next, the 10 remaining participants were entered into a multiple baseline across participants design in which participants were collapsed into treatment groups based on baseline trends. During the baseline phase, participants were contacted every four days

through email and prompted to access and complete the BFNES online through Qualtrics. After three BFNES measures were given, four participants were entered in to the active treatment condition. The specific participants selected to comprise the first treatment group were determined by assessing baseline scores for desirable qualities. In multiple-baseline designs, such desirable qualities include stability (i.e. limited variability) and lack of a clear trend of improvement (Byiers, Reichle, & Symons, 2012). Upon entering the active treatment condition, a face-to-face meeting with the study's author was scheduled. During this meeting, the author installed the application on to the participants' phones, answered any questions or concerns they had, provided contact information for crisis support, and informed the participants of the timeline for the study. Participants were given a handout that suggested a recommended speed for completion of levels (see Appendix G). After four more days, the next group of three participants who showed the most stable scores were invited to this initial meeting. A number of participants were unable to meet face-to-face due to scheduling difficulties so the study's author provided the app and the same information through email instead.

Over a 55-day period, the participants worked their way through the application. Every four days, their symptoms were measured using the BFNES. Treatment progress was assessed through the same BFNES Qualtrics survey by asking each participant in the active treatment condition to report the furthest level that he or she had reached at that point in time. Nearly eight weeks after the application was started, the initial collection of measures was given again and a final meeting was scheduled. At this final meeting, a debriefing was conducted in order to better understand the subject's experience of using the application and to assess if participants would benefit from referrals to the college's counseling center. Face-

to-face meetings were not possible with all participants, so the remaining participants were debriefed through email.

Analyses

Data was analyzed first through visual inspection, the primary method recommended for single-case, multiple baseline designs (Barlow, Nock, & Hensen, 2009; Kazdin, 2011). Visual inspection involves visually reviewing the amount and direction of change across phases and subjects. A percentage of non-overlapping data (PND) value can be calculated to arrive at an index of the treatment's effectiveness. To calculate PND in behavior reduction interventions, the lowest point of baseline data is used to determine the proportion of active treatment data points that fall below it. The number of intervention data points that fell below the lowest baseline is divided by the total number of intervention data points to arrive at a PND percentage score (Olive & Franco, 2008). This score can be interpreted as an effect size, with any scores below 50% considered ineffective, 50-70% considered questionable to low effectiveness, 70-90% considered moderately effective, and greater than 90% considered highly effective (Scruggs & Mastropieri, 2001).

In addition to visual inspection, reliability of change was gauged by generating 95% confidence intervals for participant change scores on the BFNES. Confidence intervals were generated for baseline change scores from the initial baseline score to the final baseline score as well as treatment change scores from the initial treatment score to final treatment score. Next, a standard error of difference score (S_{diff}) was calculated to estimate the average change in BFNES score that would be likely to occur by chance variation alone using a reliable change calculation method developed by Jacobson and Truax (1991). The S_{diff} for the BFNES was then used to create a 95% CI around each participant's baseline and treatment change

score. In addition to estimating reliability, these confidence intervals allow for the determination of statistical significance when the CI does not include zero. Individual participant BFNES item endorsements across time were visually analyzed to ensure validity and rule out satisficing.

Finally, paired sample t-tests were used to evaluate mean differences between absolute first and last scores for the study's primary and secondary measures.

To assess average percentage of application completed, final completion percentages for each participant were added together and divided by number of participants. Rate of completion was assessed for each participant by dividing number of levels completed by number of days using the application until completion, adding all scores, and dividing by number of total participants.

Results

Figure 8 shows SAD symptom severity scores during baseline (blue), treatment (orange), follow-up (gray) for all 10 participants. Table 2 shows change scores for each participant including baseline change (i.e. first to last baseline before treatment), and treatment change (i.e. first to last recorded treatment score).

SAD Symptom Severity on the BFNES

In the initial screening, all ten participants met criteria for probable diagnoses of SAD on the BFNES (M = 50.1, SD = 4.98, range = 50-56), a score that is greater than the mean of a large clinical sample of individuals diagnosed with SAD who were used to validate the BFNES (M = 46.91, SD = 9.27; Weeks et al., 2005). During baseline, visual inspection indicated slight variation in all participant BFNES scores (see Figure 8), although it should be noted that no change scores from first to last baseline were statistically significant (see

Table 2). P1, P4, and P10 showed baseline scores that initially increased slightly and then decreased slightly while P2 showed a stable then increasing score. P5 and P7 showed decreasing then increasing baseline scores, while P5 and P7 showed a decrease, increase, and then stable baseline score. Finally, P8 showed a decreasing, stable, then further decreasing score while P9 showed an increasing then stable score. During the treatment phase, SAD symptom severity decreased for six out of ten participants, showed no change for three participants, and increased for one participant.

Percentage of non-overlapping data calculations yielded mixed results. Among all participants, regardless of intervention completion, four met PND criteria for a very effective treatment, two showed moderate effects, and the remaining four were ineffective. However, among those who completed the intervention (i.e. completed level 28 of 28 in the application) three of four saw moderate to large effects as assessed by PND (see Figure 8).

A paired sample t-test was used to determine whether there was a statistically significant mean difference between pre- and post-treatment scores on the BFNES. For the BFNES, assumption of normality as assessed by Shapiro-Wilk's test (p = .271) was not violated, indicating a normal distribution. Overall, participants showed a reduction in social anxiety symptoms as indicated by BFNES scores from pre-test (M = 53.14, SD = 2.61) to post-test (M = 40.14, SD = 12.308), a statistically significant mean decrease of 13, 95% CI [2.05, 23.94], $t(7) = 2.907$, p = .027, d = 1.461.

SAD Symptom Severity on the LSAS-SR

For the secondary measures of the LSAS-SR, a paired sample t-test was used to determine whether there was a statistically significant mean difference between pre- and post-treatment scores. For the LSAS-SR, assumption of normality as assessed by Shapiro-

Wilk's test (p = .637) was not violated, indicating a normal distribution. Overall, participants showed a reduction in social anxiety symptoms as indicated by LSAS-SR scores from pre-test (M = 76.29, SD = 11.6) to post-test (M = 51.71, SD = 24.36), a statistically significant mean decrease of 24.58, 95% CI [4.69, 44.46], $t(7) = 3.024$, p = .023, d = 1.288.

Overall Distress

A paired sample t-test was used to compare pre- and post-treatment scores on the K10. For the K10, assumption of normality as assessed by Shapiro-Wilk's test (p = .252) was not violated, indicating a normal distribution. Overall, participants showed a reduction in psychological distress as measured by K10 scores from pre-test (M = 27.29, SD = 2.87) to post-test (M = 25, SD = 8.04), a non statistically significant mean decrease of 2.29, 95% CI [-3.433, 8.005], $t(7) = 0.948$, p = .336, d = 0.379.

Quality of Life

A paired sample t-test was used to compare pre- and post-treatment scores on the WHOQOL-BREF. For the measure, assumption of normality as assessed by Shapiro-Wilk's test (p = .546) was not violated, indicating a normal distribution. Overall, participants showed an increase in quality of life as measured by WHOQOL-BREF scores from pre-test (M = 94.0, SD = 14.56) to post-test (M = 100.4, SD = 13.9), a non statistically significant mean increase of 6.4, 95% CI [-14.869, 2.012], $t(7) = -1.864$, p = .112, d = 0.450.

Patterns of Symptom Change

Because participants recorded their progress in the application at the time of each BFNES measure, patterns in symptom change as they relate to the content of the application level can be inferred from visual inspection of graphs (see Figure 8).

P1 remained stable through first eight levels of intervention. These first seven levels provided basic psychoeducation about the nature of anxiety, social anxiety, the costs of social anxiety, and basic CBT concepts (e.g. thoughts, feelings, and actions) as well as assessment of player's specific symptomatology. P1 saw a significant drop in BFNES scores between levels 8 and 12 where the application moves in to cognitive restructuring. Interestingly, there was a small decrease between levels 12 and 17 where each player continues to explore cognitive distortions and techniques for challenging them but another large decrease beginning at level 17, the second journal activity. In the journal of level 17, the player kept track of thoughts, feelings, and actions while challenging any distortions that arose by using previously learned techniques. After level 17, the participant rapidly completed the remainder of the application and saw her largest symptom reduction thus far. Overall, P1 completed all 28 levels of the intervention and dropped 30 points on the BFNES.

Like P1, P5 remained stable for the first two measures, completing levels one through six before a symptom decline was seen. Also like P1, P5 saw her first symptom decline during the cognitive restructuring portion of the application. The participant's symptoms further declined between levels 11 and 20, which consisted of further cognitive restructuring as well as the introduction of mindfulness skills. P5 showed a period of symptom stability between levels 20 and 24, which included mindfulness skills, mindfulness practice, and the introduction of acceptance skills and practices. P5 showed a slight decline after mindfulness and acceptance skills were completed, a stabilization during the first round of exposure, and a further decline during the final exposure. P5 was one of the few participants for which follow-up data was collected and she showed some variability in her follow-up scores

including a slight rise, a slight fall, and another slight rise in symptomatology post-treatment. Overall, P5 completed all 28 levels of the intervention and dropped 13 points on the BFNES.

P8 showed an initial gradual decline in baseline scores and then a slight increase at the start of treatment. Through levels one to seventeen, the participant maintained her score, neither deviating higher or lower. P8 completed 17 of 28 levels and dropped zero points on the BFNES. The trend in P2's scores seemed to represent an inversion of P8's trend, with a stable then slightly increasing baseline, a moderate drop at start of treatment, and a completely stable score from beginning to end. Follow-up data for P2 showed an initial decrease and a subsequent increase that matched her final treatment score. P2 completed all 28 levels and dropped zero points during the treatment phase.

P6 showed an initial slight drop in scores from baseline and made quick progress in the application, completing levels 1-4 in the day between app installation and the first treatment measure. P6's scores stabilized over the course of the next three measures and her progress slowed. After completing level 12, where the participant began to learn specific techniques to challenge cognitive distortions, the participant showed a gradual decline. A small spike occurred between levels 19 and 20 (the introduction of mindfulness skills and the first mindfulness practices), and then a steep drop occurred after practicing mindfulness skills and learning about acceptance skills in level 22. Finally, P6 showed a slight increase and then a slight decrease between practicing acceptance and the introduction of exposure. Overall, P6 completed 25 of 28 levels and dropped 16 points on the BFNES during treatment.

P9 showed an elevation in baseline and then score stability in levels one through eight. P9 did not consistently complete BFNES measures and dropped out of treatment altogether at level 10. P3 showed a gradual decline at the beginning of treatment, a gradual

increase between levels eight and nine (this first journal and the introduction of cognitive distortions respectively), and a moderate decline until level 14 where he remained relatively stable until level eighteen, a level where participants apply techniques for challenging cognitive distortions to events in their lives. Finally, P3 showed a moderate decrease in SAD symptoms during level 18. Overall, P3 completed 18 of 28 levels and dropped 17 points on the BFNES.

Like P6, P7 made rapid progress in completing levels initially, finishing levels one through seven between app installation and the first treatment measure. P7 saw a steep drop in SAD symptoms in the first 14 levels of the application, a slight increase between the cognitive restructuring based levels of 14 and 17, and a slight drop between 17 and 20 (application of techniques for challenging distortions and the introduction of mindfulness respectively.) Between levels 16 and 20, P7 showed a gradual increase in scores. These levels all shared the commonality of exposure, first in exposure to thoughts and feelings through mindfulness and acceptance, and then in exposure to actual feared social situations. During the second round of exposure (level 27), P7's scores began to drop. Follow-up data indicated a slight elevation in scores post-treatment and then a moderate drop to a score below the final treatment score. Overall, P7 completed all 28 levels and saw a 22 point drop on the BFNES.

P10 showed an initial elevation in scores, a slight drop and another elevation before stopping treatment at level 13. P1 dropped one point on the BFNES during treatment. Finally, P4 showed an initial stabilization, a slight drop between levels 13 and 16 and then an elevation between 16 and 17. P4 was inconsistent in completing BFNES and remained on level 17 for the remainder of treatment. P4 showed a four-point increase on the BFNES.

Engagement and Motivation

Although no specific measure of engagement and motivation was used, it may be possible to infer engagement and motivation from rates of completion and speed of progress. In regards to completion, four of ten participants completed the full intervention, eight of ten completed more than half, and the average percentage completed was 75.71%. The average rate of completion was approximately 0.76 modules per day. Through these percentages we may be able to infer that there was a range in engagement, but for the majority of participants the application was at least moderately engaging. Speed of progress varied between participants, with one participant completing the entire application within three weeks while others moved much more slowly. Some participants seemed to get hung up on specific levels, but it cannot be determined whether that was related to the content of the levels or life events. It may be that some levels were perceived as more aversive, tedious, or time consuming than others leading to a loss of or decrease in motivation.

Discussion

The major aims of this study were to determine if the use of a gamified mobile application targeted towards the treatment of social anxiety could: 1) reduce symptoms of social anxiety; 2) reduce overall psychological distress and increase quality of life; and 3) increase engagement and motivation, leading to better adherence and completion rates than those found in other purely self-directed interventions.

Results showed that, overall, use of the application led to statistically significant reductions in social anxiety symptomatology, with large effect sizes. However, important differences in effectiveness emerged when completers and non-completers were compared. Among all participants, half showed significant reductions in social anxiety, while the other

half showed no statistically significant change. Among the four participants who completed all 28 levels, three showed significant reductions in social anxiety and one showed no statistically significant change. The most straightforward explanation for the differences in symptom reduction between completers and non-completers is that the full benefits of the treatment required the completion of the entire application, with in-vivo exposure exercises—a crucial treatment component—being limited to the final levels. Notably, only those four participants who completed 100% of the application completed any exposure levels. However, it should be noted that the heterogeneity of the sample was not limited to differences between completers and non-completers. Strong differences emerged even among completers, with P1 completing the entire application within three weeks and showing a reduction of 30 points on the BFNES while P2 completed the application over a period of one month but showed no significant differences in pre to post social anxiety symptomology. It is unclear why such stark differences were seen but one possibility is that individual differences among the participants themselves emerged. Such differences may have included personality characteristics, comorbidity of specific disorders, or higher or lower responsiveness to the specific interventions that composed this application. In support of this possibility, two of the three participants who endorsed diagnoses of generalized anxiety disorder (GAD) showed slight, non-statistically significant increases in social anxiety symptoms on the BFNES. However P1, the other participant who endorsed a GAD diagnosis, showed the study's most significant decrease in social anxiety symptoms on the BFNES. Another finding that lends support to the possibility of reduced effectiveness due to individual differences emerged when examining those participants who had received prior psychotherapy: P10, P8, and P4. These participants benefited the least from the treatment,

with all three showing an increase (albeit not statistically significant) in BFNES scores pre- to post-treatment. One possibility is that these three participants had more treatment-resistant forms of SAD that neither responded to previous therapy nor the intervention used in this study.

In reference to the study's secondary measures**,** participants showed mean reductions in psychological distress and mean increases in quality of life, but neither of these changes achieved statistical significance. It is unclear why significant reductions in social anxiety pre- to post-treatment did not lead to greater improvements in these areas. Since some participants endorsed disorder comorbidity, it may be that certain comorbid disorders attenuated any effects of reducing social anxiety on overall distress and/or quality of life.

Engagement and motivation were assessed through overall percentage of application completed in addition to the rate of progress. The average percentage of completion was relatively high, at 75.71%, but only four participants completed 100% of the application. One possibility for noncompletion of the application is that the speed at which participants chose to progress through the application was not rapid enough to fit in to the artificial time constraints under which this study was conducted. A longer study time may have led to higher rates of completion. Because this study was investigating a purely self-guided treatment, it was important to prevent any external encouragement or pressure for participants to progress through the application more quickly. Although a recommended rate of completion was provided to participants at the beginning of the study (see Appendix G), participants were free to move at their own speeds. Within the application, reminders could be set and bonuses were awarded for faster progress but ultimately each participant moved at the rate that he or she chose. In addition to the effect of time constraints, history effects

should not be overlooked. In the context of an academic semester, it is possible that motivation and engagement decreased in response to mounting coursework and looming final exams. Finally, the design of the application itself likely led to differential rates of completion. Based on visual analysis of graphs, it appears that some participants seemed to slow down or stop on specific levels. It may be that some levels were perceived as more aversive, tedious, or time consuming than others leading to a loss of or decrease in motivation. Some levels could be completed very rapidly (e.g. psychoeducation, assessment) while others (e.g. journaling, exposure) had set minimum requirements for passing. For instance, the participant could not pass the first journaling level until he or she had completed six entries or at least four days had passed. It is possible that certain levels may have acted as chokepoints for progression, leading some participants to slow down or stop progressing altogether. However, in examining participant progress through visual analysis, no clear patterns emerged.

The mixed results in effectiveness and adherence are consistent with previous studies that have compared purely self-guided interventions to self-guided interventions with minimal therapist contact (MTC). In multiple studies, MTC interventions have been found to be highly effective and show high rates of adherence, even when compared to traditional therapy (Furmark et al., 2009; Carlbring et al., 2006; Carlbring et al., 2007). However, purely self-guided interventions have not always compared favorably to MTC interventions. A 2006 study of an internet-based CBT program with no therapist contact found high withdrawal rates (Christensen, Griffiths, Groves, & Korten, 2006) while a 2012 study that compared guided and unguided self-help for SAD found significant discrepancies between groups, with 73.2% of the guided self-help group completing seven or more modules compared to 54.4%

of those in the unguided group (Nordgreen et al., 2012). Interestingly, Nordgreen and colleagues found that a significant predictor of adherence rates in the unguided group was the participant's perception of the credibility and legitimacy of the program itself.

A recent series of studies that attempted to deliver treatment for social phobia over the internet further illustrates some of the difficulties with purely self-directed interventions. Beginning in 2008, Titov and colleagues examined the effectiveness of an internet-based CBT application for the treatment of social phobia across three separate studies. In the first study, participants using the application were compared to those in a waitlist control group (Titov, Andrews, Schwencke, Drobny, & Einsteen, 2008). Those in the active treatment condition completed the CBT application while participating in an online discussion forum and engaging in regular email contact with a therapist. Overall, results were promising, with significant pre- to post reductions in scores on a social phobia outcome measure and an effect size of 1.15. A replication study followed, finding slightly stronger results, with 80% completion and an effect size of 1.18 (Titov, Andres, & Schwencke, 2008). A third study divided participants in to three groups: a clinician assisted group, a purely self-guided group, and a waitlist control group (Titov, Andrew, Choi, Schwencke, & Mahoney, 2008). While 77% of those in the clinician-assisted group completed the full CBT program, only 33% of those in the self-guided group did. In the clinician assisted group, significant pre- to post reductions in social anxiety were seen, with a between-group effect size of 1.47. However, those in the self-guided group showed no significant differences in symptom scores from those in the waitlist control group. When just completers were examined, results were significant and an effect size of 0.96 was found. The study's authors proposed that a critical barrier to completion of the self-guided program was a lack of motivation. Although the

application used in this study showed only slightly higher completion rates (40%) than the Titov's self-guided group, it showed significantly higher effectiveness. Further, average completion rates on the application used in this study were higher (75.71% of 28 lessons) than those in Titov's study, where average completion rates were 66.2% of six lessons.

When considering the larger question of overall effectiveness, this study compares favorably with previous studies that have examined the use of MTC treatments as well as traditional therapy. A 2008 meta-analysis of the effectiveness of individual and group therapy treatment for SAD found a mean effect size across studies of 0.70 (Acarturk, Cujipers, van Straten, & de Graaf, 2009). A randomized controlled trial that used an internet-based MTC CBT intervention for SAD found a within-group effect size of 0.82 (Berger, Hohl, & Caspar, 2009), while an internet-based bibliotherapy with MTC via email for the treatment of SAD found a within-group effect size of 0.88 (Carlbring, Furmark, Steczko, Ekselius, & Andersson, 2006). Finally, a 2009 study that looked at an MTC bibliotherapy intervention found effect sizes on its two social anxiety outcome measures of 1.39 and 1.24 (Abramowitz, Moore, Braddock, & Harrington, 2008).

The results of this study also compare favorably with results from other studies that looked at mobile-delivered and gamified treatments. A 2014 study that examined the effectiveness of an attention bias modification training app on social anxiety symptoms found significant reductions on two social anxiety measures, with effect sizes of 0.71 and 1.06 (Enock, Hofmann, & Mcnally, 2014). A study that used a gamified application focused on breathing retraining for the treatment of anxiety disorders found small effect size differences between treatment and control groups for anxiety and panic measures ($d < 0.3$) but were unable to demonstrate clinical efficacy (Pham, Khatib, Stansfeld, Fox, & Green, 2016). A

2013 RCT compared a computer-based CBT application to a smartphone based CBT application and found that 69% of participants in the app group completed all eight lessons while both groups showed significant reductions in depression scores on the PHQ-9, with large effect sizes (d = 1.41) that were not statistically different (Watts, Mackenzie, Thomas, & Griskaitis, 2013). Finally, a 2014 study compared a cognitive behavioral based application to an interpersonal psychotherapy based app and found 63% of those in the CBT condition completed all modules while 52% of those in the interpersonal therapy condition completed all modules, with the CBT app leading to significant pre- to post declines on the LSAS-SR with a d value of .99 (Dagöö et al., 2014). In comparing this application to the non-gamified self-guided interventions discussed previously, a small to moderate increase in adherence can be seen. It is possible that gamification acted to increase motivation, leading to further overall progress, lower dropout rates, and higher completion rates than those found in Christensen et al. (2006), Nordgreen et al. (2012) and Titov et al. (2008). Further, it is possible that gamification increased the effectiveness of the intervention when compared to other self-guided interventions. For example, Titov and colleagues (2008) found no significant effect of the purely self-guided intervention, compared to a large effect for the MTC intervention. Although a large effect (d = 0.96) was found when Titov et al. (2008) examined only completers, effect sizes in this study for social anxiety measures were high, (d = 1.461; d = 1.288) regardless of full completion. These effect sizes also compare favorably with other gamified treatments, such as those found in Enock, Hoffman, & Mcnally (2014) and Pham et al. (2016). Finally, effect sizes in this study were comparable to those found in the previously cited MTC interventions, suggesting that gamification may have helped to bridge the effectiveness gap between therapist guided and purely self-guided interventions.

In addition to analyzing overall effectiveness and motivation, an overarching purpose for the creation of a purely self-directed intervention was to help dissolve treatment barriers for those with mental disorders and social anxiety specifically. These barriers can be both environmental (e.g. cost, transportation, lack of providers) and psychological (e.g. avoidance, shame). In looking at treatment barriers specific to those who experience social anxiety, Olfson (2000) uncovered a number of common themes in his interviews with socially anxious individuals. The most common theme was that interviewees did not know where to go for help. Those interviewees who had some idea of where to go reported that financial constraints had prevented them from seeking help. The cost of treatment may represent a particularly acute problem as previous research shows an inverse association between level of social anxiety and socioeconomic status (Magee, Eaton, Witchen, McGonalgle, & Kessler, 1996.) Psychological treatment barriers also seem to play a significant role, with many of Olfson's interviewees expressing the fear of what others would think of them if they sought treatment in addition to feelings of shame and embarrassment. Further, there is a sad irony in the fact that, to receive treatment, those with social anxiety have to enter in to a vulnerable and anxiety-provoking social situation not only in setting up treatment but in interfacing with a therapist as well. The potential aversiveness of this experience may be why the vast majority of those with social anxiety drop out of treatment after one appointment (Santana & Fontenelle, 2011). Finally, even those who manage to overcome environmental and psychological barriers to treatment are faced with the fact that many providers do not provide evidence-based or adequate treatment (Stein & Stein, 2008; Wang et al., 2005).

The gamified mobile application created for this study, and others like it, are one of a number of emerging treatment possibilities that address many of these barriers. For one, such

applications are inexpensive—typically significantly cheaper than a self-help book—and do not require transportation or the presence of qualified providers in one's immediate area. As long as the individual has a smartphone, such applications are easy to find and obtain with simple search terms. The confidential and personal nature of a smartphone may also help address psychological barriers of shame, embarrassment, or fear over what others may think. Further, there are no social hurdles to overcome in regards to setting up appointments and meeting with professionals. Likewise, the barrier of finding providers who deliver evidence-based treatments such as CBT can be overcome with the careful, thoughtful, and consistent use of evidence supported interventions by application developers. However, mobile applications are not without disadvantages. For one, the individual must own a smartphone and have adequate cellular or internet service. Although such barriers are decreasing every year, they may remain problems for low SES individuals or those who live in very rural areas. Additionally, there is no easy way for an individual to tell if a particular application is supported by evidence. Although there have been discussions around regulating applications that purport to treat mental health conditions, thus far the marketplace is without constraint and many applications may be ineffective or, possibly, iatrogenic. A 2016 systematic review of available anxiety apps found that the majority (67.3%) did not involve experts or mental health professionals in their development and only 3.8% had been rigorously tested (Sucala et al., 2016).

The findings of this study suggest that continuing research in to self-guided interventions and interventions dispensed on mobile technology represent a promising field of exploration. Further, studies on ways in which gamification and mobile technology can enhance adherence and motivation while reducing treatment barriers are also warranted.

Limitations

This study had a number of limitations including a small and non-diverse sample size, a lack of a comparison group, a lack of randomization, some difficulties with data collection, and the spacing of measures. The study's small sample size may have limited the generalizability of findings, may have increased the probability of type 2 errors, and may have led to the possibility that outlier cases distorted effects (in either direction) on overall scores and effect sizes. A lack of a comparison group limited our ability to test effectiveness against other self-directed interventions (e.g. bibliotherapy), as well as traditional psychotherapy and treatment control groups. Further, the lack of a control group meant that placebo effects could not be ruled out. It is possible that some participants showed decreases in BFNES scores over time due to the effects of mere exposure to frequent prompting or due to their own positive expectations for the effectiveness of treatment.

We relied upon self-report of utilization and completion rates, which is potentially problematic. It is conceivable that false reporting occurred, with the possibility that some participants reported that they had completed more of the application than they had due to demand characteristics. Despite the fact that completion or noncompletion was neither rewarded nor punished respectively and contact with the study's principal investigator was limited to automated emails that prompted participants to take the BFNES survey, it is possible that some participants felt pressure to report continual progress through the application.

Finally, a further limitation may have arisen due to the spacing of the study's main measure, the BFNES, which was given to participants every four days. Some participants showed remarkably stable scores when completing the BFNES and it is possible that practice

effects occurred, with the frequency of completing the same measure leading to a tendency or intention to be consistent.

Summary

Results of this study showed that a gamified mobile application can significantly reduce symptoms of social anxiety with no therapist contact. This finding is important in addressing substantial environmental treatment barriers including cost and access, as well as psychological barriers such as shame and embarrassment. Although very few studies with purely self-guided interventions have been published, results of this study suggest that the use of gamification may have had a positive motivational effect when compared to other self-guided interventions. Finally, results showed no statistically significant change in overall psychological distress or quality of life pre- to post-treatment.

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Table 1

Participant Characteristics

	Age	Gender	Race	Relationship Status	Education	Employment Status	Previous diagnoses
P1	18	Female	White	Single	SC	Part time	SAD, MDD, GAD
P2	18	Female	White	Single	SC	Unemployed	
P3	19	Male	White	Relationship	SC	Part time	
P4	19	Female	White	Single	SC	Part time	
P5	18	Female	White	Relationship	SC	Unemployed	
P6	20	Female	White	Single	SC	Unemployed	
P7	21	Female	White	Relationship	SC	Unemployed	
P8	18	Female	White	Single	SC	Unemployed	GAD
P9	20	Female	White	Single	SC	Part time	
P10	19	Female	White	Relationship	SC	Unemployed	GAD

Note. P = Participant; SC = Some College; SAD = Social Anxiety Disorder, MDD = Major Depressive Disorder; GAD = Generalized Anxiety Disorder; OD = Other Disorder.

Table 2

Change scores with 95% CIs for social anxiety severity as measured by the BFNES and participant characteristics

	BFNES $95\%CI = CS \pm 1.833$	% Complete	# friends	Phone hrs. per day	Prior treatment	Freq. of gaming
P1†						
BL	1 [-0.833, 2.833]	100%	1-5	1-3	No	Occasional
Pre-Post	-30 [-31.833, -28.167]*					
P7†~						
BL	3 [1.167, 4.833]	100%	6-10	1-3	No	Frequent
Pre-Post	-22 [-23.833, -20.167]*					
P3~						
BL	-1 [-2.833, 0.833]	64.3%	6-10	6+	No	Rarely
Pre-Post	-17 [-18.833, -15.167]*					
P6~						
BL	1 [-0.833, 2.833]	89.3%	1-5	4-6	No	Occasional
Pre-Post	-16 [-17.833, -14.167]*					
P5†~						
BL	-4 [-5.83, -2.167]	100%	1-5	4-6	No	Rarely
Pre-Post	-12 [-13.833, -10.167]*					
P2†~						
BL	1 [-0.833, 2.833]	100%	10+	1-3	No	Never
Pre-Post	0 [-1.833, 1.833]					
P9						
BL	5 [3.167, 6.833]	35.7%	1-5	4-6	No	Rarely
Pre-Post	0 [-1.833, 1.833]					
P10						
BL	0 [-1.833, 1.833]	46.4%	10+	1-3	Yes	Rarely
Pre-Post	2 [0.167, 3.833]^					
P8~						
BL	-6 [-7.833, -4.167]	60.7%	6-10	6+	Yes	Frequent
Pre-Post	3 [1.167, 4.833]^					
P4~						
BL	1 [-0.833, 2.833]	60.7%	6-10	4-6	Yes	Rarely
Pre-Post	4 [2.167, 5.833]^					

Note. The second column shows each participant's change score on the Brief Fear of Negative Evaluation Scale (BFNES) during baseline and pre-post intervention. Positive change scores represent an increase on the BFNES and negative change scores represent a decrease. At the top of the right column is the 1.96 X S_{diff} value for the BFNES, which was used to generate 95% CIs around each change score. CI = Confidence Interval; CS = change score; BL = change from initial to final baseline score; Pre-post = change from initial intervention score to final score. * indicates improvement $p < .05$; ^ indicates deterioration $p < .05$; † indicates participant completed the full intervention (i.e. all 28 levels of the application). ~ indicates participant completed all BFNES measures as well as secondary measures.

Table 3

Descriptive Statistics and t-test Results for BFNES, LSAS-SR, WHOQOL, and KPD10

	Pretest		Posttest			95% CI for Mean Difference			
Outcome	M	SD	M	SD	n		t	df	Cohen's d
BFNES	53.14	2.61	40.14	12.31	7	2.05, 23.94	2.907*	6	1.461
LSAS-SR	76.29	11.6	51.71	24.36	7	4.686, 44.456	3.024*	6	1.288
KPD10	27.29	2.87	25.0	8.04	7	-3.433, 8.005	0.948	6	0.379
WHOQOL	94.0	14.56	100.4	13.9	7	-14.869, 2.012	-1.864	6	0.450

* $p < .05$.

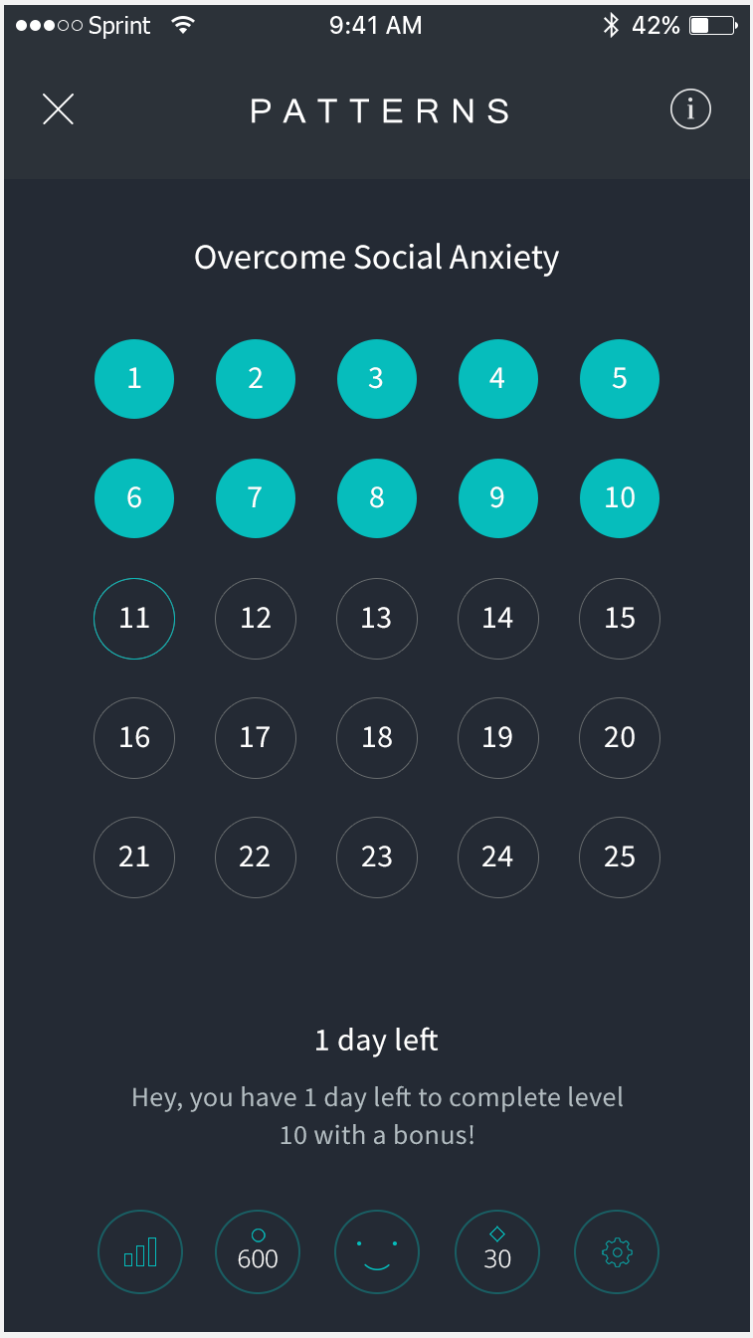


Figure 1. Gameboard screen. The gameboard screen represents the home screen of patterns where levels and settings can be accessed. Level numbers are shown in circles, with completed levels turning blue and uncompleted levels remaining gray. Below the levels, a message area is used to notify player of deadlines for special bonuses. Below the message area is the navigation bar, allowing the player to access (from left to right): progress, coins, character, gems, and settings screens.

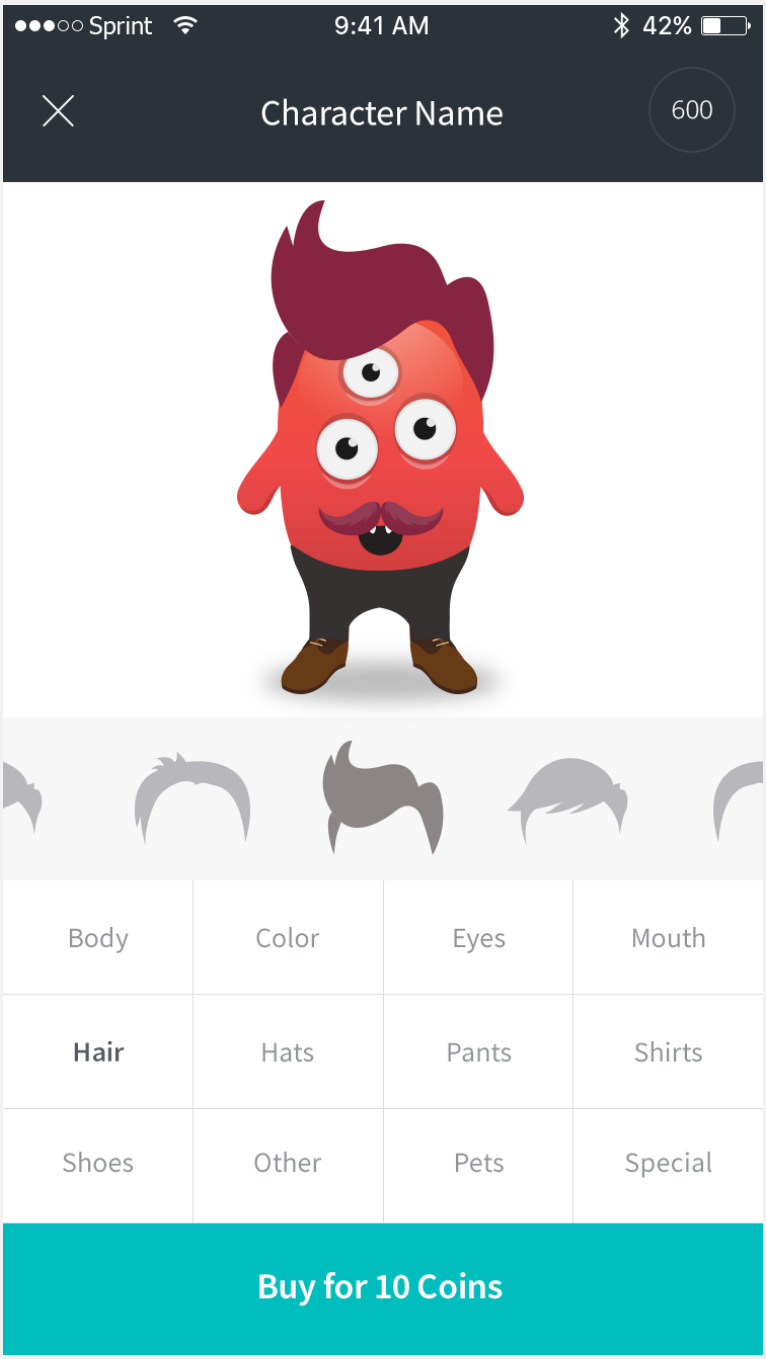


Figure 2. Character customization screen. The character customization screen allows the player to change attributes of his or her character such as body shape, facial features, and clothing accessories. Each customization category requires are certain number of gems to open while each specific customization costs a certain number of coins.

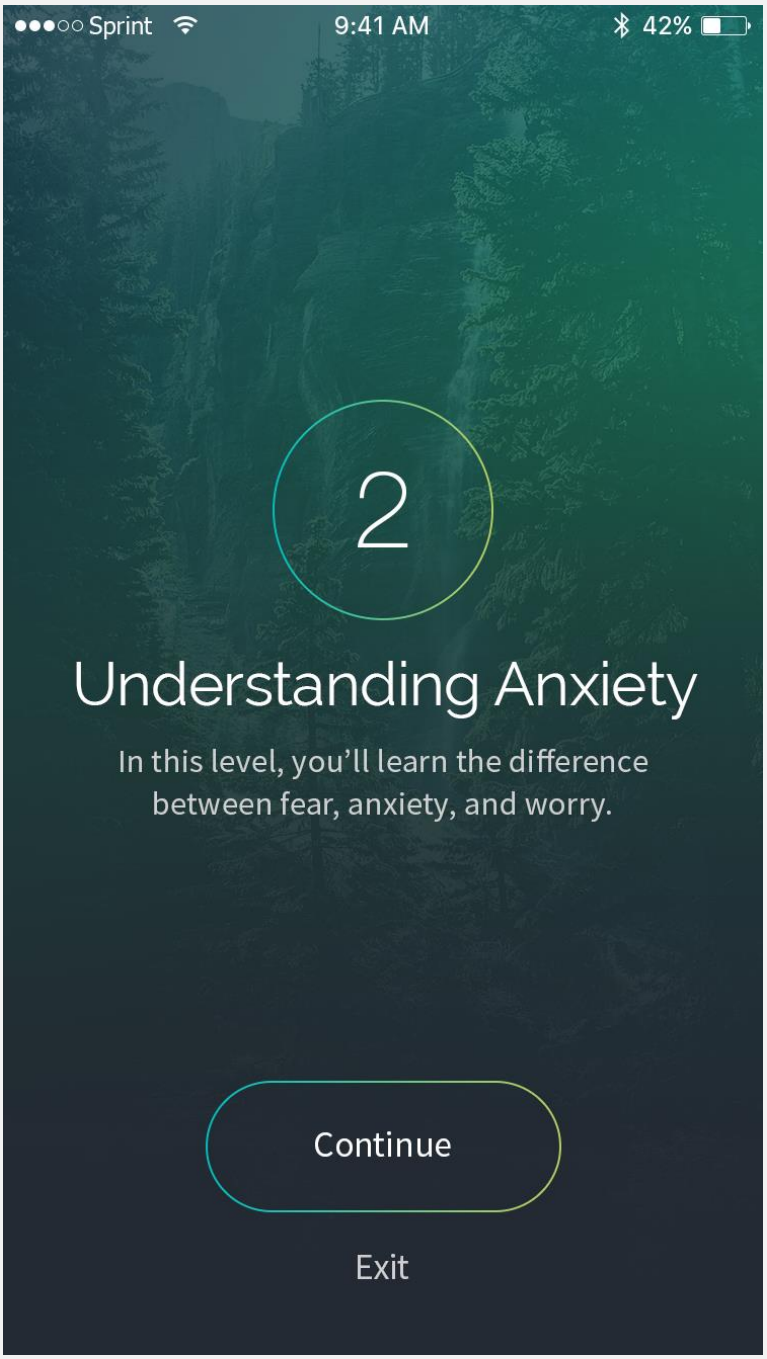


Figure 3. Level title screen. The level title screen provides a brief overview of the level before the player starts. The player can exit the level at any time without losing progress.

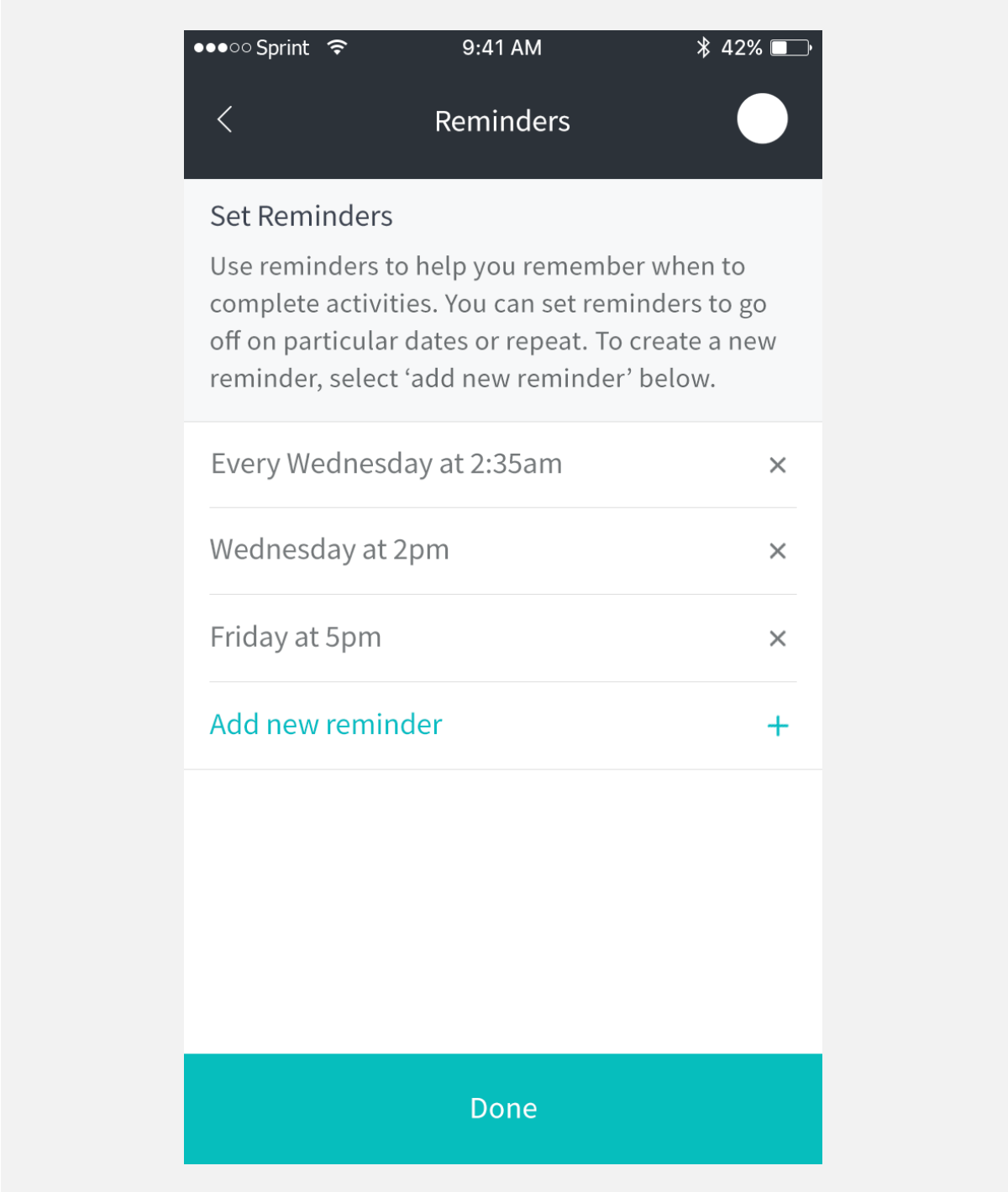


Figure 4. Set reminder screen. In order to encourage completion of tasks, readings, and other assignments, the player is encouraged to set reminders. The player may set reminders for specific days and times and may set repeating reminders.

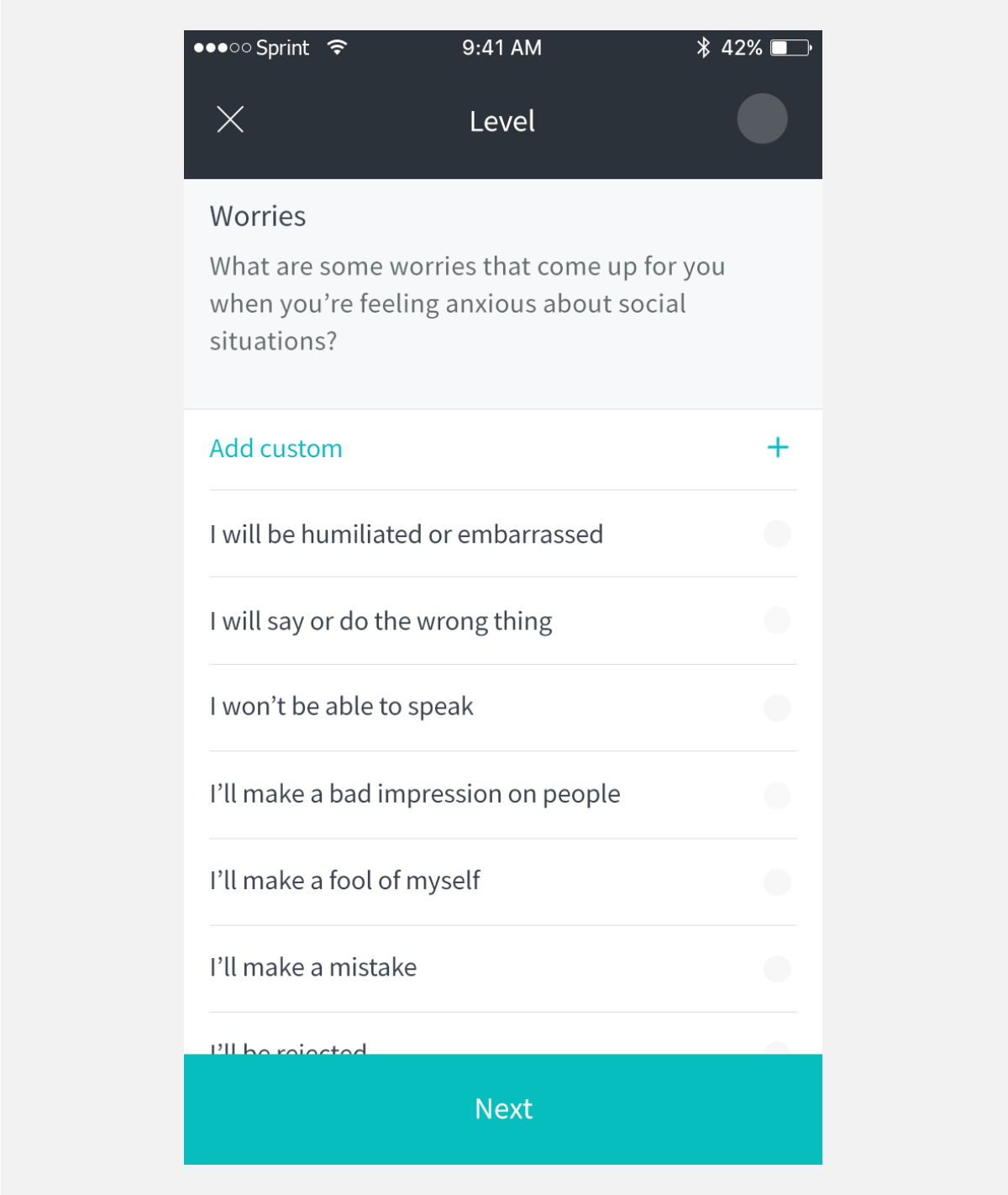


Figure 5. Assessment screen example. Throughout the use of the application, the player is being assessed for social anxiety symptomatology. These assessments serve to build the player's awareness of his or her thoughts, feelings, and actions. In some cases, these assessments are used to generate exposure activities.

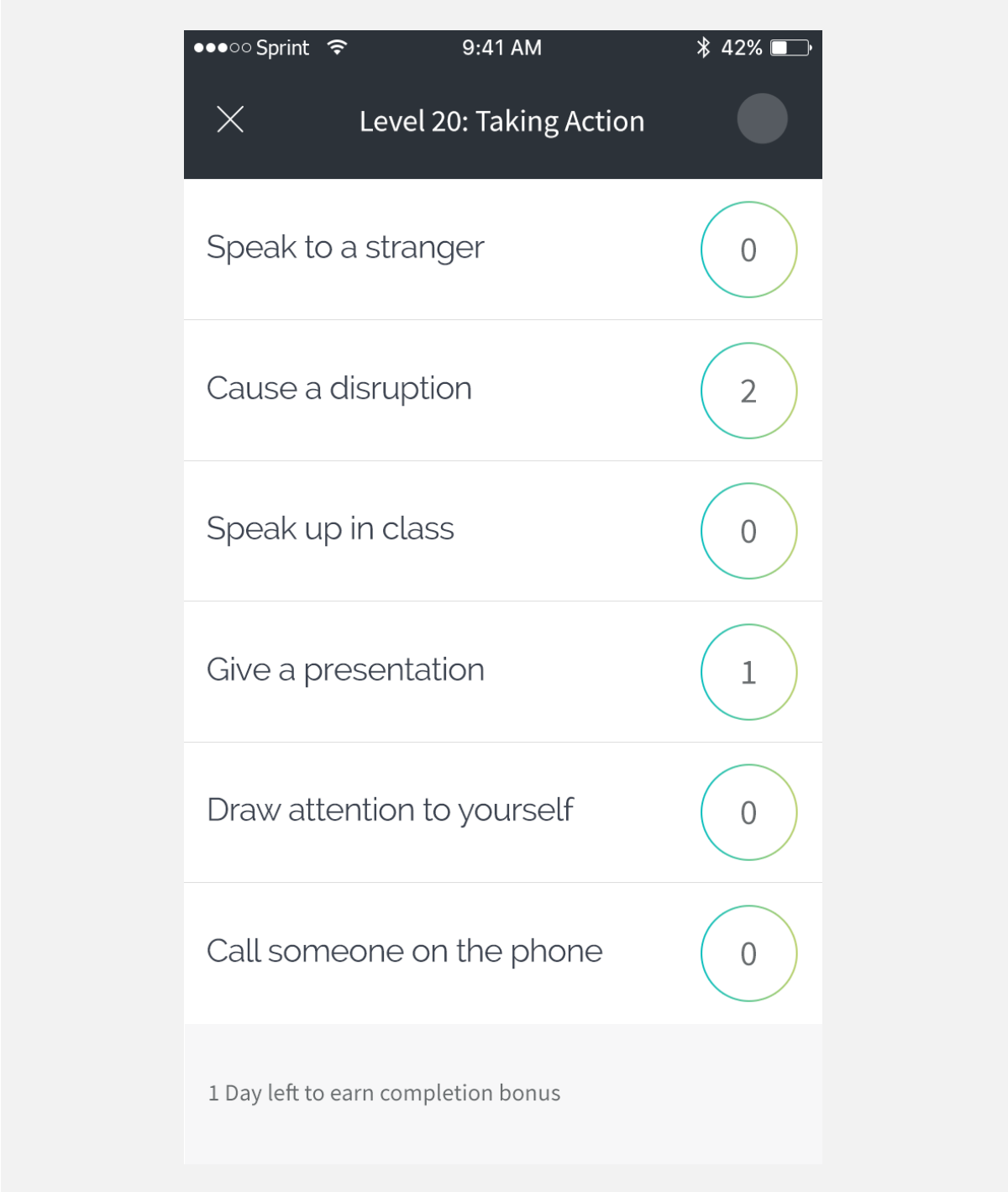


Figure 6. Exposure task list. The exposure task list screen displays exposure tasks that are assigned to the player for a set amount of time. The player is encouraged to complete as many exposures as possible and he or she may repeat exposures. The number of times an exposure task has been completed is tabulated in the circles that run along the right side of the screen.

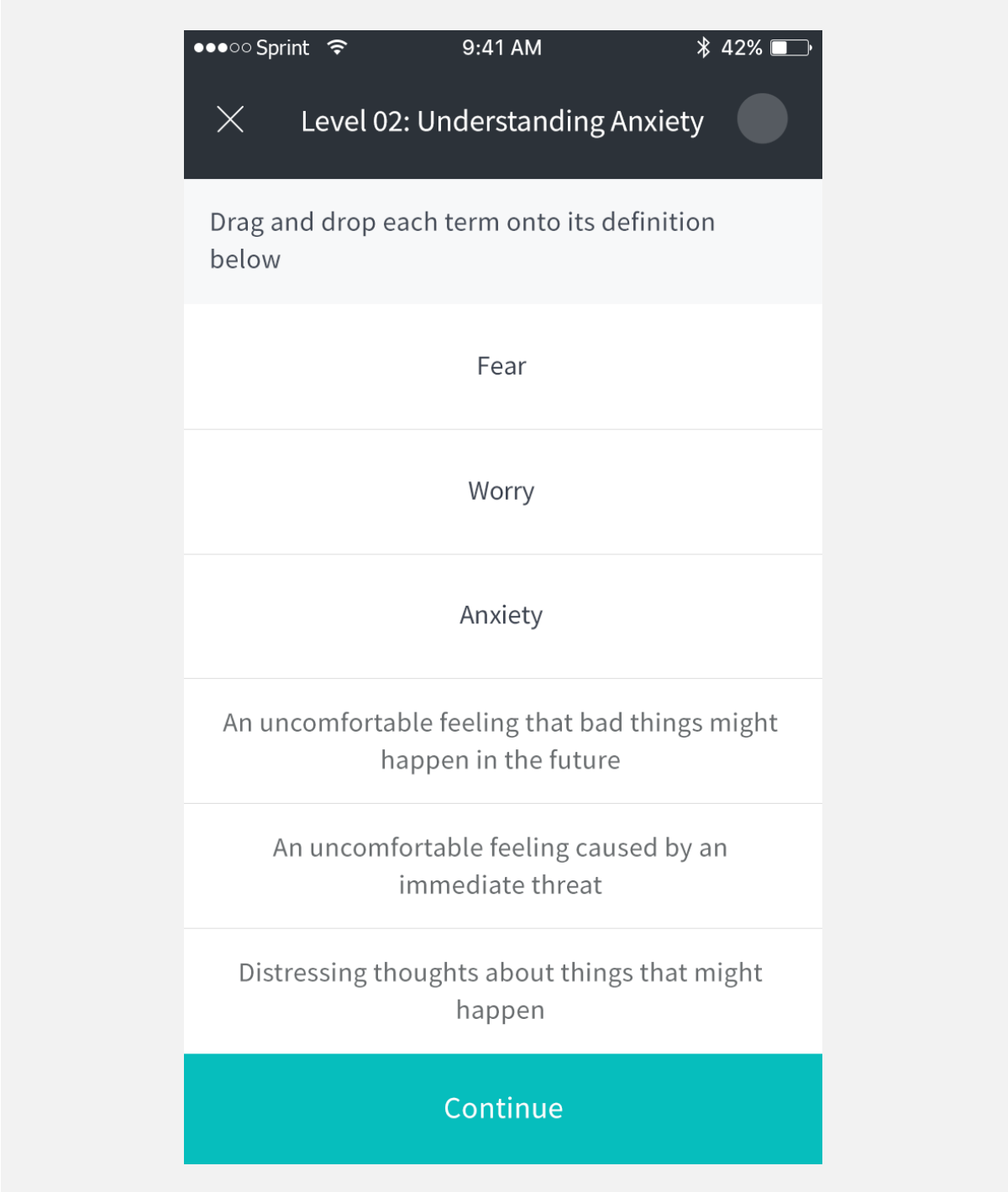
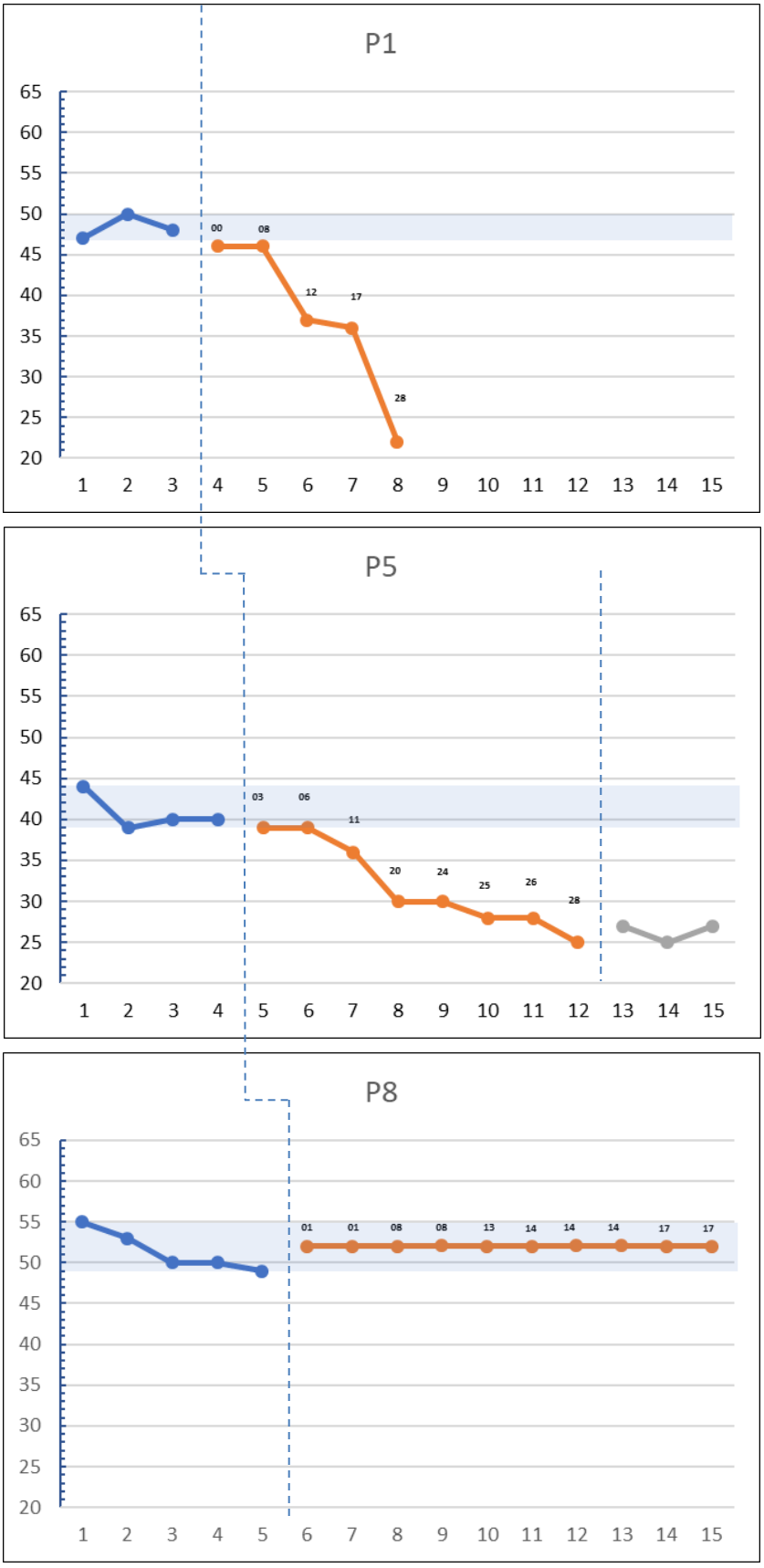


Figure 7. Matching quiz screen. Psychoeducational levels monitor progress and comprehension through the use of matching and multiple choice quizzes. In this matching quiz, the player must drag and drop each term on to its definition in order to proceed.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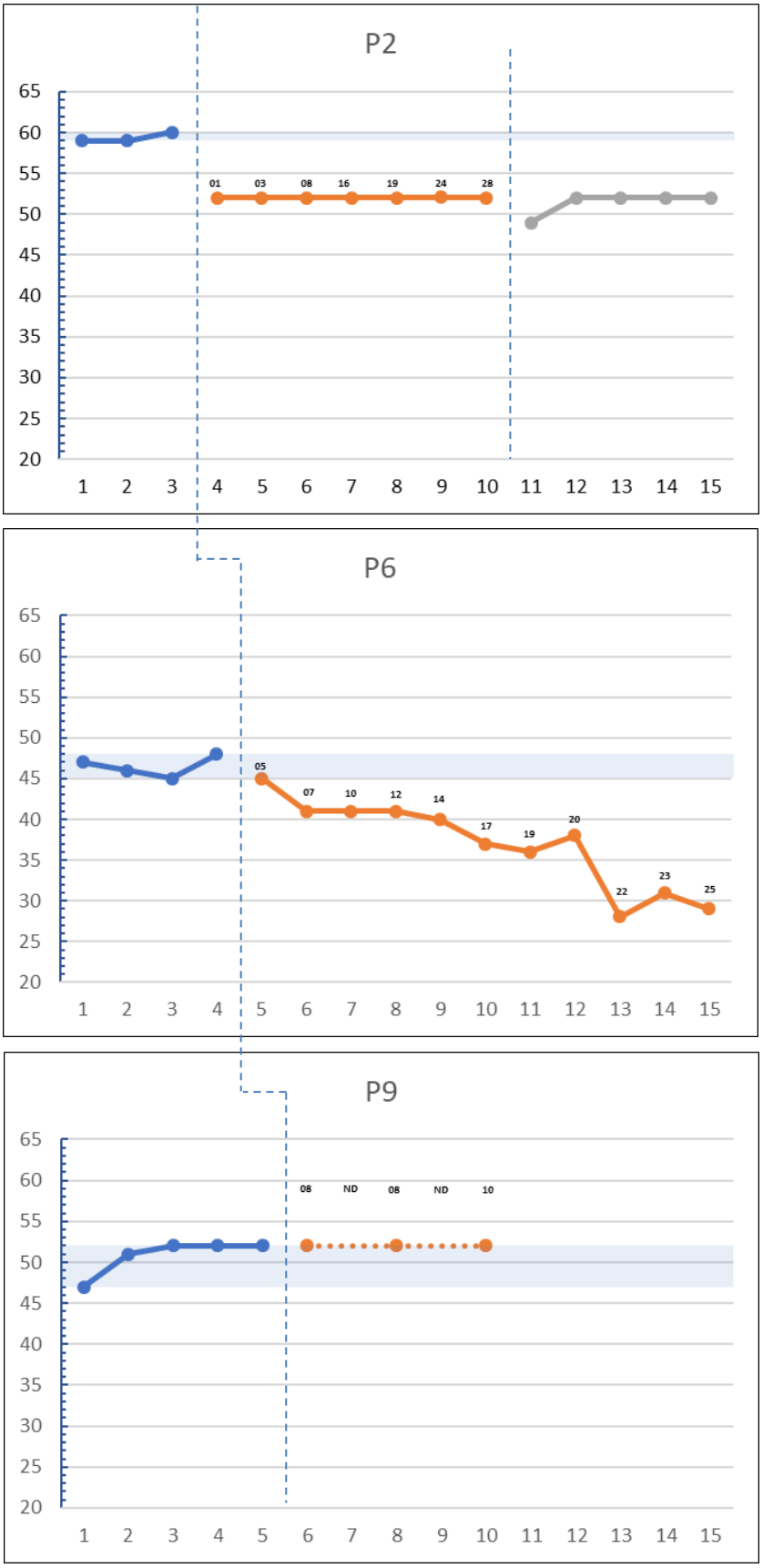
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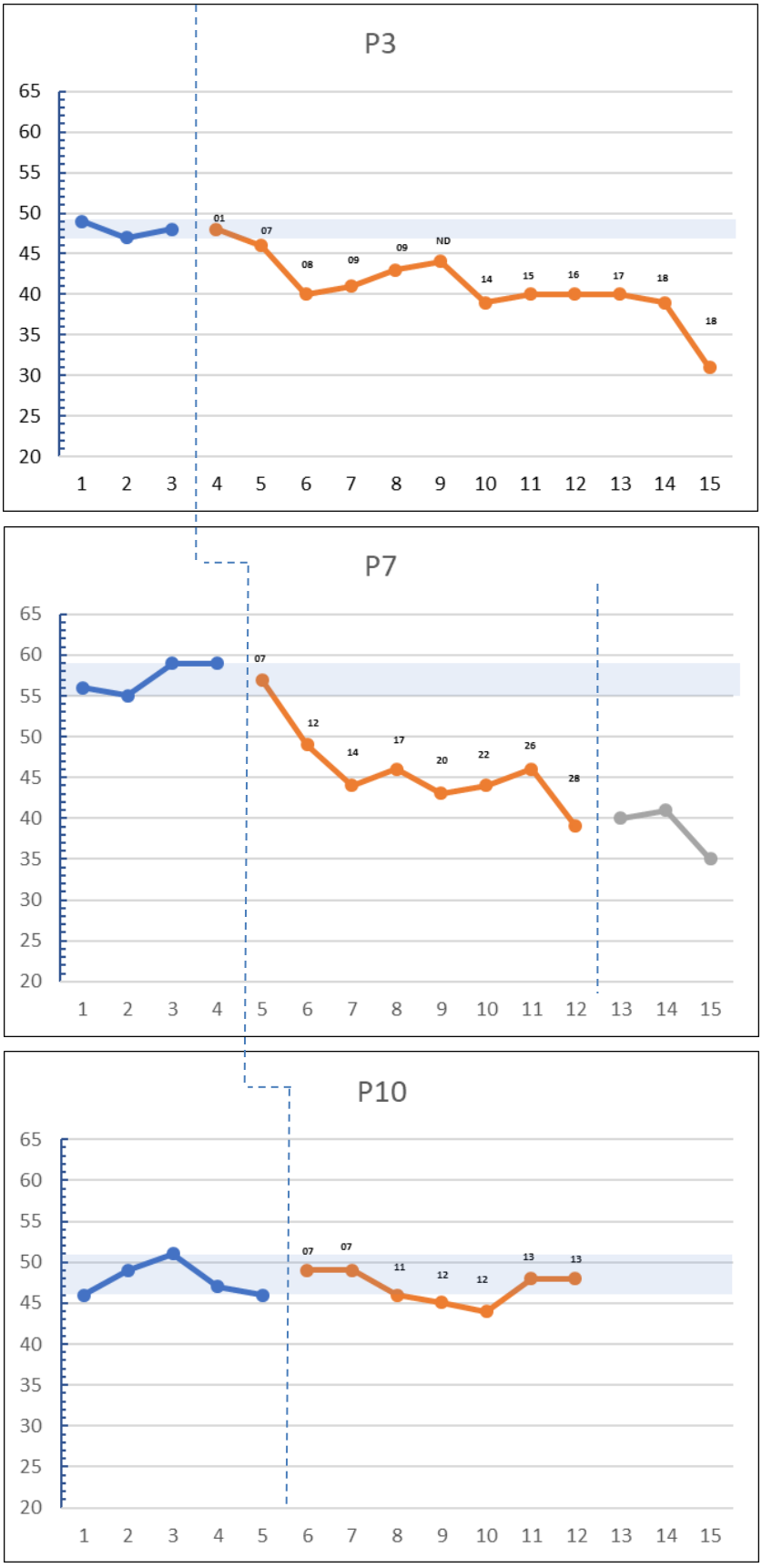
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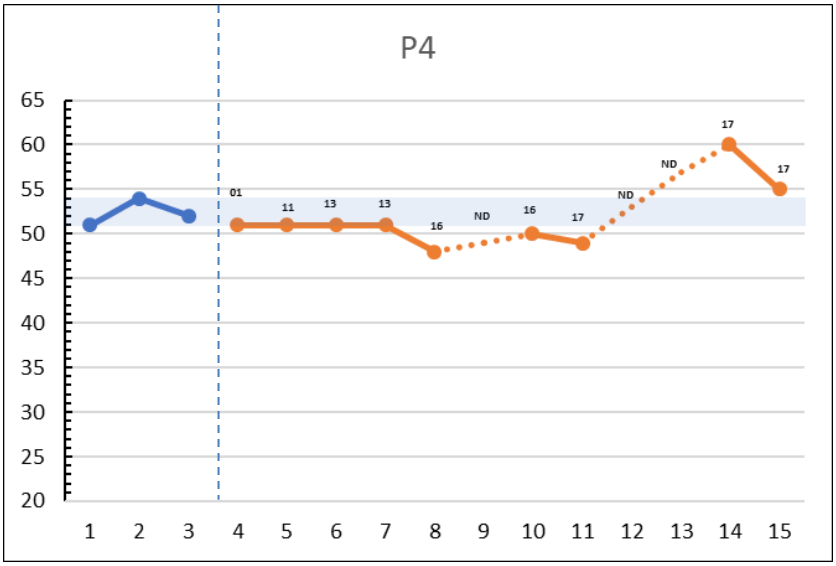

Figure 8. Individual outcomes throughout baseline (Blue), during treatment (Orange), and during follow-up (gray) on BFNES. The shaded regions show the range of baseline scores. Number above each treatment data point indicate the self-reported furthest level reached at the time of measure. ND = no data, meaning participant did not report furthest level reached or did not take measure at all. Missing data points represent measure not being taken, with dotted lines representing estimated trends. P = Participant.

Appendix A

Brief Fear of Negative Evaluation Scale

A = Not at all characteristic of me B = Slightly characteristic of me
C = Moderately characteristic of me D = Very characteristic of me
E = Extremely characteristic of me

Read each of the following statements carefully and indicate how characteristic it is of you

1. I worry about what other people will think of me even when I know it doesn't make any difference……. A B C D E
2. I am unconcerned even if I know people are forming an unfavorable impression of me…….. A B C D E
3. I am frequently afraid of other people noticing my shortcomings…… A B C D E
4. I rarely worry about what kind of impression I am making on someone…. A B C D E
5. I am afraid others will not approve of me……..... A B C D E
6. I am afraid that people will find fault with me……. A B C D E
7. Other people's opinions of me do not bother me…….. A B C D E
8. When I am talking to someone, I worry about what they may be thinking about me…… A B C D E
9. I am usually worried about what kind of impression I make…… A B C D E
10. If I know someone is judging me, it has little effect on me……. A B C D E
11. Sometimes I think I am too concerned with what other people think of me……. A B C D E
12. I often worry that I will say or do the wrong things A B C D E

Appendix B

Leibowitz Social Anxiety Scale (LSAS-SR)

Fill out the following questionnaire with the most suitable answer listed below. Base your answers on your experience within the past week and, if you have completed this scale previously, be as consistent as possible in your perception of the situation described. Be sure to answer all items.

Fear or Anxiety	Avoidance
F0 = None	A0 = Never (0%)
F1 = Mild	A1 = Occasionally (1%-33% of the time)
F2 = Moderate	A2 = Often (33%-67% of the time)
F3 = Severe	A3 = Usually (67%-100% of the time

1. Telephoning in public…….. F0 F1 F2 F3 A0 A1 A2 A3
2. Participating in small groups……... F0 F1 F2 F3 A0 A1 A2 A3
3. Eating in public places……. F0 F1 F2 F3 A0 A1 A2 A3
4. Drinking with others in public places…….. F0 F1 F2 F3 A0 A1 A2 A3
5. Talking to people in authority……. F0 F1 F2 F3 A0 A1 A2 A3
6. Acting, performing or giving a talk in front of an audience……... F0 F1 F2 F3 A0 A1 A2 A3
7. Going to a party……... F0 F1 F2 F3 A0 A1 A2 A3
8. Working while being observed…… F0 F1 F2 F3 A0 A1 A2 A3
9. Writing while being observed……. F0 F1 F2 F3 A0 A1 A2 A3
10. Calling someone you don’t know very well…… F0 F1 F2 F3 A0 A1 A2 A3
11. Talking with people you don’t know very well……... F0 F1 F2 F3 A0 A1 A2 A3
12. Meeting strangers…… F0 F1 F2 F3 A0 A1 A2 A3
13. Urinating in a public bathroom…… F0 F1 F2 F3 A0 A1 A2 A3
14. Entering a room when others are already seated……. F0 F1 F2 F3 A0 A1 A2 A3
15. Being the center of attention…… F0 F1 F2 F3 A0 A1 A2 A3
16. Speaking up at a meeting……. F0 F1 F2 F3 A0 A1 A2 A3
17. Taking a test…… F0 F1 F2 F3 A0 A1 A2 A3
18. Expressing a disagreement or disapproval to people you don't know very well……... F0 F1 F2 F3 A0 A1 A2 A3
19. Looking at people you don’t know very well in the eyes… F0 F1 F2 F3 A0 A1 A2 A3
20. Giving a report to a group……... F0 F1 F2 F3 A0 A1 A2 A3
21. Trying to pick up someone…….. F0 F1 F2 F3 A0 A1 A2 A3
22. Returning goods to a store……... F0 F1 F2 F3 A0 A1 A2 A3
23. Giving a party…….. F0 F1 F2 F3 A0 A1 A2 A3

24. Resisting a high pressure salesperson…….. F0 F1 F2 F3 A0 A1 A2 A3

Appendix C

WHOQOL-BREF

VP = Very poor
PO = Poor
NP = Neither poor nor good
GO = Good
VG = Very good

VD = Very dissatisfied
DI = Dissatisfied
ND = Neither satisfied nor dissatisfied
SA = Satisfied
VS = Very satisfied

NA = Not at all
AL = A little
AM = A moderate amount
VM = Very much
AE = An extreme amount

NA = Not at all
AL = A little
MD = Moderately
MO = Mostly
CM = Completely

NE = Never
SE = Seldom
QO = Quite often
VO = Very often
AY = Always

The following questions ask how you feel about your quality of life, health, or other areas of your life. Please choose the answer that appears most appropriate. If you are unsure about which response to give to a question, the first response you think of is often the best one.

Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life in the last four weeks.

1. How would you rate your quality of life?..... VP PO NP GO VG
2. How satisfied are you with your health?..... VD DI ND SA VS

The following questions ask about how much you have experienced certain things in the last four weeks

3. To what extent do you feel that physical pain prevents you from doing what you need to do?..... NA AL AM VM AE
4. How much do you need any medical treatment to function in your daily life?..... NA AL AM VM AE
5. How much do you enjoy life?..... NA AL AM VM AE
6. To what extent do you feel your life to be meaningful?..... NA AL AM VM AE
7. How well are you able to concentrate?..... NA AL AM VM AE
8. How safe do you feel in your daily life?..... NA AL AM VM AE
9. How healthy is your physical environment?..... NA AL AM VM AE

The following questions ask about how completely you experience or were able to do certain things in the last four weeks.

10. Do you have enough energy for everyday life?	NA AL MD MO CM
11. Are you able to accept your bodily appearance?	NA AL MD MO CM
12. Have you enough money to meet your needs?	NA AL MD MO CM
13. How available to you is the information that you need in your day-to-day life?	NA AL MD MO CM
14. To what extent do you have the opportunity for leisure activities?	NA AL MD MO CM
15. How well are you able to get around?	VP PO NP GO VG
16. How satisfied are you with your sleep?	VD DI ND SA VS
17. How satisfied are you with your ability to perform your daily living activities?	VD DI ND SA VS
18. How satisfied are you with your capacity for work?	VD DI ND SA VS
19. How satisfied are you with yourself?	VD DI ND SA VS
20. How satisfied are you with your personal relationships?	VD DI ND SA VS
21. How satisfied are you with your sex life?	VD DI ND SA VS
22. How satisfied are you with the support you get from your friends?	VD DI ND SA VS
23. How satisfied are you with the conditions of your living place?	VD DI ND SA VS
24. How satisfied are you with your access to health services?	VD DI ND SA VS
25. How satisfied are you with your transport?	VD DI ND SA VS

The following question refers to how often you have felt or experienced certain things in the last four weeks.

26. How often do you have negative feelings such as blue mood, despair, anxiety, depression?	NE SE QO VO AY

Appendix D

Kessler Psychological Distress Scale

A = None of the time B = A little of the time
C = Some of the time D = Most of the time
E = All of the time

These questions concern how you have been feeling over the past 30 days. Choose the answer to each question that best represents how you have been.

1. During the last 30 days, about how often did you feel tired out for no good reason?..... A B C D E
2. During the last 30 days, about how often did you feel nervous?..... A B C D E
3. During the last 30 days, about how often did you feel so nervous that nothing could calm you down?..... A B C D E
4. During the last 30 days, about how often did you feel hopeless?..... A B C D E
5. During the last 30 days, about how often did you feel restless or fidgety? A B C D E
6. During the last 30 days, about how often did you feel so restless you could not sit still?..... A B C D E
7. During the last 30 days, about how often did you feel depressed?..... A B C D E
8. During the last 30 days, about how often did you feel that everything was an effort?..... A B C D E
9. During the last 30 days, about how often did you feel so sad that nothing could cheer you up?..... A B C D E
10. During the last 30 days, about how often did you feel worthless?..... A B C D E

Appendix E

Drug Abuse Screening Test 10

N = No Y = Yes

The following questions concern information about your potential involvement with drugs, excluding alcohol and tobacco, during the past 12 months.

When the words “drug abuse” are used, they mean the use of prescribed or over-the-counter medications/drugs in excess of the directions and any non-medical use of drugs. The various classes of drugs may include: cannabis (e.g., marijuana, hash), solvents, tranquilizers (e.g., Valium), barbiturates, cocaine, stimulants (e.g., speed), hallucinogens (e.g., LSD) or narcotics (e.g., heroin). Remember that the questions do not include alcohol or tobacco.

If you have difficulty with a statement, then choose the response that is mostly right.

These questions refer to the past 12 months.

1. Have you used drugs other than those required for medical reasons?..... N Y
2. Do you abuse more than one drug at a time?..... N Y
3. Are you always able to stop using drugs when you want to? (If never use drugs, answer “Yes.”)…… N Y
4. Have you had "blackouts" or "flashbacks" as a result of drug use?..... N Y
5. Do you ever feel bad or guilty about your drug use? If never use drugs, choose “No.”…….. N Y
6. Does your spouse (or parents) ever complain about your involvement with drugs? N Y
7. Have you neglected your family because of your use of drugs?..... N Y
8. Have you engaged in illegal activities in order to obtain drugs?..... N Y
9. Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking drugs?..... N Y
10. Have you had medical problems as a result of your drug use (e.g., memory loss, hepatitis, convulsions, bleeding, etc.)?..... N Y

Appendix F

Demographic Questionnaire

1. What is your birthdate?
2. What is your gender?
    a. Male
    b. Female
    c. Other
3. What is your race?
    a. White
    b. Black or African American
    c. American Indian or Alaska Native
    d. Asian
    e. Native Hawaiian or Pacific Islander
    f. Other
4. What is your education level?
    a. Some high school, no diploma
    b. High school graduate, diploma or the equivalent (e.g. GED)
    c. Some college credit, no degree
    d. Associate degree
    e. Bachelor's degree
    f. Master's degree
    g. Professional degree
    h. Doctorate degree
5. What is your current employment status?
    a. Not employed
    b. Part time
    c. Full time
6. What is your relationship status?
    a. Single
    b. Girlfriend/Boyfriend
    c. Engaged
    d. Married
7. How many friends do you have?
    a. None
    b. 1-5
    c. 6-10
    d. More than 10
8. How often do you have a drink containing alcohol?
    a. Never
    b. Monthly or less
    c. 2-4 times a month
    d. 2-3 times a week
    e. 4 or more times a week

9. How much time do you spend on your iPhone each day?
    a. Less than 30 minutes
    b. From 1-3 hours
    c. From 4-6 hours
    d. More than 6 hours
10. Do you feel your iPhone is a necessary item (e.g. you can't leave home without it)?
    a. No
    b. Yes
11. How often do you read books, other than for your school assignments? (include books read on a device)
    a. Every day
    b. Frequently
    c. Occasionally
    d. Rarely
    e. Never
12. How often do you play games on your phone?
    a. Never
    b. Rarely
    c. Occasionally
    d. Frequently
    e. Constantly
13. Have you ever received psychotherapy or counseling before?
    a. No
    b. Yes
14. How often do you play games on a computer or console?
    a. Never
    b. Rarely
    c. Occasionally
    d. Frequently
    e. Constantly
15. Have you ever been diagnosed with a mental disorder? If so, check all that apply:
    a. Social Anxiety Disorder
    b. Major Depressive Disorder
    c. Generalized Anxiety Disorder
    d. Obsessive Compulsive Disorder
    e. Attention Deficit Hyperactivity Disorder
    f. Bipolar Disorder
    g. Other

Appendix G

Recommended Speed of Progress

The following chart represents a recommended minimum speed of progress through the application. It's up to you to proceed faster or slower, but to get the most out of the application, you should go through it at approximately the following pace:

Week 1

0. Initial tutorial
1. Getting Started
2. What is Anxiety?
3. Social Anxiety
4. The Effects of Social anxiety
5. Bonus Round: Anxiety Quiz
6. The Path Ahead
7. Three Components

Week 2

8. Keeping Track
9. Looking at Your Thinking
10. Bonus Round: Thinking about thinking
11. Thinking Traps
12. Thinking Skills
13. Fortune Retelling
14. Perspective Shifting
15. Additional Thinking Traps
16. Bonus Round: Identifying Thinking Traps

Week 3

17. Thinking Differently
18. Language and the Mind
19. Being Skills
20. Practicing Being
21. How do you Feel?
22. Willingness

Week 4

23. Practicing Feeling
24. The Problem with Avoidance
25. The Case for Taking Action
26. Taking Action: Round 1

Week 5

27. Taking Action: Round 2
28. The Road Ahead

Appendix H

Informed Consent

Consent to Participate in Research

Information to Consider About this Research

Assessing the Efficacy of a Self-Administered Treatment for Social Anxiety Disorder in the Form of a Gamified Mobile Application

Principal Investigator: Daniel George
Department: Psychology
Contact Information for faculty advisor:
J.P. Jameson, Ph.D.,
222 Joyce Lawrence Lane
Boone, NC 28608-32109
Office: (828) 262-2272 ext. 424

You are being invited to take part in a research study about using a mobile application to treat social anxiety. This application has been created by the study's principal investigator, Daniel George. If you take part in this study, you will be one of about 12 people to do so. By doing this study we hope to learn if social anxiety can be successfully treated through a smartphone application.

The research procedures will be conducted at Appalachian State University, as well as on your own time, wherever you may be.

Initially, you will be asked to take multiple assessment measures online that assess your current level of social anxiety. After a period of time you will be scheduled to meet with the principal investigator of the study, at which point a mobile application will be installed on your iPhone. This application will take you through the process of overcoming your social anxiety over a 9-week period. Within the application, you will consider your experience of social anxiety, learn about social anxiety, and be encouraged to participate in different exercises that will help you overcome your social anxiety. The application itself will take around 9 weeks to complete, although it is possible to complete it in a shorter amount of time.

You should not participate in this study if you are currently receiving psychotherapy or counseling. You cannot volunteer for this study if are under 18 years of age.

What are possible harms or discomforts that I might experience during the research?
To the best of our knowledge, the risk of harm for participating in this research study is no more than you would experience in everyday life as someone who experiences social anxiety.

What are the possible benefits of this research?

Possible benefits of your participation include a reduction in your experience of social anxiety as well as a reduction in the impairment you experience from social anxiety in your day to day life.

Will I be paid for taking part in the research?
You will not be paid for your participation in this study. However, you can earn up to 10 ELC credits for your participation. There are other research options and non-research options for obtaining extra credit or ELC's. One non-research option to receive 1 ELC is to read an article and write a 1-2 page paper summarizing the article and your reaction to the article. More information about this option can be found at: psych.appstate.edu/research. You may also wish to consult your professor to see if other non-research options are available.

How will you keep my private information confidential?
We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information or what that information is. Your name and contact information will be kept separate from any information you provide and the information you provide will be stored under number rather than your name. All information will be kept in secured and encrypted folders and password protected.
This data will be kept in its secured form for 5 years, after which it will be destroyed.

Who can I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator, Daniel George at 828-832-6402 or by email at georgedl@appstate.edu or his faculty advisor, J.P. Jameson at (828) 262-2272 ext. 424 or by email at jamesonjp@appstate.edu you have questions about your rights as someone taking part in research, contact the Appalachian Institutional Review Board Administrator at 828-262-2692 (days), through email at irb@appstate.edu or at Appalachian State University, Office of Research and Sponsored Programs, IRB Administrator, Boone, NC 28608.

Do I have to participate? What else should I know?
Your participation in this research is completely voluntary. If you choose not to volunteer, there will be no penalty and you will not lose any benefits or rights you would normally have. If you decide to take part in the study you still have the right to decide at any time that you no longer want to continue. There will be no penalty and no loss of benefits or rights if you decide at any time to stop participating in the study. If you decide to participate in this study, let the research personnel know. A copy of this consent form is yours to keep.
This research project has been approved by the Institutional Review Board (IRB) at Appalachian State University.

This study was approved on:

This approval will expire on _____ unless the IRB renews the approval of this research.

By pressing ACCEPT, you acknowledge you have read the terms of the research outlined above, understand how to have questions related to the research answered and that you may have a copy of this consent document, and are voluntarily agreeing to be in the research by providing your “digital signature.”

ACCEPT **DECLINE**

Appendix I

Notice of Institutional Review Board Request of Additional Information

To: Daniel George
Psychology
CAMPUS EMAIL

From: IRB Administration
Date: 7/06/2017
RE: Contingencies to be addressed following IRB Review
STUDY #: 17-0053

STUDY TITLE: Assessing the Efficacy of a Self-Administered Treatment for Social Anxiety Disorder in the Form of a Gamified Mobile Application
Submission Type: Initial

Thank you for requesting IRB review. The IRB requests revisions to your study materials before confirming level of review. Please clarify and/or address the study specific details so that the review of your study may proceed.

Regulatory and other findings:

Daniel,

Additional information is needed on this study. Please change your answer to A.4.1 to "yes" and complete the questions related to "investigational device." You are testing the effectiveness of the mobile app on treatment of a condition, and it will require the IRB to review at the July meeting as a device (per FDA definitions of a device). Please also indicate whether this is an app you have created or you are testing a commercial application--it is not clear in the IRB what application you are using.

Please return the revised IRB to us by Tuesday July 11 so we can include it on the July agenda.

This study was reviewed using the IRB Information System (IRBIS).

Please respond to these concerns by editing the appropriate study documents using tracking changes and/or otherwise highlighting changes and returning these edited documents to irb@appstate.edu with a reference to your IRB study number. If your application is on our online system, you can log in at https://appstate.myresearchonline.org/irb/index_auth.cfm and make the changes.

Thank you for your cooperation! Feel free to call at (828) 262-2692 or email at irb@appstate.edu if you have any questions regarding the review.

Note: This notice does not constitute IRB approval. Research procedures with human participants may not begin for the study until the IRB approves the study.

CC:
John Jameson, Psychology

Appendix J

Notice of Minor Contingencies to be addressed following Full Board IRB Review

To: Daniel George
Psychology
CAMPUS EMAIL

From: Lisa Curtin, PhD, IRB Chairperson
Date: 7/26/2017
RE: Minor Contingencies to be addressed following Full Board IRB Review

STUDY #: 17-0053
STUDY TITLE: Assessing the Efficacy of a Self-Administered Treatment for Social Anxiety Disorder in the Form of a Gamified Mobile Application

Submission Type: Initial

Thank you for requesting IRB review. Your study has been reviewed by the IRB at a convened meeting on 7/18/2017. The IRB requests that you clarify and/or address the study specific details described below.

Please respond to these concerns by addressing them in IRBIS. To access these stipulations, log into your IRBIS account, click the link on the left-hand side of the page titled, "Waiting PI Response," and follow the prompts which will walk you through the process. You may respond to the stipulations directly and/or edit the application itself. If you have additional attachments to upload, you may do so. Updated versions of attachments should replace the old versions and not uploaded as new documents. If you experience any issues or have questions about this process, please email irb@appstate.edu with a reference to your IRB study number (not the reference number).

Thank you for your cooperation! If you have any questions regarding the review, contact Robin Tyndall at (828) 262-2692 or irb@appstate.edu, or the IRB Chair, Dr. Lisa Curtin.

Note: This notice does not constitute IRB approval. Research procedures with human participants may not begin for the study until the IRB approves the study.

CC:
John Jameson, Psychology

Appendix K

Notice of IRB Request for Further Clarifications

To: Daniel George
Psychology
CAMPUS EMAIL

From: Dr. Andrew Shanely, PhD, IRB Chairperson
Date: 8/28/2017
RE: Minor Contingencies to be addressed following Full Board IRB Review

STUDY #: 17-0053
STUDY TITLE: Assessing the Efficacy of a Self-Administered Treatment for Social Anxiety Disorder in the Form of a Gamified Mobile Application
Submission Type: Initial

The IRB requests that you clarify and/or address the study specific details described below.

Regulatory and other findings:

Daniel,

I apologize for this delay, the assigned IRB reviewer just returned comments today from your responses to the letter from the Board. We are watching your IRB and will process as soon as we can once we receive your updates.

Please respond to these concerns by addressing them in IRBIS. To access these stipulations, log into your IRBIS account, click the link on the left-hand side of the page titled, "Waiting PI Response," and follow the prompts which will walk you through the process. You may respond to the stipulations directly and/or edit the application itself. If you have additional attachments to upload, you may do so. Updated versions of attachments should replace the old versions and not uploaded as new documents. If you experience any issues or have questions about this process, please email irb@appstate.edu with a reference to your IRB study number (not the reference number).

Thank you for your cooperation! If you have any questions regarding the review, contact Robin Tyndall at (828) 262-2692 or irb@appstate.edu, or the IRB Chair, Dr. Andy Shanely.

Note: This notice does not constitute IRB approval. Research procedures with human participants may not begin for the study until the IRB approves the study.

CC:
John Jameson, Psychology

Appendix L

Notice of Institutional Review Board Study Approval

To: Daniel George
Psychology
CAMPUS EMAIL

From: Dr. Andrew Shanely, PhD, IRB Chairperson
Date: 9/11/17
RE: Notice of IRB Approval by Full Board Review

STUDY #: 17-0053
STUDY TITLE: Assessing the Efficacy of a Self-Administered Treatment for Social Anxiety Disorder in the Form of a Gamified Mobile Application
Submission Type: Initial
Approval Date: 9/11/2017
Expiration Date of Approval: 9/10/2018

The Institutional Review Board (IRB) reviewed this study at a convened meeting and approved this study for the period indicated above. IRB approval is limited to the activities described in the IRB approved materials, and extends to the performance of the described activities in the sites identified in the IRB application. In accordance with this approval, IRB findings and approval conditions for the conduct of this research are listed below.

All approved documents for this study, including consent forms, can be accessed by logging into IRBIS. Use the following directions to access approved study documents.

1. Log into IRBIS
2. Click "Home" on the top toolbar
3. Click "My Studies" under the heading "All My Studies"
4. Click on the IRB number for the study you wish to access
5. Click on the reference ID for your submission
6. Click "Attachments" on the left-hand side toolbar
7. Click on the appropriate documents you wish to download

Approval Conditions:

Appalachian State University Policies: All individuals engaged in research with human participants are responsible for compliance with the University policies and procedures, and IRB determinations.

Principal Investigator Responsibilities: The PI should review the IRB's list of PI responsibilities. The Principal Investigator (PI), or Faculty Advisor if the PI is a student, is ultimately responsible for ensuring the protection of research participants; conducting sound ethical research that complies with federal regulations, University policy and procedures; and maintaining study records.

Modifications and Addendums: IRB approval must be sought and obtained for any proposed modification or addendum (e.g., a change in procedure, personnel, study location, study instruments) to the IRB approved protocol, and informed consent form before changes may be implemented, unless changes are necessary to eliminate apparent immediate hazards to participants. Changes to eliminate apparent immediate hazards must be reported promptly to the IRB.

Approval Expiration and Continuing Review: The PI is responsible for requesting continuing review in a timely manner and receiving continuing approval for the duration of the research with human participants. Lapses in approval should be avoided to protect the welfare of enrolled participants. If approval expires, all research activities with human participants must cease.

Prompt Reporting of Events: Unanticipated Problems involving risks to participants or others; serious or continuing noncompliance with IRB requirements and determinations; and suspension or termination of IRB approval by an external entity, must be promptly reported to the IRB.

Closing a study: When research procedures with human subjects are completed, please log into our system at https://appstate.myresearchonline.org/irb/index_auth.cfm and complete the Request for Closure of IRB review form.

Websites:

1. PI responsibilities: http://researchprotections.appstate.edu/sites/researchprotections.appstate.edu/files/PI%20Responsibilities.pdf

2. IRB forms: http://researchprotections.appstate.edu/human-subjects/irb-forms

CC:
John Jameson, Psychology

Appendix M

Student Request for Release of Intellectual Property Rights Invention and Discovery Disclosure Form

Appalachian State University

Student Request for Release of Intellectual Property Rights Invention and Discovery Disclosure Form

Please submit the completed form via email to:
ip@appstate.edu

Submit a hardcopy with original signatures to:
IP Council
C/O Office of Research Protections
385 John Thomas Building
Appalachian State University
Boone, NC 28608

For the sake of readability, hand written disclosures will not be accepted.

Questions?
Email ip@appstate.edu or call (828) 262-2692

I. Inventors

Identify all inventors below and obtain signatures. Note: For this form, the Primary Inventor must be a student at Appalachian State University. Please attach an additional copy of this page if needed.

Inventor's Name (Primary Contact): Daniel L. George

Citizenship: US Citizen | Department: Psychology

Email: georgedl@appstate.edu | Telephone: [redacted]

Permanent Address: [redacted] | City: Boone

State: NC | Country: US

Percentage Share of Inventor Royalties: 100%

Check one ___ Faculty ___ Staff _X__ Student ___ Other (describe):

II. Description of Invention

1. Invention Title: Overcoming Social Anxiety Mobile Application

2. Select a category for the invention:

☐ Health Care/Medical Devices ☒ Software

☐ Computational and Efficiency Enhancers ☐ Manufacturing/Process Enhancers

☐ Biotechnology and Agro-medicine ☐ Other:

3. Check all boxes that apply to the category of the invention:

☐ New Process ☒ New Product

☐ New composition of Matter ☐ New Device

☐ Improvement to an Existing Process/Product ☐ New use for an Existing Process/Product

4. Invention conception date: Summer, 2014

5. Describe how the invention came to be:

Initially conceptualized as a habit formation application, the application became more specific as time went on.

6. Was the work self-directed? ☒ Yes ☐ No

7. Has the invention been reduced to practice? ☐ Yes ☒ No

8. PLEASE DESCRIBE THE INVENTION IN DETAIL.

The invention is a mobile application for Apple IOS devices. The application is 9 week self-directed intervention for the treatment of social anxiety. The application is based on bibliotherapeutic interventions with the addition of "gamified" elements which encourage treatment adherence and completion. (See prospectus for more detail.)

9. Describe the particular problem the invention seeks to solve.

Dispensing treatment for social anxiety on a mobile platform

10. What existing technologies or products solve or attempt to solve the same or similar problems?

Social anxiety workbooks

11. What novel and/or unusual features distinguish this invention from existing technologies or products?

Gamification and the mobile platform

12. Have you published, submitted, prepared or publicly presented data, theses, reports, abstracts or journal articles pertaining to the invention? Please list these disclosures with actual or projected publication dates and attach copies, if possible. If disclosed to specific individual(s), please give name(s).

No

13. What university resources (e.g., materials, facilities, employee time and effort) were used in the development of the invention?

None

14. If available, please attach separate pages with related figures, drawings and/or photographs that help to describe the nature of operation and invention applications. Diagrams and visual representations are strongly encouraged.

See "Prospectus" and "Screenshots

Vita

Daniel Lewis George was born in Chapel Hill, North Carolina, to James and Mary George. He completed his undergraduate studies at Appalachian State University where he earned his Bachelor of Science in Psychology. He began study toward a Master of Arts degree in Clinical Psychology at Appalachian State University in August 2015 and was awarded the degree in May 2018.