Exploring the use of mobile applications in Generalized Anxiety Disorder

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Abstract

Mental health disorders affect about 1 in 5 adults in the United States, and less than half (45%) of those people have received treatment in the last year (SAMHSA, 2020). As technology makes its way into many homes, there has been a rise in mobile health applications. This project aims to explore the use of these applications in those who suffer from Generalized Anxiety Disorder. Specifically, we hope to better understand the features which participants feel are the most helpful for coping with anxiety, and the elements which motivate participants to continue using the application (more than one time). Generalized Anxiety is defined by the National Institute of Mental Health (2016) as excessive worry that is difficult to control, and often interferes with daily tasks. Within this project an online survey was disseminated to collect data and feelings on the use of current applications which may or may not be aimed towards those struggling with anxiety. Following this, a prototype of a new application was created using the feedback gained from the original survey. Then the prototype was run through a usability test and more feedback was gathered about how this application could help people with anxiety in coping with their worry. The top feature which was mentioned in both the survey and the interviews was guided meditation. There are many applications currently available which include or are centered around guided meditation. The two elements of motivation that were mentioned most frequently is that that app actually helps to lower their anxiety, and that the app is also enjoyable. This project allows us to gain insight on the uses of mobile health applications and understand what features and design patterns are considered most useful.

Exploring the use of mobile applications in Generalized Anxiety Disorder

Mental health conditions are among the most prevalent and expensive health care costs. They affect 1 in 5 adults in America each year (Substance Abuse and Mental Health Services Administration [SAMHSA], 2020) and cost the US more than $225 billion each year (Open Minds, 2020). In particular, Generalized Anxiety Disorder (GAD) is one of the most widespread mental health conditions, reported by the Anxiety & Depression Association of America (ADAA) to affect 6.8 million people annually. GAD is defined by the National Institute of Mental Health (2016) as a chronic condition characterized by ongoing (six months or longer) and excessive worry which can be difficult to control and often interferes with daily tasks. It very often goes undiagnosed for years so it is impossible to know how many people it may truly affect (Wittchen, 2002). Additionally, it causes an economic burden due to decreased productivity at work and sick days, as well as frequent use of health care services. GAD is also highly comorbid with other mental health conditions such as major depression, panic disorder, PTSD, and specific phobias (Wittchen, 2002).

In 2019, less than half (44.8%) of people affected by a mental health condition received treatment (SAMHSA, 2020). There are many barriers which people experience that cause them to not seek treatment. Inadequate transportation is an obstacle for many older adults as well as those living in rural areas (Brenes et al., 2015; Weinberger et al., 2009). Access to care is also limited by the cost of standard treatment in tandem with navigating insurance (Jones et al., 2014). The public stigma of mental health also can cause many to not seek traditional help (Goetter et al., 2020). Stigmatizing beliefs such as perceived violence, or incompetency often cause stigmatizing actions such as social distancing from those who experience mental health conditions. (Parcesepe & Cabassa, 2013). Along with outside stigmas, many internalize these

stigmas and feel shame and embarrassment which affect their likelihood of receiving conventional care (Goetter et al., 2020).

The COVID-19 pandemic also created and aggravated many barriers to accessing standard treatment. For those who were already receiving some sort of in-patient treatment, the pandemic caused a disruption in their care as the world was told to shelter in place. The pandemic also increased isolation which can be detrimental to those who are already experiencing mental health conditions and can cause new mental health conditions to arise. As mentioned previously, cost is a major barrier to accessing treatment, and the pandemic has caused economic uncertainty, which is disproportionately affecting marginalized communities (Altiraifi & Rapfogel, 2020).

With the rise and rapid adoption of mobile technology, there is a potential to increase access to care through mobile applications, often referred to as *mhealth*.

Digital therapeutics like mhealth applications aim to provide help for those who do not receive typical treatment and/or to complement their treatment which they are already receiving. However, many of these applications have not been clinically tested or proven effective (Huguet et al., 2016). Most applications are developed and added to app stores with no indication of how successful they are in treating various conditions or relieving symptoms for users. Mobile applications might be able to provide users who experience barriers to typical in-person treatment, an accessible and affordable way to cope with their illness. However, if the applications are not effective, then they may not be adopted, and might even be harmful to people who use them.

One app which was recently empirically tested aimed to gamify deep breathing exercises. The app named “Flowy” allows users to swipe to navigate a boat around obstacles while an

animated cloud shows how long to breathe in and out, simulating the forward movement of the boat as you breathe. Participants in this trial were split into a treatment and control group. The treatment group received four weeks of free access to the app, while the control group was placed on a waitlist before being offered access subsequent the four weeks. Following the trial period, it was determined that Flowy was able to reduce anxiety, and panic while also improving quality of life. Flowy users described the app as fun, and useful. They reported to use it proactively as part of their care and would recommend it to others. (Pham et al., 2015)

Another app which is highly rated in the Apple app store, and well known for its mindfulness exercises, Headspace was the focus of a study aiming to determine the impact mindfulness training specifically through a digital format could have on affect, irritability, and stress. (Economides, 2018). The study split participants into a treatment group who were given access to the Headspace app, and a control group who were given access to an audiobook on mindfulness which discussed the background, and key concepts behind the practice. Participants were given three questionnaires to measure their positive and negative affect, irritability, and stress levels both before and after they completed the 10 sessions required to be included in the study. Although this study did not test adults specifically with anxiety disorders it was shown that mindfulness training in this digital format does decrease stress and irritability, while increasing positive affect in healthy adults. The practice of mindfulness which includes forms of deep breathing and meditation is a popular feature of apps aiming to decrease stress and anxiety. It is expected that the benefits of this practice would also carry over to those who experience high levels of anxiety and would be a sought after feature.

Due to the small amount of anxiety specific apps which have been empirically studied for effectiveness, the subsequent paragraphs discuss apps which have been studied among other

mental health conditions. As mentioned above, often those who experience GAD have comorbidity with other major mental health conditions (Wittchen, 2002). Additionally, therapies such as Cognitive Behavioral Therapy (CBT), breathing techniques, and Behavioral Activation (BA) are used regularly across many of these conditions and will inform our subsequent work.

Huguet et al. (2016) did a systematic review of mhealth apps for those with symptoms of depression. The researchers aimed to evaluate applications which utilized a CBT or a BA approach; both are evidence-based therapies shown to improve depression. Out of the 117 self-help apps they found, only 12 of these applications were identified to provide support related to these evidence-based practices. These apps were evaluated based on their usefulness, usability, and integration/infrastructure. The researchers discussed the idea of usefulness in terms of how effective the app may be in decreasing the user's symptoms of depression. In many cases, the researchers had trouble determining the effectiveness because almost all of the apps had not been tested and thus could not be found in the scientific literature.

The researchers found that apps that had a low usability score created barriers to adoption. When looking at integration/infrastructure the researchers were primarily concerned with privacy and safety. Most of the apps that were evaluated did not have a privacy policy and also did not provide mechanisms to handle high risk of suicidality. This review reinforces the idea that many mhealth apps have yet to be evaluated or regulated, and although this might be a new space for mental health treatment and/or education, there is a lot of work that can be done to improve the apps in this domain.

A newer mhealth application was created by Schroeder et al. (2018) and evaluated. This app focused on Dialectical Behavioral Therapy (DBT), which is a form of CBT. The app provides a module like environment where users can work through topics in a conversational

format. The conversation is held with a bot called eMarsha, which is based on Dr. Marsha Linehan, who is the creator of DBT. Participants in the evaluation were recruited from a DBT listserve, all of whom were currently in a therapy which used DBT techniques. The participants used the application for about a month and were sent reminders via text message to motivate them to use the application. Following the study, participants were found to have an increase in their DBT skill use, and a decrease in anxiety and depression symptoms. Participants felt that the application "complimented" their in-person therapy, and many felt that the use of eMarsha and Marsha Linehan's techniques made the app more trustworthy. Many participants also felt that the reminder text messages served as a good reminder to use the application and might have increased the motivation to use the app.

Another application which has been evaluated strayed away from the typical education or conversational type applications discussed above. This application developed by Franklin et al. (2016) utilizes a game type approach to engage users. The application was tested on users who were self-harming or had self-harming thoughts. Participants were randomized between an "active" and a control group. Those in the active group received access to the application which involved a pairing game developed by the researchers called Therapeutic Evaluative Conditioning (TEC), whereas those in the control group received access to a control application. Following the participants use of the applications over one month, those in the active group showed reduction in self harming thoughts and behaviors, although this did not include suicidal ideation.

Similarly, Begale et al. (2013) worked on developing an application for managing schizophrenia. The app includes medication management and reminders, Behavioral Activation therapy techniques, anger management, and cognitive restructuring. Over half (63%) of those

surveyed owned a mobile device and many expressed interest in utilizing mhealth applications. After conducting usability tests on the application, a majority of participants felt that the app was easy to use as well as helpful in managing their symptoms. Additionally, those who had little prior experience using mhealth applications were able to learn to use the system fairly quickly. Taking it a step further than just smartphone applications, Ben-Zeev et al. (2015) looked at smartphone sensors which can record geospatial activity, kinesthetic activity, sleep patterns, and time spent proximal to human speech. The researchers had participants complete daily ratings of stress, as well as depression and loneliness scales (pre and post-test). Participants were instructed to use the smartphones given out for the study throughout the 10-week period. The researchers found that the geospatial activity and sleep duration were associated with daily stress levels. The time people spent proximal to human speech was associated with feelings of loneliness. The researchers feel it is an important take-away that smartphones are useful instruments for collecting behavioral markers associated with mental health unobtrusively.

As previously mentioned, there are a small number of applications which have been empirically tested in order to understand their effectiveness. However, there are a plethora of apps available in the app stores geared towards practicing mindfulness, deep breathing, mood tracking, and overall lowering anxiety. In 2018 at the start of this project, some of the highest-rated apps in the app store included Headspace, Calm, MoodPath, Pacifica, and Youper. All these apps provide different experiences and features so it is difficult to tell which features participants find most helpful. However, based on the study completed by Economides et al., (2018), we believe that guided meditation and other forms of mindfulness training will be a highly rated feature in our subsequent study. Both Headspace and Calm focus mainly on guided meditations, with Calm also offering relaxing sounds aimed at improving sleep. MoodPath and

Pacifica's main feature is a way to track your moods and anxiety levels, and Pacifica specifically will allow you to save or print a report to share with your doctor or other mental health professional. Youper focuses on Cognitive Behavioral Therapy techniques which can help users better understand patterns of unhelpful thoughts and behaviors and learn better ways of coping. Youper's main feature is an Artificial Intelligence (AI) chatbot that users can talk with for free, while also including a way to track your moods and stress levels.

Considering the findings above, while noteworthy, there needs to be more work done to understand the effectiveness of mhealth applications and what motivates people to use and continue to use these technologies. Mhealth applications have the potential to make mental health treatment more accessible for many who face barriers to receiving traditional treatment options. For the purpose of this study, we focused specifically on people who experienced frequent anxiety.

Methods

Online Survey

Originally, an online survey (see appendix A) set up through Survey Monkey was disseminated through various online Reddit forums for users with anxiety. These forums included r/Anxiety, r/AnxietyDepression as well as r/gradschool. Using this method, we collected a very small number of usable results. Following this, the survey was disseminated through UserZoom, a software which automatically recruits qualified participants in the United States. For this project a qualified participant is defined as someone 18 years or older, who has experienced anxiety at least a few times in the last year, and who has used a mobile application to combat their anxiety in the past. The online survey consisted of three demographic questions

and nine questions surrounding their anxiety and experience with one or more applications they have used to cope with anxiety.

Interactive Prototype

A prototype was wireframed on paper and then created and made interactive using Axure software. All features included in the prototype were based off the top features mentioned in the online survey responses. A usability test was conducted via Skype with ten participants who experience anxiety at least a few times a year, and have used, or currently use a mobile application to combat their anxiety. Each participant was given a $10 USD Amazon virtual gift card at the conclusion of the interview. The usability test consisted of three pre-test and demographic questions, five tasks which users were asked to complete, followed by four stand-alone questions (see appendix B). Additional methodological details pertaining to exactly how these interviews were conducted and analyzed are discussed later in conjunction with the specific results from these interviews.

Analysis

The results from the online survey and interviews were analyzed using Microsoft Excel. Grounded theory was used to analyze open-ended responses by coding and categorizing responses to assist in the collection of major themes presented by participants. For the online survey, this included all questions which contained a possible response of "other (please specify)", as well as one question which asked participants to describe a particular feature that they felt would be helpful if added to their app of choice. Major themes which emerged specifically around features were used to inform the design of our prototype for a new mobile application aimed at lowering anxiety. Each interview was transcribed completely to ensure accuracy while evaluating the final results. All responses (excluding demographic questions)

from the interviews were coded and categorized into themes the same way the open questions in the online survey were. These themes (discussed below), help us further understand the nuances which may have been harder to dissect from the just survey alone.

Results

Online Survey (August 2019)

Participants were asked to provide demographic information, though it was not required. See following figures for demographic information including age, education level, and gender. According to the CDC's National Health Interview Survey (Terlizzi et.al., 2019), the percentage of adults who experience any level of anxiety (mind, moderate, severe) was highest among the ages of 18-29 and lessened with age. The CDC also reported that women were more likely to experience symptoms of anxiety than men (Terlizzi et.al., 2019). This report did not discuss education level, however according to the results from the 2008-2012 Mental Health Surveillance Study (SAMHSA, 2014), adults who obtained less than a high school education were more likely to suffer from any anxiety disorder (including but not limited to GAD).

The demographics of participants in our study are similar to the findings regarding age and gender by the CDC, though it is possible our sample included a larger number of participants who received higher education. This could be due to some of the places where participants were recruited from, namely the university where this work was completed, and a Reddit forum called r/gradschool. Education level as well as participants usage and understanding of technology

could impact our results and minimize experiences had by users who have different backgrounds.

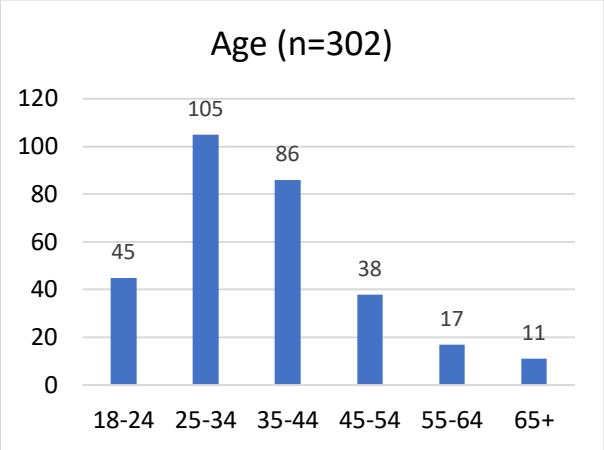

Fig. 1 Age of Survey Participants

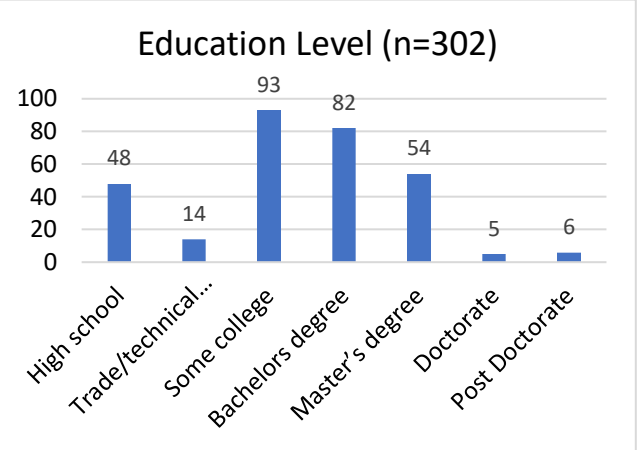

Fig. 2 Education of Survey Participants

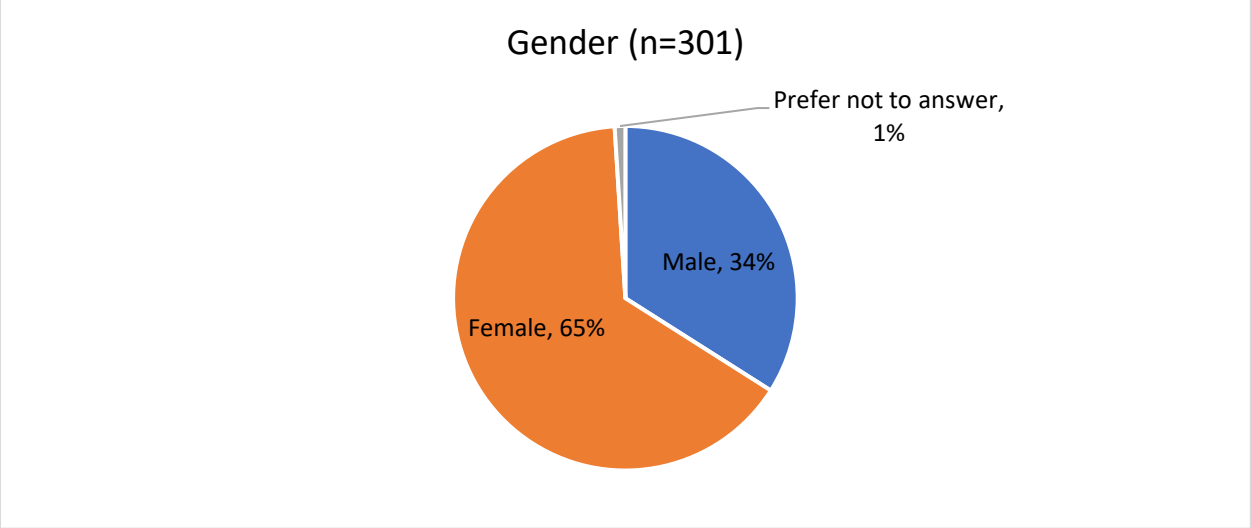

Fig. 3 Gender of Survey Participants

The first question in the initial online survey asked participants how often they experienced anxiety throughout their life. Close to 75% of respondents said anxiety is felt anywhere from a few times a week to every day (see Fig. 4).

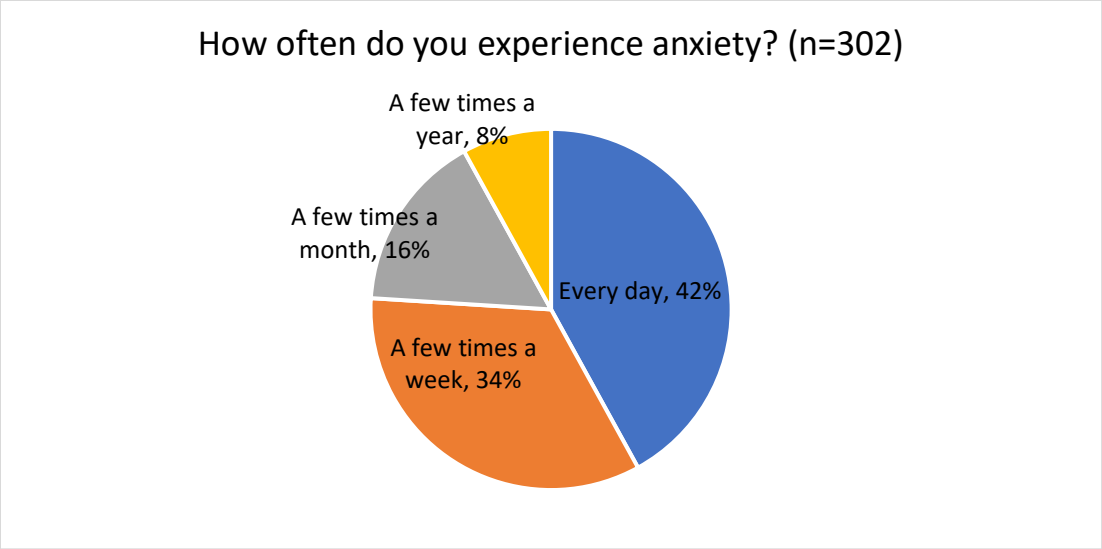

Fig. 4 Frequency of Anxiety

The next question addressed which mobile applications were most commonly used among participants. The question listed five highly rated apps (4 stars and above), Headspace, Calm, MoodPath (now known as MindDoc as of late 2019), Pacifica (now known as Sanvello as of late 2019), and Youper. There was also a selection for "Other" where participants could list any other app they used including apps not geared towards anxiety specifically (e.g. YouTube, games, music/sounds). Participants were allowed to report more than one selection, since it is possible to have multiple apps on your device at one time.

The apps listed were chosen based on their high rating in the app stores as well as the fact that they all have unique and differing features including meditations, sounds, mood tracking, and an AI assistant.

A majority used the Calm or Headspace apps (see Fig. 5). Of the participants who specified other mobile apps they used to help, half listed mobile game applications (e.g. Candy

Crush, Clash of Clans, Solitare, Farmville). The next most common mention at 12% was other apps specifically geared towards meditation or breathing (e.g. Stop Breathe Think, Buddihfy).

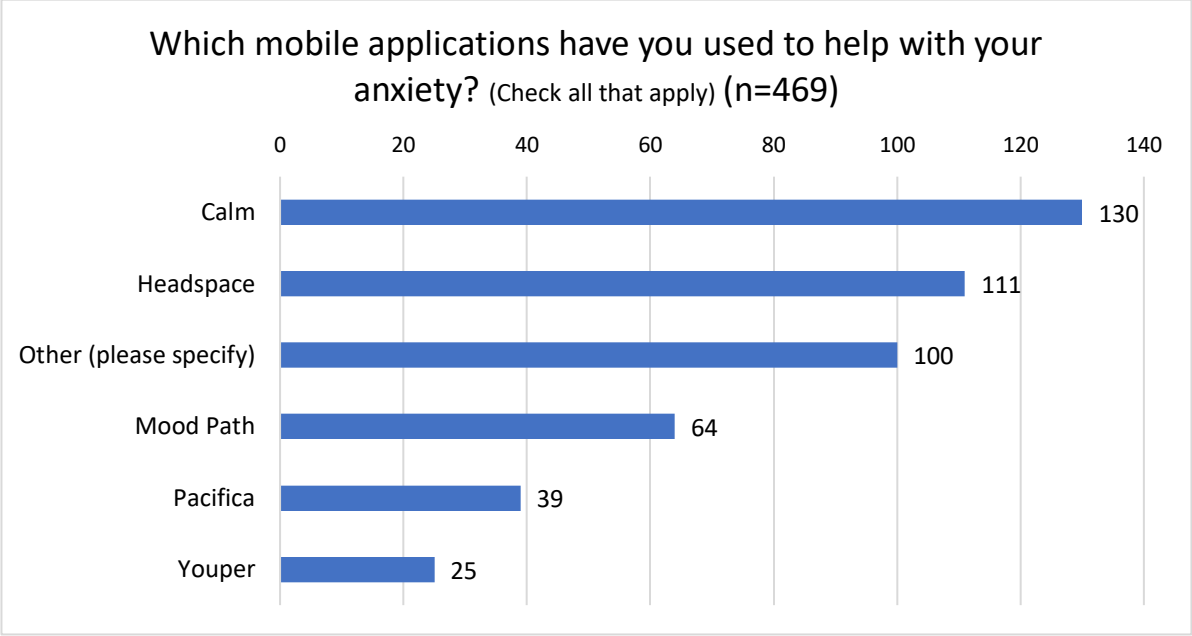

Fig. 5 Type of Apps Used

Seeing Calm and Headspace as the most used apps of our participants supports our expectation that meditation and mindfulness techniques could be among the highest rated features within this app space. In addition, many participants utilized apps which also incorporated meditation or breathing features. Headspace and Calm are also among the oldest applications first introduced to the app stores in 2010 and 2012 respectively, which suggests the possibility of participants being some of the early adopters of these particular apps and may continue use to this day. For reference, MoodPath and Youper were both founded in 2016 and Pacifica was founded in 2014.

The next question addressed how long the participant continued to use the mobile app on a regular basis. About half of respondents stopped using the app after one week or less (see Fig. 6). As anxiety is a chronic condition, a high percentage of drop-off after a week or less would seem to point to users abandoning the app rather than simply no longer needing it to combat their

anxious feelings. Understanding the reasons why there is such a high drop off rate in app usage, can better help answer the question surrounding elements which motivate users to continue turning to these apps.

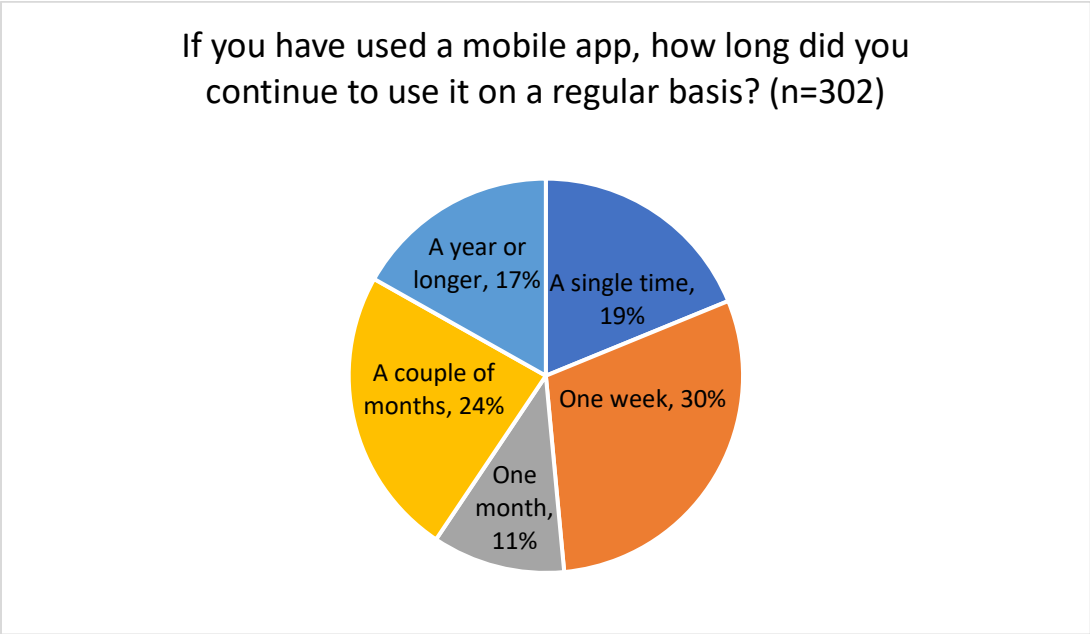

Fig. 6 Length of Use

The next question helps to supplement the previous question by asking participants why they stopped using their preferred app. The results varied showing that there are many reasons why app usage can decline. The highest ranked answer was that the app "did not help", followed closely by the app taking up too much storage space (see Fig. 7). Responses which fell into the "other" category included forgetting about the app or being too busy to use it, and not needing it anymore. Seeing that close to 20% of participants felt that the app was not helpful in relieving their symptoms, lets us know that more research needs to be done to better understand which app features are the most beneficial in combating anxiety.

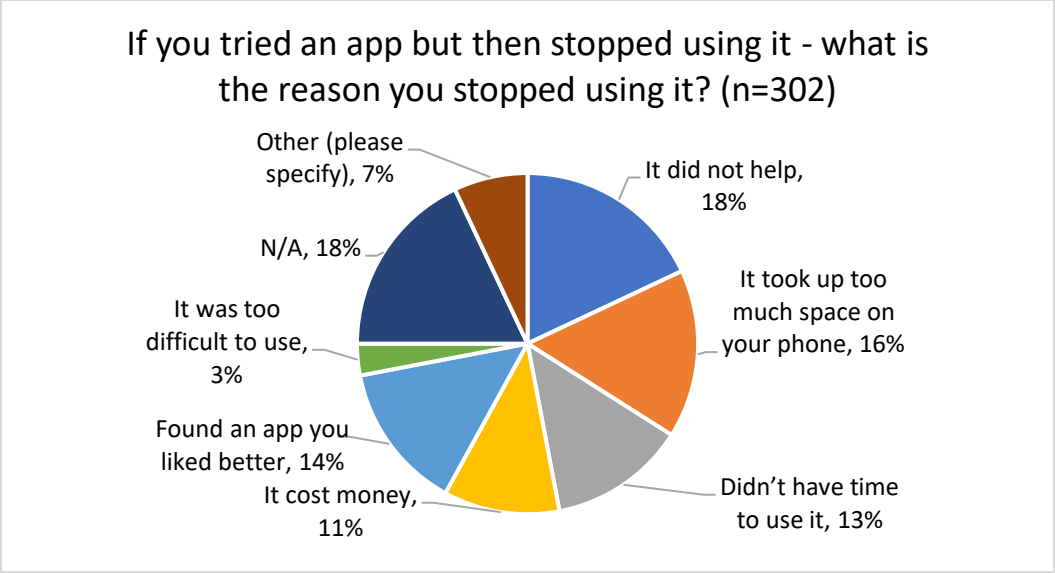

Fig. 7 Reasons for stopping the use of an app

The next question asked participants what prompted them to seek out help from a mobile app. Just over half of participants sought out a mobile app to help with anxiety because of a recommendation from a friend or doctor. Another important point is that using the mobile app allowed them some privacy or anonymity over regular healthcare options like visiting a doctor or therapist (see Fig. 8).

From our previous research, we know that there are many potential barriers people experience leading them to not seek out conventional therapy or mental healthcare. While some of our participants did receive a recommendation from a doctor, close to 40% said it was instead a recommendation from a friend. This finding is particularly interesting since one well known barrier is the public stigma around mental health, although it is likely that people feel safer confiding in those close to them rather than the general public or a stranger (e.g. a doctor or mental health professional). Still 20% of participants noted that they sought out help from a mobile app due to the privacy or anonymity aspect of mobile apps. This could also be related to worries about being publicly stigmatized, shamed or personal embarrassment. Another well-known barrier is access to treatment either physical (transportation by car, bus, etc.) or financial

(out of pocket costs, insurance costs, etc.), and we can see that access was mentioned by 12% of our participants. The results from this question nicely touch on some established barriers, while the open-ended part of the question touched on a couple notable points as well. A majority of those who chose "Other" stated that they were self-motivated to seek out help from mobile app and thus researched and found these potential coping mechanisms on their own. Participants also mentioned coming across mHealth apps while browsing which prompted them to try one (or many) out.

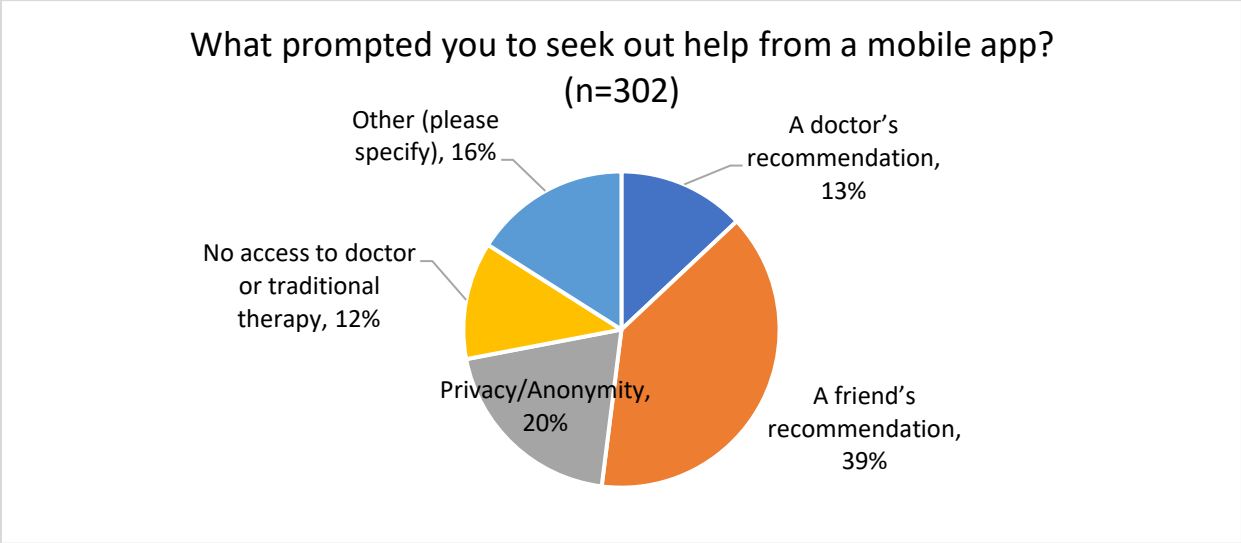

Fig. 8 Reasons for using mobile apps

The next question aimed to drill down features which participants felt they liked the most about the app they used. A majority of participants felt that guided meditation was the feature they most liked (see Fig. 9). In the previous question discussing the specific apps participants were familiar with, a majority used Calm, or Headspace both which are focused on meditation and mindfulness (see Fig. 5).

Secondly, participants liked the ability to track their mood and write things down (see Fig. 9) which are features included in the MoodPath and Pacifica apps mentioned above. Many people in the "Other" category described "distraction" as the feature they most liked. While

distraction is not a particular feature it helps us to understand that some people are seeking a distraction from their anxious feelings rather than directly addressing them through other methods such as engaging in a meditation or writing down their feelings. Considering many participants listed mobile app games (like CandyCrush, or Sudoku) as an app they used to help with their anxiety, it is possible some those participants also listed "distraction" as one of their most liked features.

Understanding the most enjoyed and utilized features of Mhealth apps was an integral part of designing the following prototype. As such, all these features including games (which was not explicitly and original choice) were included as part of the prototype in the hope that more specific feedback can be gained on the expected functions and flows of each feature. It comes as no surprise that a large majority of participants listed guided meditation as their top feature based on our previous research as well as some of the results to the earlier question in this survey asking participants about which mobile app they have used or currently use.

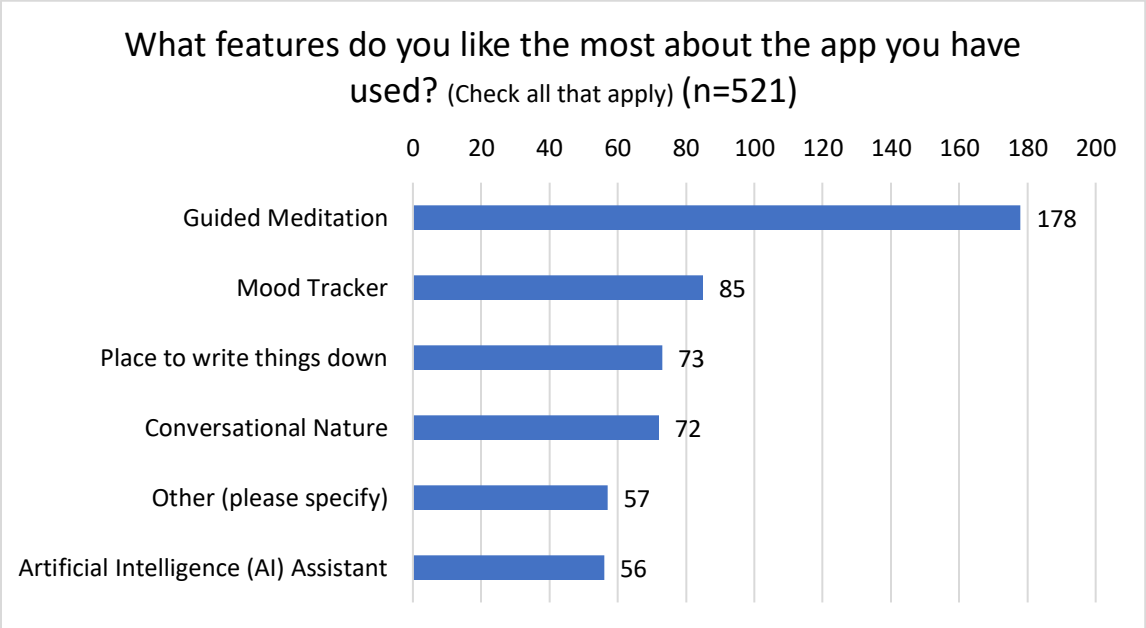

Fig. 9 App Features

Finally, we asked participants what motivates them to use an app for lowering their anxiety. It is almost predictable when considering this question that the major motivation for many users would be that the app does lower their anxiety or helps to manage the symptoms they experience. The survey data does support this theory, but also highlights an important aspect that could be easy for app designers to overlook. Participants top rated motivations were that the app actually did what it set out to do, which is lowering the user's anxiety, and that the app was enjoyable to use (see Fig 10). The theme of having a pleasurable or enjoyable experience within an app emphasizes the results that were seen when creators tested the gamified app "Flowy" mentioned above. Users of this app described the app as fun as well as useful. Additionally, the study showed that participants experienced an increase in quality of life and a decrease in anxiety. This question aimed to help inform us of one of our main research questions, which asked what elements of the app motivate users to continue use of the app. Other than simply asking the question we determined there was not a suitable way to measure user motivations through their actions in the usability testing portion of this research. As such, the prototype focused on understanding the most valued features, and the importance of the experience users have with these features.

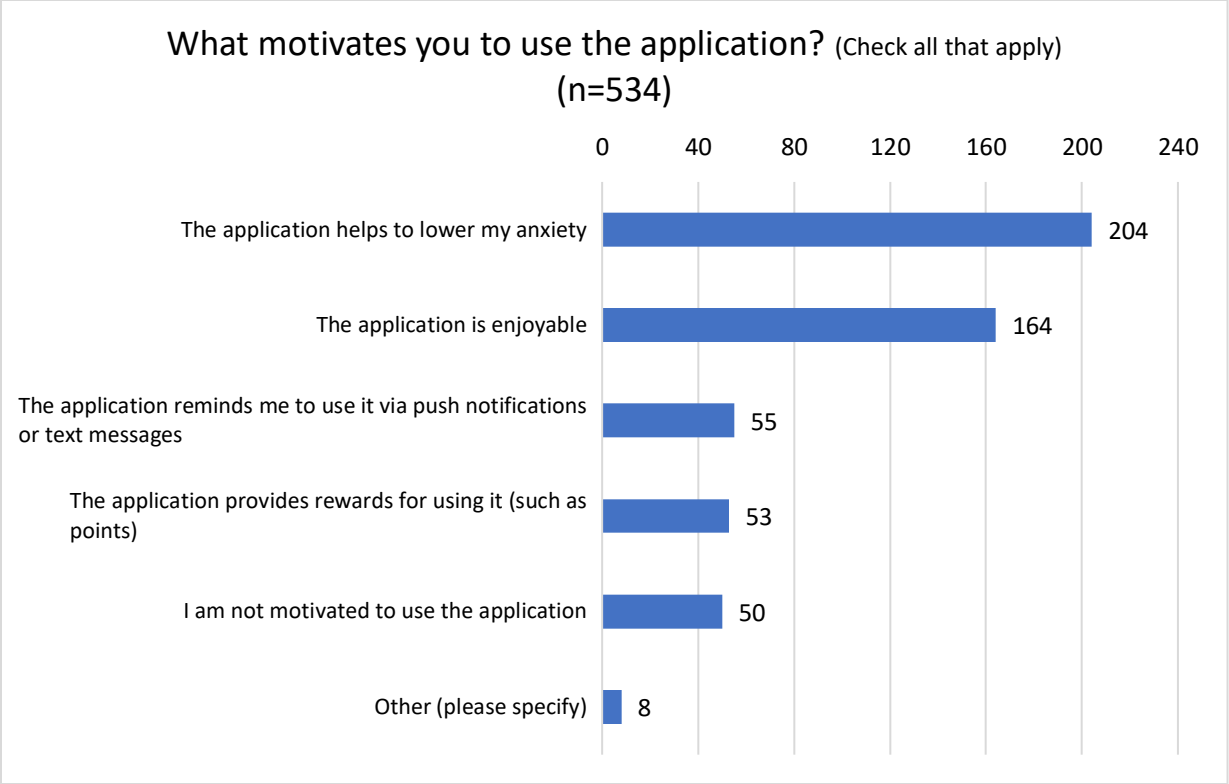

Fig. 10 Motivations to Use the Application

Prototype

A low-fidelity prototype was created using Axure software and you can experience the prototype for yourself at this link: https://eekxye.axshare.com/ . The main purpose of this prototype and subsequent testing was to dig deeper into the particular functions which users felt to be most helpful in dealing with their anxiety. We aimed to understand why people felt drawn to certain features over others, and their expectations of how each feature would operate.

When the app is first opened the user will first see the dashboard (see Fig. 11). This screen shows users five functions, as well as a profile icon in the top right where they ideally would be able to access any personal profile information, app settings, and helpful documents to help them navigate the app (see Fig. 25). Each function provides a different way to manage

symptoms of anxiety and was chosen based on the results of the most mentioned features in the initial online survey. Each function is described in more detail in the figure captions.

Fig. 11 Dashboard: Each function from left to right and top to bottom: Guided Meditation, Notes, Chat, Trends, and Games.

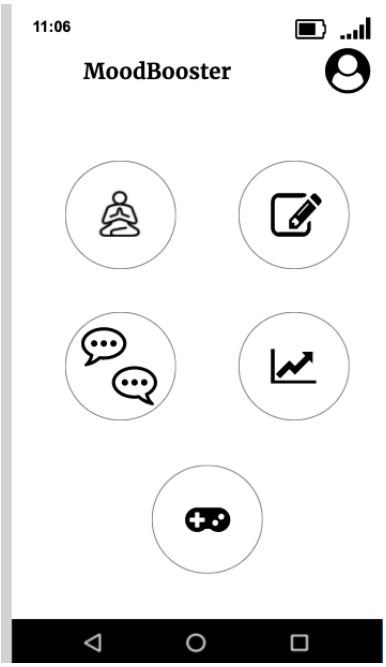

Fig. 12 Dashboard with alternate game icon (video game controller) shown to users at the end of the interview to help determine if the participants felt they understood how the icons mapped to each function.

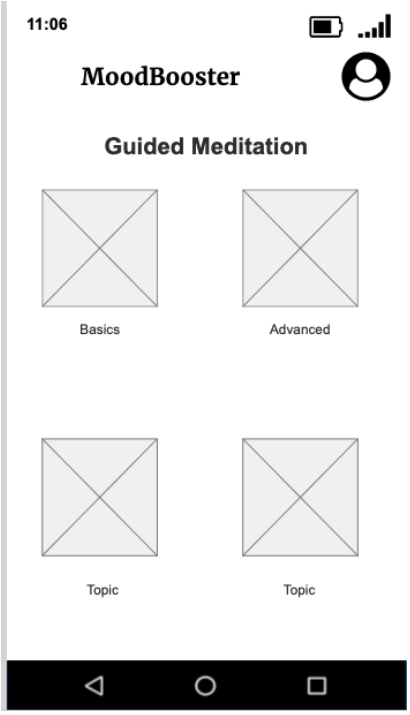

Fig. 13 Meditation Dashboard: here participants could choose from a basic or an advanced meditation showcasing two separate meditation styles (audio and visual). The topic sections at the bottom were not functional at this time, but were explained as specific meditations that could touch on topics like work stress or social anxiety.

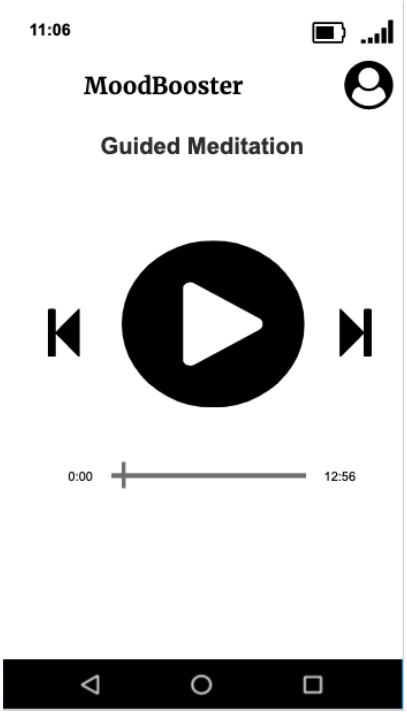

Fig. 14 Basic Meditation: this type of meditation is audio only and would likely focus on beginner meditation topics.

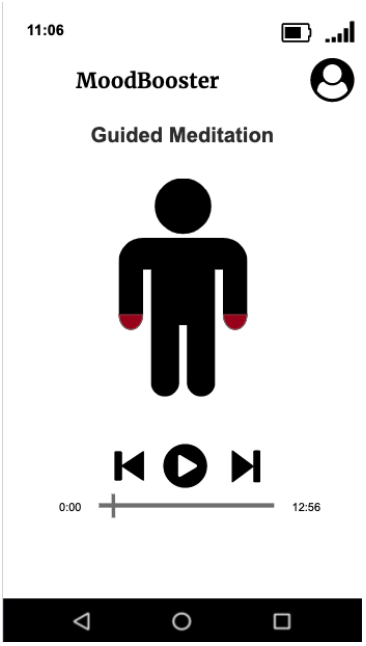

Fig. 15 Advanced Meditation: this type of meditation includes a visual highlighting different

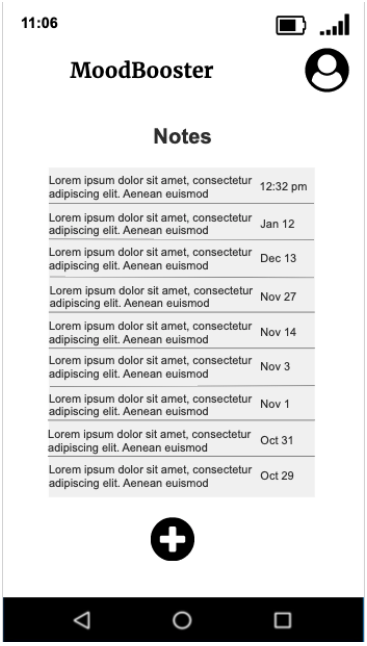

Fig. 16 Notes: in this section users can type notes freely, get their feelings, concerns, and ideas

body parts (by using color) to help the user focus on muscle tensing and relaxing.

Fig. 17 New Note: after a user taps on the plus sign they will be brought to a blank note and the keyboard will automatically appear for them to type.

written down with no structure. Users are also able to look back at notes they wrote in the past. To begin a new note, users can click on the plus sign at the bottom.

Fig. 18 Prompts: when a user taps on the question mark, a window appears which lists some writing prompts that would help a user get started in expressing their feelings.

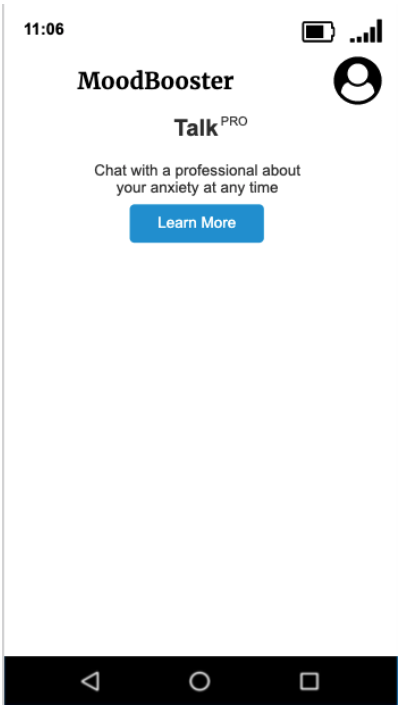

Fig. 19 Chat: when a user taps on the chat bubble icon from the dashboard they will be taken to this screen which lets them know that this is an advanced feature allowing them to speak with a professional counselor. There are no other tappable functions on this screen. It is imagined that the "Learn More" button will take them to the service and payment options.

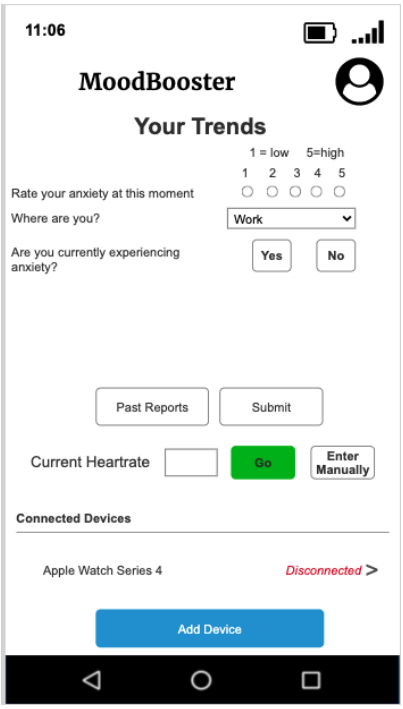

Fig. 20 Trends: when a user taps on the graph icon from the main dashboard they are brought to this screen which allows them to input data surrounding their current symptoms. This data would then be documented and made available through the "Past Reports" button halfway down the page. This screen will also let a user connect a device like a FitBit or an Apple Watch to monitor heartrate and gives this function a more personalized experienced while also hitting on some artificial intelligence type features to track physical symptoms.

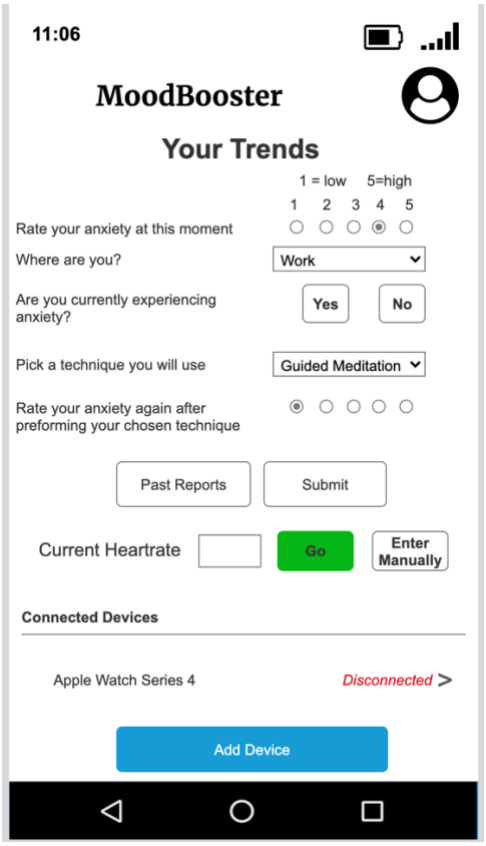

Fig. 21 Trends Expanded: when a user taps "Yes" they are currently experiencing anxiety, two more questions populate in the empty space asking them to try a technique (or other feature within the app) and then rate their anxiety level again. This will help users to track what techniques or features are most useful in those moments of anxiety. All of the radio buttons and dropdowns are functional in this prototype.

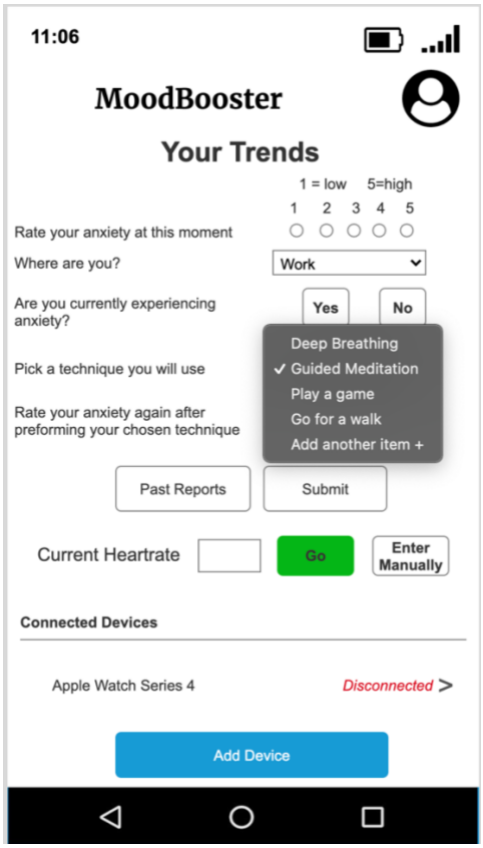

Fig. 22 Trends Expanded with Dropdown Options: if a user clicks the technique dropdown they are able to see a few options of techniques to utilize in order to lower their anxiety. They would also be able to add their own items here for tracking purposes.

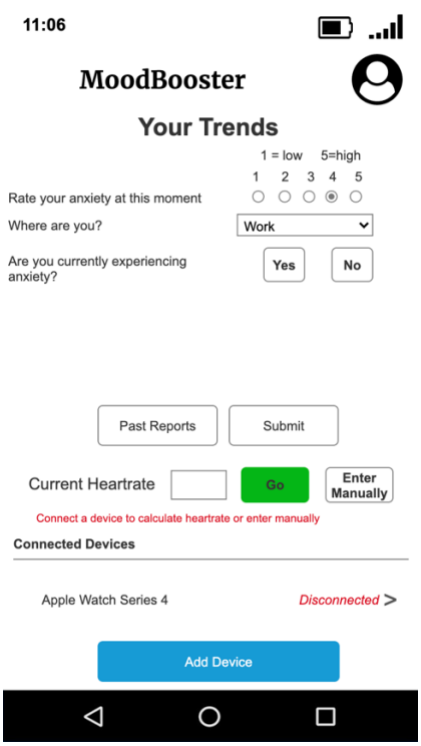

Fig. 23 Trends following a user tapping the green "Go" button: As you can see this user's Apple Watch is showing a current state of being disconnected. Because of this when a user taps "Go" in order to import their current heartrate they will see an error message telling them to either connect a device or enter their heartrate manually.

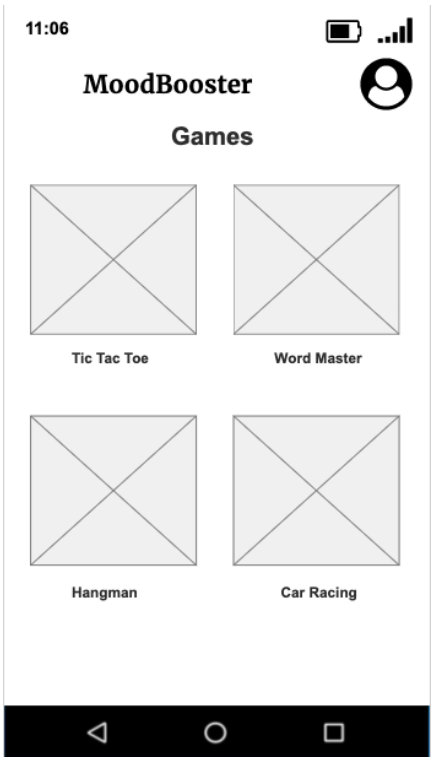

Fig. 24 Games: When a user taps the puzzle piece icon (or the game controller on the alternate dashboard), they will see a screen presenting four game options. For the purpose of the prototype, none of these games are functional.

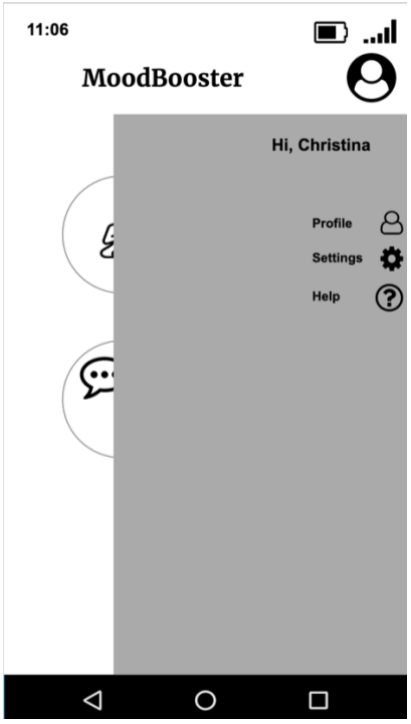

Fig. 25 Account Profile: when a user taps on the round person icon in the top right, a side bar appears showing them options to view or edit a user profile, account settings, as well as a place for help documents regarding the app.

Usability Test Interviews Conducted via Skype (May 2020)

Originally the interviews were planned to be conducted in person. Due to the COVID-19 pandemic beginning in early March of 2020, the interviews were restructured to take place over Skype. The methods of recruiting participants also changed due to the pandemic. Originally, flyers were printed and planned to be hung at local yoga studios and public places such as bus stops and grocery stores. When the lockdown started, the recruitment moved online to be shared on my personal Facebook page, as well as posted in Reddit forums r/RIT, r/gradschool, r/Anxiety, and r/AnxietyDepression. Participants were screened to ensure they met the same criteria as the original survey, meaning that they were 18 years old or older, experienced anxiety at least a few times a week, and had previously or currently use(d) a mobile application to help

their anxiety. Participants were instructed to share their screens while they interacted with the prototype. The interviews were recorded and transcribed for analysis. There were ten interviews conducted in total. Data from eight of those interviews are included here. Unfortunately, two of the recorded interview files were corrupted and not able to be recovered. Due to time constraints, it is recognized that this sample size is small and may not represent all opinions and feelings regarding mobile applications in anxiety.

The interview participants were between the ages of 19 and 30 at the time of the interviews in May 2020. A majority identified at female, and all had at least some amount of college education (Fig. 26 and Fig.27).

It is important to note that the demographics of the interview participants and survey participants are similar to each other. Their age and gender is also comparable to the statistics reported by the CDC regarding GAD (Terlizzi et.al., 2019). While participants from both the survey and interview groups were comparable to each other demographically on age, gender, and education level, it is likely that both groups consisted of participants which were more highly educated than the general population of those living with GAD. Despite this, the experiences which these participants discussed with me, are valid experiences which can help to inform our research questions.

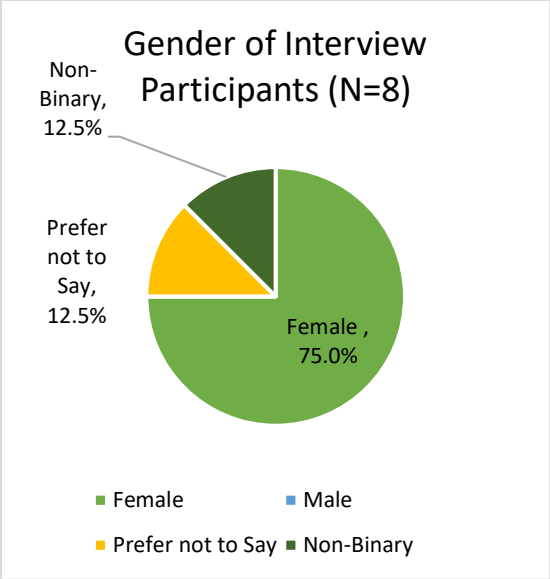

Fig. 26 Gender of interview participants

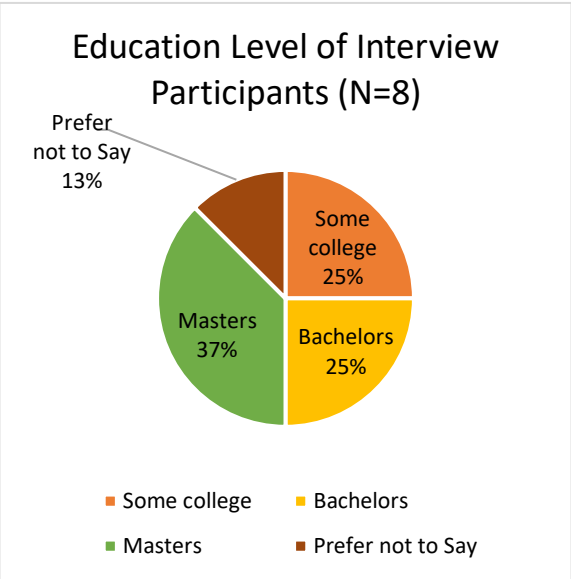

Fig. 27 Education level of interview participants

Initial Questions Replicated from Survey

The first two questions in the interviews replicated questions from the survey asking participants which applications they have used in the past or currently use to help them combat their feelings of anxiousness, as well as which features about those apps they liked the most.

The first question regarding the apps utilized by participants, had varied results. There were many applications mentioned but the most popular option was Calm (Fig. 28). As explained above the Calm app is mostly focused on meditation and also includes stories to help you fall asleep with calm imagery. In our original survey, Calm was also the most utilized app, followed by Headspace. Also, in that original survey a majority of people (n=178) claimed that guided meditation was the feature they liked most about the applications they have tried. It is also important to call out that the next highest apps were Breathe iOS (on the Apple watch), Headspace, and other meditation apps. Seeing Calm as well as other meditation or deep breathing apps, mentioned by a majority of interview participants reinforces the idea that guided

meditation is an important feature of an anxiety application.

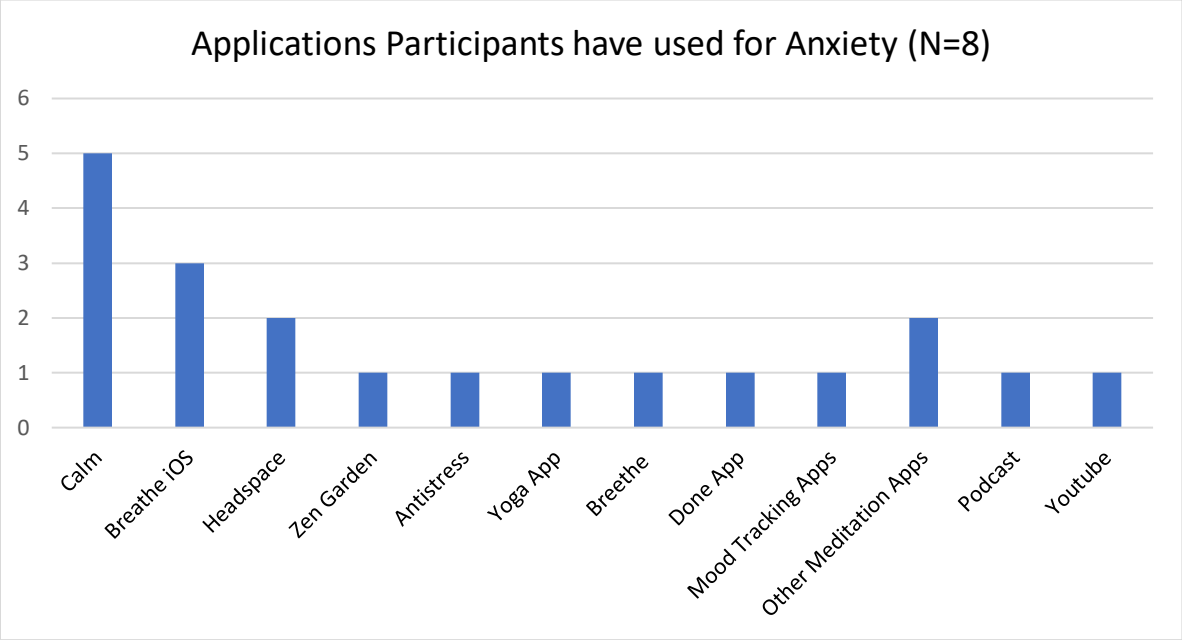

Fig. 28 Applications used by interview participants

The next question asked participants what features they liked about an application they have used. The answers to this were varied for each individual with no common theme emerging. The features which were mentioned by more than one individual were guided meditation and some type of unstructured sounds (either music or calming nature sounds).

Similarly, participants were also asked what features they did not like about an application they have used. Again, the answers were varied for each individual although four participants claimed they were frustrated that the app required payment for advanced features. Pay walls were also mentioned in our above survey as a reason why participants stopped using a particular application.

Initial Impressions of the User Interface (UI)

After the initial questions were answered by the participant, they were directed to view the prototype by navigating to the webpage (https://eekxye.axshare.com/) on the browser of their

choice. Participants were instructed not to click or tap anything yet while we gathered their initial impressions of the UI. As a reminder, everything that each participant said throughout this interview was recorded and transcribed to ensure accurate analysis of major themes. After each participants session was recorded and transcribed the researcher highlighted and categorized general thoughts, feelings, as well as specific terminology into overarching themes which allowed us to determine the following results.

As part of this usability test, we wanted to understand if the symbols we chose for each feature accurately mapped the functions they represented. To do this we asked each user to explain their prediction of how each function would work prior to exploring the prototype. The sitting person we chose to represent meditation was correctly identified by all eight of the participants. The pencil/writing icon we chose for the notes feature was correctly identified by six out of eight of the participants. One participant who did not correctly identify this function felt that the pencil could represent an edit feature, maybe to edit your profile as this icon commonly used in other apps for some type of editing of information. The other participant felt it could represent a forum similar to Reddit where users could write a post and others could comment. The chat bubbles were correctly identified by all participants as connecting with another person. The function we depicted was specifically aimed to talk with a counselor, but many brought up that it might be helpful to have a peer-to-peer connection as well. The graph icon was correctly identified by all eight participants as some sort of anxiety tracker, either to track your moods or feelings. The puzzle piece icon was mostly mapped with games although a couple participants were confused and thought it might have something to do with links, connections, or personalization options. When participants were shown the second version of the

dashboard with the game controller icon instead of the puzzle piece five out of eight participants felt the game controller was a better icon to depict a game function.

Primary Feature Interaction

The first time we allowed participants to interact with the prototype, we asked them to pretend they were anxious in this moment and had just opened the app for the first time. We asked them to interact with the app freely. We then noted the first function they clicked on and asked them why they chose that function first over all the others. The results for this were varied, although unsurprisingly, the meditation function was chosen the most often (see Fig. 29). When asked why participants chose a particular function seven out of eight related it back to something they are already comfortable with and/or something they know works to help lower their feelings of anxiety. The one person who did not mention this said that they chose the notes feature because they were "curious about what it did".

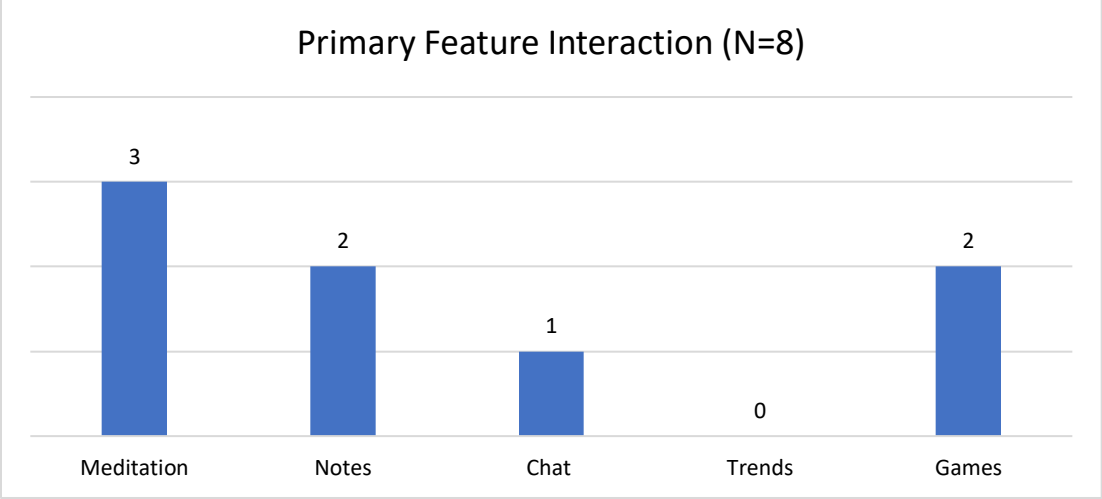

Fig. 29 First function each user chose while interacting freely

Task Completion and Navigation

The next section of the interview asked participants to complete a set of specific tasks to determine how easy it was for the app to navigate. The first task given to participants in this

section was to navigate to a basic meditation. All eight participants were able to navigate to the basic tab of the meditation feature on the first try. They were then asked if the screen they saw was what they would expect to see under a basic type of meditation. A majority said “yes”, one mentioned they would expect to see pictures or videos and not just audio. Another participant also mentioned that the length of the audio was a bit long at close to 13 minutes and would prefer a shorter meditation.

In the second task participants were asked to navigate to an advanced meditation. All participants were able to complete this task on the first try. The advanced meditation included a visual of a person. The hands on the person were highlighted in red to signify where to focus your energy throughout the meditation. Half of the participants felt this would be useful, some mentioning that the visual was something they liked. Others did not like structured meditation at all, while some felt the visual was useless because they like to close their eyes while they meditate.

The next tasked aimed to get participants to click into the trends tab, signified by a graph icon. We asked users to log how anxious they are feeling at this moment. Exactly half of the participants clicked correctly into trends and the other half clicked into the notes tab. Three participants noted that they clicked into trends because it looked externally consistent to other fitness apps (Apple watch, FitBit) where they could log their activity and see progress. Two participants mentioned that they originally felt the graph icon would only show progress and not actually be a place to log feelings. Three participants suggested that notes and trends should be combined into one feature.

The next task aimed to get participants to tap on the notes tab by asking them to create a new file to express their thoughts (if the participant tapped notes in the previous task they were

redirected to trends for completion of that task). All eight participants were able to create a new note on the first try. Within the new notes tab, there was a question mark bubble which included writing prompts to help a user get started in writing down their feelings (see Fig. 18). Participants were asked what they would expect to happen *if* they tapped on the question mark (without physically tapping it). All but one participant guessed correctly and assumed it would be some type of writing prompt or guided questions. One participant thought it would be a suicide helpline and explained further that they were thinking big picture as a way to help someone in crisis. This participant said that it would be clearer to a user if instead of a question mark symbol it used text which said something like "getting started" or "prompts".

The next task asked participants to look at previous data on their anxiety and aimed to have them click into trends and onto a tab which said "Past Reports". Many participants got this on the first time (likely because they had seen the tab in the previous task when we asked them to log how anxious they were feeling at that time). One participant it took six tries to find where to look at past reports. First, they tried the chat bubbles, and then they tried to click into the user profile. After that they clicked into trends again but didn't see the button for past reports and again tried to click on the user profile option. Once they found the correct location, they said "oh, it was right in front of my face". The user profile was a great idea as to where someone might find past data and we believe this is an important take away from watching someone interact with the current prototype. It is hard to know if those who found the past reports button on the first try would have found it just as quickly if they did not already see it while completing the previous task. Along with this task we asked participants if they felt that looking at trends and past reports would be helpful for them. The results were varied, with four participants saying "yes". Some explained that they felt understanding triggers and which interventions have worked

for them in the past would help them lower their anxiety in the future. Others said they are analytical or mathematical people so they enjoy looking at data. Of the people who said “no” it would not be helpful, one person explained that they don’t like to look back and relieve certain scenarios which caused them anxiety.

Final Impressions of the UI

The final couple questions asked participants to go back to the dashboard and look at the icons again. Participants were allowed to click on any of the functions which they may not previously explored. Then they were asked if they felt all the icons accurately depicted the function which they represent. Five of the participants felt that all the icons were accurate. The pencil icon was brought up twice, one user reiterating that it could be mistaken for an “edit” feature as it is similar to other apps which have an edit button. Another participant explained that they would have felt the graph would only be data, or show the data first with maybe a plus sign there to then add more data. Others mentioned that the puzzle piece was a bit confusing, one mistook it for a “plug-in” similar to how you see on the Google Chrome browser. As mentioned before, once users were shown the alternate dashboard with the game controller icon, five of the participants felt that this was a more accurate icon to depict games. All participants were asked if there were any other icons or pictures, they could imagine for any of these functions. One participant mentioned a pair of dice for the game feature would be more accurate, while another participant felt that a book or a piece of paper would make the notes feature clearer to users.

Throughout the usability study we gained a lot of insightful feedback. The major findings that could be addressed in the next iteration of this prototype are listed below:

- There was some confusion about where to go within the app to express feelings or log data surrounding moods and anxiety levels. It was not obvious that the graph icon was a

place to input data, many felt it would only be a place to look back at previous data. From hearing this, we feel that combining the Notes and Trends features into one place a user can express feelings and log data would be beneficial and easier to understand.

- The “Past Reports” icon was difficult to find by one participant, and although it was only one participant, we mentioned previously that it is difficult to know whether this function was easily found due to the proceeding tasks taking them into the Trends function. Due to the immense amount of trouble this one participant had locating this function, more testing should be done to locate an optimal place to view past data. Considering the above bullet point suggesting combining the Notes and Trends features, it’s likely in the next iteration this combined feature would look much different than it currently does.
- A majority of participants were adamant that the video game controller icon was a better fitting icon than the puzzle piece icon to represent Games. It is possible that this is due to the rise in video games over the last couple of decades, making this icon easier to associate with gaming.
- Even though this study only examined the opinions of eight participants, there was a lot a variability in which features they felt were the most helpful and in their own personal experiences with anxiety. It is important to remember that not everything will work for everyone and there is not only one feature that will work for every person struggling with anxiety. Still, we see many people discussed guided meditation as a helpful feature which aligns with our original online survey as well as past work on this topic. We feel that there are many features that can prove beneficial in this space and the appropriate research should be done prior to designing and developing an Mhealth app to determine

which features should be focused on depending on which subset of this audience the app creators would like to target.

Future Work

Following the valuable insight received from the usability interviews, it would be great if this prototype could be refined to include the feedback from participants and tested again. We would love to see this prototype coded and fully functional with features that could be offered to many who experience anxiety regularly. Unfortunately, that is outside the scope of this particular project, however some valuable insights can be understood from the conversations had surrounding this particular prototype and applied to future applications designed, coded, and created.

Due to the nature of the interview process, a lot of data discussed here is qualitative and based solely on participants thoughts and feelings. In some of our prior research it is common for researchers to utilize pre and post-test questionnaires which are validated and peer reviewed. These questionnaires can reliably measure anxiety levels, stress levels, positive and negative affect, and many more. These validated tests can also be compared across studies as other researchers utilize them. If this prototype was iterated on and created to be functional, it would be interesting to provide a validated questionnaire to the same participants over a period of time to determine if the application could actually lower symptoms of anxiety and the results could be quantified.

This project aimed to understand important features to users of these type of apps. It is apparent that many people find guided meditation to be one of the most important features. It is also important to note that features that participants value can vary widely and we believe offering multiple features which work together is helpful for users. The other aim of this project

was to understand the motivations for utilizing a mobile application for anxiety. Through the original survey, it is clear that the two top motivations are that the application actually lowers the person's anxiety and that the application is also enjoyable. These two motivations should be kept top of mind while designing an app to help with anxiety and should also be considered when evaluating these apps. The motivation(s) for a user to continue use of a mental health application can prove useful for both the user by lessoning their symptoms over time, and for those who are putting time into researching and creating an app which they hope will be utilized by many.

Discussion

Anxiety is something that affects many people every year (SAMHSA, 2020). It can be a debilitating condition which causes people to seek relief via mobile applications. As there are many apps in the app store offered to help with anxiety it is important to understand how and why people use these apps. This project aimed to understand important features and motivations users have to utilize and continue to utilize these apps in order for designers, engineers, psychologists, and others to make useful products.

It is important to mention a few limitations of this study which could affect the results we have outlined above. First, the sample population demographics of those who participated in the survey and the usability testing interviews may not have been representative of people who suffer from Generalized Anxiety Disorder as a whole. While some demographics like gender and age seemed to mirror the statistics reported by the CDC and other organizations, we feel the education level of our participants was likely higher than the generalized population. This is due to our recruiting methods in and around the university where this work was completed.

Another limitation would be the impact COVID-19 presented on this work as well as those suffering from anxiety. As our surveys were conducted prior to the pandemic while our

interviews were conducted at the height of the pandemic, it is possible some of the participants answers could have changed due to the complexities of sheltering in place and higher feelings of anxiety in general.

While it was not discussed in the interview portion of this project, privacy concerns are a legitimate and important worry that many potential users may have. During the survey portion of this project, 20% of participants felt that privacy and/or remaining anonymous was a reason why they sought out help from a mHealth application. It is possible that those participating in the interview did not consider any privacy concerns when potentially inputting their data (especially considering what they were interacting with was simply a protoype). However, we feel as such a large portion of participants mentioned privacy as a concern in the initial survey, exploring this concern and ways applications can allow users to feel that what they share is private, is a topic that could be built upon following this research.

Finally, our prototype did include a chat feature which would allow a user to talk with a mental health professional. Although there are multiple apps currently listed in app stores which allow users to talk with a professional, there are many concerns about the efficacy of this feature as well as how the contracted professionals are treated by those they work for. It is possible that participants in this study did not engage frequently with the chat feature because it is a newer feature, and less understood. The topic regarding the value of chatting with a professional as well as the application allowing 24/7 access to a counselor, is a large space which could be built on in future work on mHealth applications.

Despite these limitations, we hope that this work will add to the literature in this department and help to inform the design and creation of future mental health applications.

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Appendix A

Informed Consent and Online Survey

Informed Consent

TITLE OF STUDY

Exploring the Use of Mobile Applications in People with Anxiety

PRINCIPAL INVESTIGATOR

Christina Burnett
Rochester Institute of Technology (RIT)
Golisano College of Computing and Information Science
20 Lomb Memorial Drive
ccb4268@rit.edu

PURPOSE OF STUDY

You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to help us to understand the use and motivations for use of mobile healthcare applications and help developers and designers to understand which features are most useful when designing wellness applications and applications targeted specifically to users with anxiety disorders.

STUDY PROCEDURES

The following survey should take you about 15 minutes to complete.

RISKS

There is very minimal risk as a result of participating in this survey. The questions have to do with anxiety and may trigger some anxiety for certain people. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

BENEFITS

The benefits of this study include informing designers and practitioners of useful features, and design patterns to be used when creating similar mobile health applications.

CONFIDENTIALITY

Your responses to this survey will be anonymous. Please do not write any identifying information on your survey. Every effort will be made by the researcher to preserve your confidentiality including the following:

- Assigning code names/numbers for participants that will be used on all research notes and documents
- Keeping notes, interview transcriptions, and any other identifying participant information on a locked thumb drive in the personal possession of the researcher.
- Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

CONTACT INFORMATION

If you have questions at any time about this study, or you experience adverse effects as the result of participating in this study, you may contact the researcher whose contact information is provided on the first page. If you are an RIT student you may reach out to the Counseling Center located at 2100 August Center, second floor or by calling 585-475-2261. If you are not an RIT student you can always reach out to the National Suicide Prevention Hotline at 1-800-273-8255.

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

CONSENT

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

a. I understand and accept. I would like to participate in this study.
b. I do not accept these terms and do not wish to be part of this study. (*screenout)*

Survey

1. How often do you experience anxiety?
    a. Every day
    b. A few times a week
    c. A few times a month
    d. few times a year
2. Have you used any mobile applications to help with your anxiety? (including non-traditional applications such as games, or forums)
    a. yes
    b. no *(screenout)*
3. Which mobile applications have you used to help with your anxiety? (check all that apply)
    a. Headspace
    b. Youper
    c. Calm
    d. Pacifica
    e. Mood Path
    f. Other (please specify)
4. If you have used a mobile app, how long did you continue to use it on a regular basis?
    a. A single time
    b. One week
    c. One month
    d. A couple of months

e. A year or longer

5. If you tried an app, but then stopped using it – what is the reason you stop using it?
    a. It did not help
    b. It took up too much space on your phone
    c. Didn't have time to use it
    d. It cost money
    e. Found an app you liked better
    f. It was too difficult to use
    g. N/A
    h. Other (please specify)
6. What prompted you to seek out help from a mobile app?
    a. A doctor's recommendation
    b. A friend's recommendation
    c. Privacy/Anonymity
    d. No access to doctor or traditional therapy
    e. Other (please specify)
7. What features do you like most about the app that you use (check all that apply)?
    a. Guided Meditation
    b. Place to write things down
    c. Artificial Intelligence (AI) Assistant
    d. Conversational Nature
    e. Mood Tracker
    f. Other (please specify)

8. If you could add a feature that you feel would be helpful what would that be?

9. What motivates you to use the application? (Check all that apply)
    a. The application helps to lower my anxiety
    b. The application is enjoyable
    c. The application provides rewards for using it (such as points)
    d. The application reminds me to use it via push notifications or text messages
    e. I am not motivated to use the application
    f. Other (please specify)

10. How old are you?
    a. 18-24
    b. 25-34
    c. 35-44
    d. 45-54
    e. 55-64
    f. 65+

11. What is your education level?
    a. High school
    b. Trade/technical/vocational training
    c. Some college
    d. Bachelor's degree

e. Master's degree

f. Doctorate

g. Post Doctorate

12. What is your gender?

a. Male

b. Female

c. Prefer not to answer

Appendix B

Usability Test Script and Questions

Hi, my name is Christina and I am going to walk you through this session. I am a graduate student at the Rochester Institute of Technology. As I mentioned, I am studying the use of mobile applications to reduce anxiety. I'd like to thank you for taking the time to complete this study. Your feedback is important in helping me complete this degree requirement but will also help add to the research on this topic and hopefully will inform future designs of mental health applications. I am hoping to keep this interview under an hour. Does that work for you?

Great. If you need to stop or take a break at any time, just let me know.

With your permission, I would like to record this session. The recording is just for me to remember everything that was said and done. The recordings will not be linked back to you in any way and will be destroyed at the conclusion of the project. All aspects of the project are anonymous and will not be linked to any personal information. Do I have your permission to record this?

During this session, I am going to ask you to navigate a prototype of an application. There will be times when I ask you to do a specific task, and other times where I let you click around as you like. Please think out loud as much as you can, describe what you are looking at and what you are trying to do. Please note that because this is a prototype, not all the functions will be enabled or clickable. If something works in a different way then you expect, you can feel free to let me know that as well.

If you have any questions, you can ask throughout the session. I may not be able to answer all your questions right away, since I am interested to know what you would do on your own, without help. If you still have any questions when we're done, I'll try to answer them then.

Finally, did you have a chance to review the informed consent form and gift card acknowledgement I sent you? Did you have any questions? If you have signed the forms, please forward that on to me so I have it for our records.

Great, we are ready to start. Do you have any questions before we jump in?

First, I will ask some questions before we see the prototype.

1. Do you feel comfortable sharing your age, gender, and education level with me?
2. Have you used or do you currently use any mobile applications on a cellphone for anxiety?
    a. Which ones?
    b. What did you like/not like?
3. Would make any changes to an app you have used or currently use?

Ok now here is the prototype we will be working with today.

Walk me through each icon without clicking and tell me what you feel should happen when you click on it.

Pretend you are feeling anxious and you open this application for the first time. Go ahead and interact with the app the same way you would if it was a real app on your phone. Think aloud while you click around.

Why did you click on this function first?

Is that what you expected to see? Why or why not?

Now we will move to a list of tasks I will ask you to complete on your own. Please continue to walk me through each action and think aloud as you make decisions.

1. Go to a basic meditation.
    a. What do you see?
    b. Is this what you expected? Why or why not?
2. Go to an advanced meditation
    a. What do you see?
    b. How do you think this type of meditation would work?
    c. Is this something you would find useful?
    d. Do you prefer this over the basic meditation? Why or why not?
3. You would like to log how anxious you are feeling today. Show me how you would do that. *(notes or trends possible)*
    a. Why did you choose this option?

If they go to notes here and not trends, then reroute them to trends (let's try going to trends) *and ask:*

    b. What would you expect to see when clicking on this icon?
    c. After reviewing notes and trends, which would you prefer to log your feelings?

4. You want to make a new file to express your thoughts, how would you do this?
    a. If you click the question mark what do you think will happen?

Click it

   b. What happened? Is this what you expected?
   c. Would you want to change this?
   d. Do you or do you not think the prompts are helpful in expressing your thoughts or feelings?

5. You are interested in looking at some past data on your anxiety, how would you do that?
   a. This button isn't enabled right now (past reports), describe what you would expect to see under this tab.

Let's go back to the home page and I will ask a few more questions related to that page specifically.

1. Do you or do you not feel that these icons accurately depict the function they represent? (You may click to see what happens if you haven't already)
2. Okay what if I showed you this version? **show screen with the alternate game icon**
3. Which icon do you prefer for this function? Why?
4. Are there other icon images you could imagine for these functions? (sketch, describe, find and send to anxietyapp2020@gmail.com)

Again, I would like to thank you for your time. This information will be beneficial in designing future applications to assist users in managing their anxiety. Do you have any questions before we end the session?