Pocket Skills: A Conversational Mobile Web App to Support Dialectical Behavioral Therapy

Jessica Schroeder[1], Chelsey Wilks[2], Kael Rowan[3], Arturo Toledo[3], Ann Paradiso[3], Mary Czerwinski[3], Gloria Mark[4], and Marsha M. Linehan[2]

[1]Computer Science & Engineering, University of Washington
[2]Psychology, University of Washington | [3]Microsoft Research | [4]University of California at Irvine
jesscs@uw.edu, wilksc@uw.edu, kael.rowan@microsoft.com, arturo@toledo2.com,
annpar@microsoft.edu, marycz@microsoft.edu, gmark@uci.edu, linehan@uw.edu

ABSTRACT

Mental health disorders are a leading cause of disability worldwide. Although evidence-based psychotherapy is effective, engagement from such programs can be low. Mobile apps have the potential to help engage and support people in their therapy. We developed Pocket Skills, a mobile web app based on Dialectical Behavior Therapy (DBT). Pocket Skills teaches DBT via a conversational agent modeled on Marsha Linehan, who developed DBT. We examined the feasibility of Pocket Skills in a 4-week field study with 73 individuals enrolled in psychotherapy. After the study, participants reported decreased depression and anxiety and increased DBT skills use. We present a model based on qualitative findings of how Pocket Skills supported DBT. Pocket Skills helped participants *engage* in their DBT and *practice* and *implement* skills in their environmental context, which enabled them to see the *results* of using their DBT skills and increase their *self-efficacy*. We discuss the design implications of these findings for future mobile mental health systems.

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation (e.g., HCI): User Interfaces; J.3. Life and Medical Sciences: Health.

Author Keywords

Health Informatics; Behavioral Therapy; DBT; Mental Health

INTRODUCTION

Mental health disorders are a leading cause of disability and death worldwide. Approximately 18% of US adults suffer from a mental illness in a given year [59], and suicide is the 10th leading cause of death in the US [26]. Mental illness costs the US an estimated $193.2 billion per year [27]. Although evidence-based psychotherapy is often effective [78], an estimated 1 in 5 adults in outpatient psychotherapy quits treatment prematurely [60]. Increasing engagement in mental health treatments is therefore essential to helping people learn how to cope with symptoms associated with their psychological disorders [5, 22, 23, 49, 50].

Technology-delivered mental health treatments have the potential to reduce barriers and increase engagement in mental health treatments. As technology-delivered treatments are constantly available to anyone with an Internet connection [64], issues surrounding time and monetary costs of attending in-person therapies can be mitigated [1]. Furthermore, as interventions through technological devices offer anonymity, people may be more comfortable providing reliable and honest disclosure [29, 30, 45]. People with mental health disorders are interested in mental health apps: in a study of 176 people with depressive symptoms who were on a waiting list to participate in a mobile mental health study, more than a quarter had mental health or wellness apps on their phones [67]. Unfortunately, commercially available mental health apps are often unreliable, with only 10% of apps aimed at supporting therapies for depression meeting evidence-based principles [33].

Given the promise of technology-delivered mental health treatments, the HCI community has begun to investigate how to implement such treatments. For example, recent work has explored how technology can support people with specific psychological disorders (e.g., bipolar disorder [5], depression [22], schizophrenia [6]). To encourage adherence and decrease attrition, technology must be engaging enough for people to use it [5, 22, 23, 49, 50]. Conversational agents may promote engagement [8, 25, 35], and relatable examples can help people learn and apply knowledge [23]. Cognitive Behavioral Therapy (CBT) apps that implement these principles demonstrate promising results (e.g., [25, 37, 62]). However, although CBT is effective for low-risk individuals with single disorders [15], the effects of CBT are attenuated for patients with higher clinical complexity (i.e., those at risk for suicide who meet criteria for multiple disorders) [19, 32]. Research into technology to support people with high clinical complexity remains limited.

We contribute Pocket Skills, a mobile web app designed to support Dialectical Behavioral Therapy (DBT). DBT was developed for people with complex, difficult-to-treat disorders and suicidal behavior, and is designed to support people in developing skills to help them maintain positive relationships, control their emotions, and practice mindfulness for acceptance and stress relief, regardless of their particular disorders [41, 42]. Pocket Skills offers holistic support of DBT, including goal setting, educational components, skill practice, and self-tracking of positive and negative moods and behavior. Pocket Skills is a multi-media app that includes audio, images, and videos to teach the principles and skills

associated with DBT. People interact with the app through a conversational agent called *eMarsha*, based on Dr. Marsha Linehan, the creator of DBT [41]. Pocket Skills was iteratively developed by an interdisciplinary team of HCI experts, clinical psychologists, and mobile app developers and designers.

To assess the feasibility of Pocket Skills, we conducted a 4-week field study with 73 participants. We assessed participant symptoms via weekly evaluations of the PHQ-9, which assesses depression symptoms [40], and the OASIS, which assesses anxiety [58], as well as intake and exit evaluations of the DBT Ways of Coping Checklist, which assesses how frequently people use DBT skills versus dysfunctional coping skills [56]. We also conducted an extensive exit survey with open-ended questions about participant experiences with Pocket Skills to gather feedback. We find significant improvements across all measures throughout the study, illustrating promising preliminary outcomes when the app was used by people enrolled in psychotherapy. We further contribute a model based on qualitative findings concerning how participants felt Pocket Skills supported DBT. Pocket Skills *engaged* people in DBT and helped them *learn* skills and *implement* them in context, when they most needed them. People were then able to see *concrete results* of implementing DBT skills and increase their *self-efficacy* to improve their mental health.

BACKGROUND AND RELATED WORK

We describe Dialectical Behavioral Therapy (DBT) and review related work in designing tools to support mental health.

Dialectical Behavioral Therapy

Dialectical Behavioral Therapy (DBT) was developed by Dr. Marsha Linehan to treat complex behaviors associated with high emotion dysregulation [41]. DBT is the gold standard treatment for individuals with borderline personality disorder (BPD) [43], and DBT skills have been shown to improve their suicidal and self-injurious behavior, expressions of anger, and interpersonal problems [55]. Since its development, DBT has been also been successfully applied to people with addictive behavior, eating disorders, and mood disorders [21].

DBT skills training contains four modules: *Mindfulness*, *Emotion Regulation*, *Distress Tolerance*, and *Interpersonal Effectiveness*. DBT skills are designed to help people learn effective ways to solve problems and cope with negative events and emotions. For example, *Mindfulness* skills teach individuals methods to accept the moment without judgment. *Emotion Regulation* skills are designed to help people understand and change their emotional states. *Distress Tolerance* skills give people specific healthy alternatives to unhealthy behaviors; for example, rather than self-harming, people can take a cold shower or gently snap a rubber band on their wrist. By learning specific skills that can replace unhealthy behaviors and implementing those skills in context, people can start to better navigate negative circumstances. Traditionally, people enrolled in DBT practice their skills using worksheets [42]. Pocket Skills includes modules for *Mindfulness*, *Emotion Regulation*, and *Distress Tolerance*, and adds a module for *Addiction Skills* to help people with addictive behaviors overcome their addictions.

Standard DBT consists of individual and group therapy, in which people learn about the skills and discuss their positive and negative emotions and behaviors, as well as problems they have recently experienced. DBT also often includes phone coaching, in which people can call their therapist in moments of high distress to receiving coaching through the moment. Although these sessions help people learn skills and cope with extreme situations, people need to practice and implement those skills into their everyday life to improve their overall coping [55]. We developed Pocket Skills to help people remember their skills, practice them regularly, and implement them in their lives.

### Tools to Support Mental Health Treatment

Prior research has investigated the use of mobile apps to support mental health via a wide range of methods. Using gamification to associate images of self-harm with negative feelings via Pavlovian conditioning has helped decrease self-injurious behavior [28]. Research has investigated modeling or predicting mental health through mobile phone sensors (e.g., [7, 80]) and social media posts (e.g., [4, 17, 20, 47]). Computerized systems designed to support Cognitive-Behavioral Therapy (CBT) through education, skills practice, and communication channels between the patient and therapist have been found to help lower attrition [22] and reduce depressive symptoms [37]. Similarly, the MONARCA system provides self-assessments, visualizations of progress, and suggestions of possible actions to take, and was shown to help people with bipolar disorder adhere to their CBT [5]. Computerized CBT without therapist support can also reduce depressive symptoms (e.g., [11, 62]), and a suite of skills-based apps has been shown to reduce depression and anxiety [51]. Our work builds upon this research to determine the feasibility of using a mobile app to support DBT, a skill-based transdiagnostic treatment (i.e., one effective for a range of disorders) for people with high clinical complexity and severity [41]. Pocket Skills includes education, skills practice, and self-assessment to more fully support DBT and help people better engage with their psychotherapy.

Prior work has also examined how technology could support DBT skills practice. DBT Coach, the first app to examine adjunct DBT, is designed to augment skills generalization by providing constantly-available, interactive walkthroughs of DBT skills [65, 66]. Similarly, the Virtual Hope Box is a mobile app designed for people with Post-Traumatic Stress Disorder (PTSD) that includes sections for support, comfort, distraction, and relaxation [13], similar to the mindfulness and distress tolerance skills found in Pocket Skills. The Virtual Hope Box was found to increase self-efficacy over a 12-week study [14]. In participatory design studies with people with Borderline Personality Disorder (BPD) [74] and people who self-harm [10], participants designed physical artifacts to support DBT *Distraction* and *Mindfulness* skills. Pocket Skills takes a holistic approach to DBT support by including education about the different modules and skills as well as support for in-the-moment skill practice, to help people bridge the gap between learning and practicing skills and actually implementing those skills in their everyday lives.
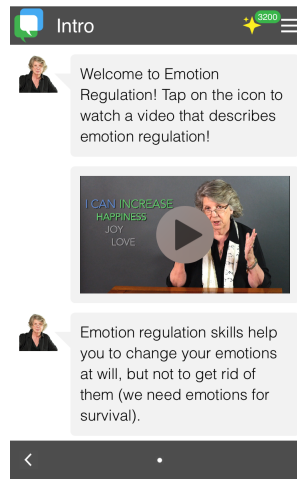
For a mental health app to be effective, it must be engaging enough to encourage people to use it [5, 22, 23, 49, 50]. One
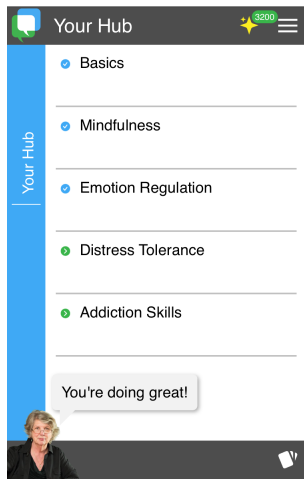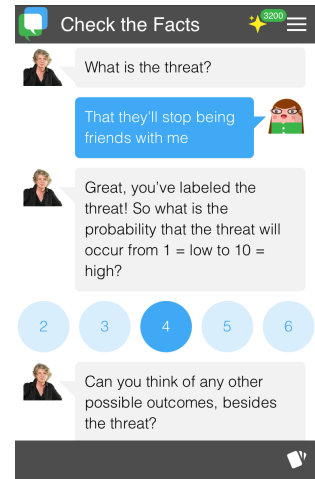
(a) The home page allows people to choose the module they want to explore. eMarsha, the app's persona, offers encouragement.
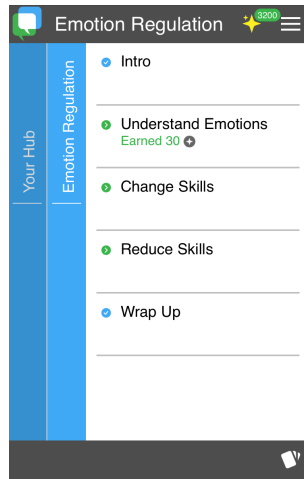
(b) Each module includes an introduction that explains the goals of the module, as well as module-specific skills.

(c) Videos of Marsha Linehan, the inventor of DBT, help explain the content, increase engagement, and build eMarsha's persona.

(d) The conversational interface walks people through the content to foster comprehension and active participation in the skills.

Figure 1: Pocket Skills allows people to learn about and practice skills on the go via an engaging conversational UI.

way to help people stay engaged with a technology is via messaging. Messages can help remind people of and support their mental health and behavioral intervention goals [81]. For example, automated text messages helped people enrolled in CBT stay in therapy for longer than those that did not get messages [3]. However, exactly what message content is best may depend on culture and personal preference [2, 54].

Another possible way to increase engagement is through conversational agents. Conversational agents for mental health technology were explored as early as the 1960s, when ELIZA was first released as a computerized psychotherapist [82]. Virtual agents can increase engagement in mental health systems (e.g., [8]) and behavior change interventions (e.g., [35, 44]), as well as adherence to antipsychotic medications (e.g., [9]). In a 2 week study with Woebot, a conversational agent designed to deliver CBT, participants reported bonding with the agent and improving depressive symptoms [25]. The Pocket Skills conversational agent was similarly designed to promote engagement. However, Pocket Skills focuses on supporting education and in-the-moment skills practice to help people implement their skills.

POCKET SKILLS DESIGN

Pocket Skills was designed by an interdisciplinary team of clinical psychologists, human-computer interaction experts, and mobile app designers and developers. The content is based on Dr. Marsha Linehan's DBT Skills training manual and workbooks [42], and includes educational videos narrated by Linehan herself. This content was licensed to us by Dr. Linehan for use in Pocket Skills. Prior to the feasibility study we present next, we conducted a pilot study in which we presented early iterations to 13 people who were enrolled in DBT to assess usability and inform iterative design.

Pocket Skills is web-based, but designed for mobile devices; we chose this method rather than a native app environment to allow access across platforms. We decided to format for mobile devices to increase availability: people can use Pocket Skills whenever they have their mobile phones and an Internet connection. As cell phone ownership among mental health patients approximately equals cell ownership in general [16], designing for mobile screens also gives us the potential to reach the majority of mental health patients. However, the fact that Pocket Skills is web-based means it does require an Internet connection to access the app content. Pocket Skills is hosted via Microsoft Windows Azure, as is the database storing app content and user data. Pocket Skills is accessed via an activation code and secure sign in.

App Flow

The home page, or "Hub", of Pocket Skills displays the supported DBT modules: *Mindfulness*, *Emotion Regulation*, *Distress Tolerance*, and *Addiction Skills* (Figure 1a). Before accessing the modules, people must first complete the "Basics" section, which walks people through the format of Pocket Skills and helps them set their DBT goals. Each module contains separate pages to introduce people to the module and the skills that module contains (e.g., Figure 1b). The module introduction consists of a high-level description, often including videos describing the goals of the module and explanations of what that module can help with (e.g., Figure 1c). After describing the module, the introduction asks people how they think it will help them and walks them through setting module-specific goals. For example, someone using the *Emotion Regulation* module may have the goal of decreasing the frequency of unwanted emotions. After the introduction, people can learn about and practice the module-specific skills (e.g., Figure 1d). These skills cannot be accessed until the introduction has been completed.

In addition to the modules, Pocket Skills includes a "diary card" where people can record the emotions they experienced each day on a scale from one to ten, as well as the time in which they engaged in specific positive and negative behaviors. For familiarity reasons, the Pocket Skills diary card is modeled on the paper diary cards often used in DBT to encourage mindfulness and track progress over time [41]. People select the behaviors they wish to track in the "Basics" section.

People earn points when they practice a skill, fill out a diary card, or complete a module. Originally, points were included to encourage continued use of the app, and did not have any other use. However, participants in our pilot study suggested that we develop extra content that people could access when they accumulated enough points. We therefore implemented a virtual store that contains guided meditations narrated by Dr. Linehan that people can purchase with the points they earn.

Pocket Skills includes daily text messages to remind people to engage with the app. Text messages are sent in the morning to encourage participants to think about DBT and apply their DBT skills throughout the day. The texts link to Pocket Skills so people can access the app directly from the message. As repetitive messages can quickly bore recipients, diversifying health-related messages is important to increase activity completion [38]. Pocket Skills messages are therefore selected from an extensive list to ensure variability between messages.

Interface Design

Pocket Skills consists of a conversational interface in which the conversational agent (*eMarsha*) walks people through the content via a text-like interface (Figures 1c and 1d). We decided on a conversational interface to help people feel more engaged with the app: by having people actively participate in conversations, rather than passively reading information, the user experience more closely resembles therapy than traditional DBT skills practice worksheets. People can choose their avatar, but the conversational agent is always an image of Dr. Marsha Linehan. We decided to model our conversational agent on Dr. Linehan for a number of reasons. For one, as she narrated the instructional videos, using her as the conversational agent provided a sense of continuity and cohesiveness. Rather than being a collection of instructional media aimed to help people learn about and implement DBT skills, the app feels like a single entity supporting the person through the development of their DBT skills. In addition, since Dr. Linehan developed DBT, people in DBT tend to be familiar with her. We hoped using her image as the conversational agent would therefore foster trust in the content.

Although the majority of the participants in our pilot study liked the conversational interface, many wanted a faster way to access the skills once they had learned about them. We therefore added a *Skill Practice* section, which allows people to select the skill they want to practice from a full list of skills, rather than going through a module. This section enables people to access a particular skill in the moment they need it, without the delay of the introductory material. Having the full list of skills also helps people remember all their skill options.

STUDY METHOD

To determine the feasibility of using Pocket Skills to support therapy, we conducted a 4-week field study. Our protocol was reviewed and approved by our Institutional Review Board.

Recruitment

Participants were recruited via a DBT listserve. Participants needed to be enrolled in psychotherapy for the duration of the study, and agreed to go to their primary therapist for

Gender	65 female, 7 male, 1 Genderqueer/androgynous
Age	min 18, max 63, mean 37.3
Depression at Intake (Via PHQ-9)	Minimal or None (6), Mild (17), Moderate (21), Moderately Severe (16), Severe (13)
Anxiety at Intake (Via OASIS)	No anxiety disorder (12), Anxiety disorder (61)
Diagnosed Disorders	Depression (38), General Anxiety Disorder (35), Borderline Personality Disorder (29), PTSD (20), Bipolar Disorder (10); 17 disorders with <10 people each

Table 1: Demographic information and diagnosed disorders.

any questions or concerns about their health or the activities in which they participated for the study. Participants also needed to own a smartphone, have a US phone number, and be willing to receive daily text messages. Study participation required consenting to the study, completing an intake survey, and logging into the app within a week of receiving login instructions. 84 people enrolled in the study. We report on data from 73 participants (Table 1), as 11 dropped out over the course of the study. These 11 participants did not explain their decision to drop out. The majority of participants were female, which reflects the fact that women are more likely to be diagnosed with BPD (although prevalence is now thought to be approximately equal) [68], and are more likely to seek therapy for BPD [31] and in general [77].

Procedures

The intake survey consisted of questions about participant demographic information and three clinical scales: the OASIS, which assesses anxiety [58]; the PHQ-9, which assesses clinical depression [40]; and the DBT Ways of Coping Checklist ("DBT WOCC"), which assesses frequency of coping via DBT skills use, general dysfunctional strategies, and blaming others [56]. Participants were then emailed an activation code, as well as instructions on how to log into Pocket Skills.

Throughout the study, participants received text messages every morning to encourage app use. Participants were randomized into two messaging groups. One group received semi-personalized messages, which reminded them of their goals, their progress in the app, and skills they had done (e.g., "One of your mindfulness goals is to reduce pain, tension, and stress! Keep practicing mindfulness skills!"). We describe these messages as "semi-personalized" because we did not use machine learning to further tailor the messages to the participant, as prior work has done (e.g., [35, 61]). The other group received non-personalized messages, which described app features (e.g., "The 'Practice Skills' section gets you to the skills ASAP!"). Prior research suggests text messages are better received when the content is personalized [52, 63], and that personalized messages can support reduced drinking [53] and smoking cessation [73]. We therefore hypothesized that people who received semi-personalized messages would use the app more and show more improvement.

Pocket Skills Feature	All Participants		Semi-Personalized Messages		Non-Personalized Messages	
	Average Per Person	Average Per Person Per Day	Average Per Person	Average Per Person Per Day	Average Per Person	Average Per Person Per Day
Days App Used	13.95	–	14.21	–	13.7	–
Time In App (h:m:s)	2:18:08	0:04:36	2:30:37	0:05:01	2:06:17	0:04:12
Total Diary Cards Saved	7.74	0.26	7.87	0.26	7.63	0.25
Total Skills Practiced	21.37	0.71	23.68	0.79	19.18	0.64
Total Videos Watched	8.74	0.29	9.16	0.31	8.35	0.28

Table 2: Usage statistics for Pocket Skills features over the 28-day study. On average, participants logged in on almost half the study days.

Every week, participants completed a short survey containing the OASIS, the PHQ-9, a 5-point Likert scale question about their satisfaction with Pocket Skills, and a text box for any feedback they had. The weekly survey did not include the DBT WOCC, as that scale is designed to be administered monthly. Due to feedback in weeks one and two requesting more content, additional *Distress Tolerance*, *Emotion Regulation*, and *Mindfulness* skills were added two weeks into the study.

At the end of the study, participants completed an exit survey that contained the OASIS, PHQ-9, DBT WOCC, the Mental Health Self-Efficacy Scale [18], and optional questions about their mental health history. The survey also contained questions about the usability and usefulness of Pocket Skills, including the System Usability Scale [69], which evaluates the usability of the system, and primarily open-ended questions about their experience with Pocket Skills. These questions asked about participants' favorite and least favorite aspects of Pocket Skills overall; their favorite and least favorite modules; whether and how Pocket Skills supported their therapy; what they liked and would change about the daily text messages; whether and how the skills Pocket Skills had were useful; and how Pocket Skills compared to their past experiences with DBT and DBT apps.

Participants were compensated with a $50 American Express gift card for every survey they completed (not including the intake survey), for a maximum total of $200. Compensation did not depend on their use of Pocket Skills.

For the qualitative analysis, two authors participated in an open coding exercise of approximately 20% of the 1015 total participant responses to the 15 open-ended exit survey questions to identify emergent themes. The first author then coded the remaining data. Themes included learning, practicing, implementing, results, self-efficacy, engagement with conversational interface, and availability and context. We then applied grounded theory analysis for model development [72].

RESULTS

We present our quantitative results on Pocket Skills feasibility and usability. We then describe our qualitative results that provide insight on how Pocket Skills was able to support DBT.

Pocket Skills Feasibility and Usability

Participants generally reported finding Pocket Skills very usable. They reported a mean of 81.82, median of 85, and standard deviation of 16.01 out of 100 on the System Usability Scale (SUS). The suggested threshold for acceptable usability for the SUS is 68 [69]. Of the 73 participants, 21 were "satisfied" with Pocket Skills overall, and 37 were "extremely satisfied". 71 participants say they plan to keep using Pocket

Skills now that the study is over. Participants used Pocket Skills for almost half the study days, on average, with total time averaging more than 2 hours (Table 2).

Participants also reported decreased depression, anxiety, and dysfunctional coping, as well as increased DBT skills use, after the study (Figure 2). We used hierarchical linear modeling (HLM; e.g., [12]) with restricted maximum likelihood estimator (REML) to analyze the data. Compared to other analytical methods, HLM is more flexible as it treats time as a continuous factor, allowing for the variability of the actual time of assessment for each participant. HLM also compensates for incomplete data across time, increasing power. We built separate unconditional growth models for the PHQ-9 and OASIS. Parameters were systematically added to each model, and deviance statistics were analytically compared [76]. For both scales, the effects of time were estimated as linear and quadratic. The time variable was centered at the mid-point (the 2-week time point) to reduce collinearity between the linear and quadratic components. For both variables, the intercept and linear components were set to random. All analyses were conducted using SPSS.

We developed separate unconditional growth curve models for both the PHQ-9 and OASIS from baseline to exit. We fitted growth models with intercept, slope, and quadratic effects capturing variation at baseline, linear change over time, and subsequent flattening over time. For the PHQ-9, both the linear component (B= -0.79, p<0.001) and quadratic component (B= 0.45, p<0.001) were significant, indicating the group's PHQ-9 scores decreased by 0.79 each week, but that rate of change slowed by 0.45. For the dependent variable of OASIS, a similar pattern emerged where the linear (B= -0.66, p<0.001) and quadratic (B= 0.13, p<0.05) components were significant. These results illustrate that participants significantly improved on both the OASIS and the PHQ-9 between the intake survey and week 1 of use, and continued improving (though at a slowing rate) throughout the study (see Figure 2). On the DBT Ways of Coping Checklist (which was evaluated only at the intake and exit surveys), participants also saw an average decrease in dysfunctional coping (B= -0.06, p <0.001) and blaming others (B= -0.04, p<0.05), as well as an increase in their use of DBT skills (B= 0.04, p<0.001), from baseline to post-study.

Once the unconditional growth models were built, we evaluated whether message type and app use affected the slopes on each dependent variable. The following group-level predictors were systematically evaluated: condition (i.e., semi-personalized or non-personalized messages), Borderline Personality Disorder (BPD) diagnostic status, and total skills practiced. Each predictor was evaluated as a main effect (i.e., on the intercept) and as an interaction term with
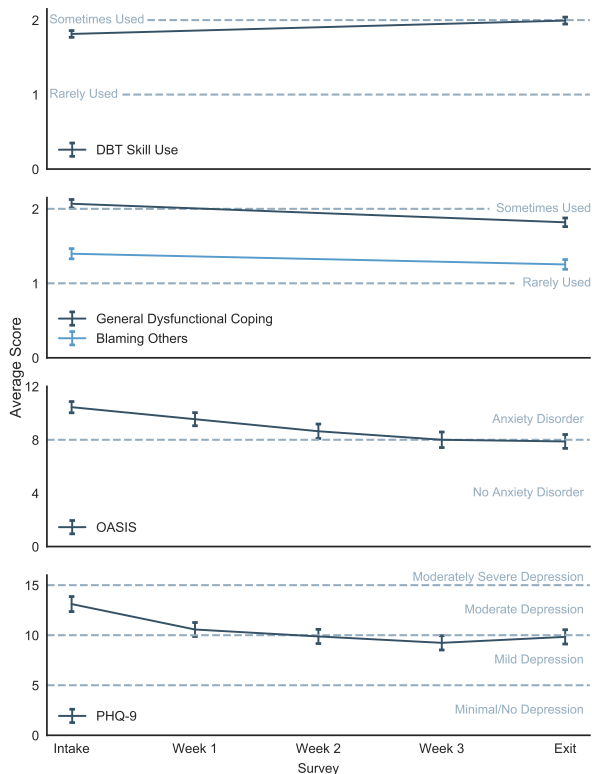
Figure 2: Scale results throughout the study. On average, DBT skill use increased and general dysfunctional coping, blaming others, anxiety (OASIS), and depressive symptoms (PHQ-9) decreased.

each other and on the linear and quadratic components. For the sake of parsimony, ill-fitting parameters were removed [76]. For the PHQ-9, the main effect of BPD was significant (B= 4.82, p<0.001), suggesting that at week 2, individuals diagnosed with BPD, on average, had PHQ-9 scores that were nearly five points higher than those without a BPD diagnosis. The main effect of condition and total number of practice sessions were not significant; however, the total skills practiced was significant at the slope (B= -0.15, p<0.01), indicating that individuals who practiced more skills sessions had faster improvements on the PHQ-9. The three-way interaction of condition, total skills practiced, and time was significant for both the PHQ-9 (B= -0.22, p<0.01) and the OASIS (B= -0.11, p<0.05), indicating that individuals randomized to the semi-personalized messaging condition practiced more skills, which resulted in faster improvements.

To further distinguish the meaningfulness of Pocket Skills on a clinical population, we calculated reliable change (i.e., positive change better than statistical chance) and clinically significant change (i.e., reliable change above a clinically meaningful threshold) using criteria suggested by Jacobson and Truax [34]. The reliable change index (RCI) was calculated for each individual and outcome using the following formula: RC = (score at baseline − post-intervention score)/S_{DIFF}, where S_{DIFF} is the standard error of difference based on baseline standard deviation and Cronbach's α. Clinically significant change (CSC) was operationalized as reaching a level of functioning, reflected in outcome scores, that was closer to the

mean score of the non-clinical population than that of the clinical population. Participants showing both reliable change (RCI>1.96) and clinically significant improvement were classified as "recovered"; those showing reliable change only were classified as "improved"; and those showing neither were classified as "unchanged/deteriorated". RC indices, CSC cut-offs, sources of reliability, and norming data were as follows: PHQ-9 (RC=±6.61, CSC≥2.31 [40]); OASIS (RC=±3.26, CSC≤13.44 [57]); DBT Skills Use (RC=± 0.47, CSC≤2.62 [56]).

Overall, 41.7% of participants were considered "recovered" on the OASIS, while 8.3% of participants improved. For the PHQ-9, 22.2% were recovered, while 4.2% of participants improved. Finally, 6.9% of participants were recovered on DBT skills use, while 12.5% improved. More individuals randomized to the semi-personalized message condition were recovered than those in the non-personalized condition for OASIS (45.9% vs 37.1%) and PHQ-9 (27.0% vs 17.1%), but more people in the non-personalized messaging condition were recovered on DBT skills use (8.6% vs 5.4%).

The mental health self-efficacy score was highly negatively correlated with general dysfunctional coping (a subscale of the Ways of Coping Checklist), as rated in the final survey: higher mental health self-efficacy was associated with lower general dysfunction at the end of the study (r= -0.658, p<0.001).

How Pocket Skills Supported DBT
From the analysis of the qualitative data, we developed a model of how participants felt Pocket Skills supported DBT. The model explains how the use of Pocket Skills led to an increase in participant *engagement* with DBT, which in turn enabled *learning* DBT principles and skills. This *learning* helped people *implement* the DBT skills in their daily lives, understand how implementing those skills led to *positive results*, and increase their *self-efficacy*. We discuss these themes and provide representative examples. We include counts of participants that expressed specific perspectives; however, as the majority of the questions were open-ended, participants were not explicitly asked about these perspectives. We therefore note that more participants than indicated in our counts may have agreed with a given perspective.

Pocket Skills Increases Engagement with DBT
Prior research has emphasized the need for mental health technology to be engaging, so people will use the technology and benefit from the intervention [5, 22, 23, 49, 50]. Engagement is particularly important for DBT, as development and adoption of DBT skills is critical to effective treatment [55]. We discovered that Pocket Skills engaged participants not only with the app itself (see Table 2), but also with DBT more generally, due to a number of reasons. One major aspect participants found helpful was the conversational interface. Thirty-one participants reported enjoying the interactive interface and finding it engaging, especially compared to traditional methods of learning and practicing DBT skills, such as using worksheets [42]. For example, *P1* thought that "*having the interactive app was vastly superior to just having a book*". Participants described particularly liking the conversational interface, which helped them more actively engage with the material. *P62* explained that what she liked

most about Pocked Skills was that "*the Q&A / conversational tone [helped] me think about how to help myself*". By guiding participants through their DBT skills, the app helped people engage with the skills they were practicing.

One of the reasons participants reported enjoying Pocket Skills was the simulated therapy with Dr. Marsha Linehan, a well-respected figure in the DBT community. Because Pocket Skills was based on Dr. Linehan's material, participants found it trustworthy. Twenty-nine participants discussed appreciating the fact that the app used "Marsha" to teach them the material and walk them through the skills. *P37* commented that she "*knew [Pocket Skills] was a legit product, not someone jumping on the mindfulness wagon, because of Dr. Linehan*". One of the top barriers to using apps for people with depression is perceived intervention efficacy: people who do not believe that the intervention is correct are not likely to engage with an app [71]. Fostering this trust in the material is therefore important.

Perhaps due to their familiarity with Dr. Linehan, participants described personifying *eMarsha*, which helped them feel supported by the app despite the lack of human involvement. Some participants described *eMarsha* as though they were actually interacting with a human coach. For example, *P4* explained why she found Pocket Skills helpful: "*[With Pocket Skills] I could have someone help me through what i was supposed to be doing instead of me just winging it by myself and getting lost in my head*". *P22* similarly felt supported by the presence of *eMarsha*, stating that "*'Marsha's' presence gave me the support that I needed to step back ... and look at my own feelings and how my actions and behavior were contributing to those feelings*". *P11* particularly liked the daily text messages because "*It really helped to know someone was there*". This sense of bonding with a conversational agent was also reported for Woebot, an agent designed to support CBT [25]. However, *eMarsha* is entirely scripted, whereas Woebot includes natural language processing so "he" can respond to free text. Despite our more rudimentary approach to a conversational agent, participants still personified *eMarsha*, which helped them stay engaged with Pocket Skills.

Although many participants liked *eMarsha*, 8 mentioned being unable to bond with the agent, which kept them from being as engaged. These participants felt the agent was too generic and impersonal. For example, what *P40* disliked most about Pocket Skills was that "*the Marsha canned responses felt stupid*". For some, the lack of human involvement was viewed as an asset; *P5* explained: "*I am introvert so I love it. I don't have to sit in a room of people so I can learn DBT. My first round of class was so uncomfortable because of that that I quit*". However, the fact that some people thought *eMarsha* felt so "*virtual*" (*P30*) can negatively impact engagement. By incorporating machine learning and natural language processing into Pocket Skills, we could make *eMarsha* more personalized and responsive, and therefore more engaging.

Another reason that people reported feeling engaged with Pocket Skills was the fact that it "*complimented*" (*P41*) their in-person therapy. Thirty-nine participants felt that Pocket Skills worked best as a supplement to traditional DBT, rather than as a replacement. *P63* explained that she found Pocket Skills "*a really excellent supplement. I wished that others in my program had the chance to use it, also. I think it is a really helpful review/refresher*". The fact that Pocket Skills had a "*consistent message*" (*P8*) with their in-person therapy may have also helped with engagement.

Participants also felt that Pocket Skills helped them stay engaged with DBT by consistently reminding them about Pocket Skills, and therefore DBT in general. Fifty-nine participants described that Pocket Skills helped remind them of and reinforce their DBT skills. One of the ways Pocket Skills helped people keep DBT on their mind was through the text messages. *P4* explained: "*I lose time and will forget to practice so the daily reminders were very helpful*". What *P40* liked most about Pocket Skills was "*just getting a text message each day*". Perhaps contributing to the fact that the semi-personalized messages did not make as much difference to usage as we expected, some participants explained that the content of the messages was moot. *P63* said, "*the texts were helpful as reminders. I did not pay close attention to their actual content too much*". Since people often tire of too-frequent messages [48], we thought participants might dislike the fact that we messaged them daily. However, when asked how frequently they would like to receive messages, 21 participants wanted *more* frequent texts, and 28 liked getting them every day. No one reported wanting to receive texts less frequently than once a week. Participants reported appreciating the reminders because it helped them stay engaged with Pocket Skills and their DBT.

In addition to reminding people to think about DBT through the text messages, participants reported that just having Pocket Skills helped remind them of and reinforce the principles and skills that DBT teaches. *P32* explained: "*The app was a concrete reminder that I have a wealth of skills - which I already know quite well - to help me get through everything that has been going on, without crashing. It gave me a quick refresher on the details of skills I hadn't thought much about for awhile*". Similarly, *P31* said: "*the app really sharpens my focus, reminds me of all the skills there are to draw on, and reminds me to practice!*". *P18* felt that Pocket Skills helped her engage with DBT even when she did not use the app: "*Sometimes just having the app in my phone even without opening it was a good reminder to practice my skills a couple of times at work this week*". Simply having Pocket Skills on their phone helped participants stay more engaged with DBT.

Engagement with Pocket Skills Enables DBT Learning
Engagement with Pocket Skills, and DBT in general, seemed to help participants learn the principles and skills associated with DBT. Sixty-six participants felt that Pocket Skills helped them learn useful skills. One of the main reasons people reported being able to learn with Pocket Skills was its clear explanations of the module and skills, which 35 participants mentioned appreciating. *P51* explained, "*I like it the best of the other apps I have tried, because it actually teaches the skills rather than just reminding you of them or tracking things*". By including explanations, Pocket Skills ensured that the content was accessible to everyone, even people who had not learned, struggled with, or forgotten the DBT material.

Some participants also felt Pocket Skills helped them learn by including "*actual realistic scenarios and situations*" (*P54*). Ten participants mentioned that the examples that Pocket Skills included facilitated learning the material. *P24* explained how the examples helped her learn the material: "*The Mindfulness skills and explanation of it and examples in each section really helped to clarify the concept of mindfulness itself, which I struggle with*". Through the concrete examples, participants felt they could better understand the material.

Although Pocket Skills helped many participants learn, 15 felt their learning was hindered due to their inability to ask any questions. For example, *P7* felt she needed someone to help her through the material: "*I needed more guidance on what units to practice, on how to work my way through the app. So, it needs an online coach (a live person, not just the eMartha avatar), or it needs to be used under the direction of a real-world therapist*". *P36* summarized that one of the biggest weaknesses of Pocket Skills is that it "*doesn't allow you to discuss anything with a real human.* Prior work has investigated allowing people to message their therapists about technology designed to support mental health, or even through it (e.g., [5, 22]). Pocket Skills may benefit from such a feature.

In addition to gaining knowledge about DBT, 18 participants felt Pocket Skills helped them gain insight about themselves. For example, *P19* felt that Pocket Skills helped her learn which skills were helpful to her personally: "*In high emotional state it is good to know these are effective for me*". Pocket Skills also helped people learn about their emotions, which is a major goal of the *Emotion Regulation* Module. *P54* said, "*[Pocket Skills] helped me be able to recognize my emotions better*". This self-knowledge often helped people cope more effectively; *P25* explained: "*knowing exactly what I'm feeling helps me be able to intercede appropriately*". The fact that Pocket Skills helped people learn more about themselves enabled them to better relate to the DBT material.

Although the self-knowledge that people obtained through Pocket Skills was generally positive and constructive, some participants learned aspects about themselves that were upsetting. For example, *P15* mentioned that his least favorite module was the *Addiction Skills*. When asked why, he explained: "*Mostly because I learned that I engage in addictive behavior*". Such a realization is difficult, but it may ultimately be positive if it helps the participant overcome the addiction. However, other participants learned information that was less constructive. For example, *P50* said, "*community reinforcement [an Addiction skill] reminded me that i am alone and have no support*". Given these comments, future iterations of Pocket Skills may need to take the possibility of negative self-knowledge into account and either suggest resources for anyone struggling with the information they learn about themselves or encourage them to contact their therapist.

In addition to perceived learning of DBT material, participants felt Pocket Skills gave them the means to practice their DBT skills. Sixty participants felt they practiced their skills more with Pocket Skills than they would have practiced without it. For example, *P17* said, "*I've been in therapy for years, but I'm not great about practicing my therapeutic homework.*

Pocket Skills helped me practice my skills in between therapy appointments". Similarly, *P26* found Pocket Skills motivated her to recommit to her DBT skills: "*Pocket Skills got me motivated to brush up on the various skills in each [module] and to stay in practice with them*". Practicing DBT skills is an essential step to fully understanding them (and to implementing them, as we discuss in the next section) [55]. The fact that participants felt Pocket Skills encouraged them to practice is therefore a key piece to helping them learn the material.

Learning Enables Implementation
Participants reported that Pocket Skills helped them not only learn and practice their skills, but also implement those skills. As we discussed above, we found significant increases in skill use between the intake and exit surveys. Fifty-four participants talked about Pocket Skills helping them actually apply DBT skills in their daily lives. For example, *P53* explained: "*I don't just learn the skills but pocket skills helps remind me what the skills is and how to use it step by step to apply it on a daily basis so it becomes apart of me*". Even participants who had already started implementing their DBT skills felt that Pocket Skills helped them: "*[Pocket Skills helped me] increase my depth and consistency of applying skills on a daily basis from prior to using the app*" (*P31*). With help from Pocket Skills, participants were able to better bridge the gap between simply practicing their DBT skills and actually applying those skills.

One reason participants felt Pocket Skills helped them implement DBT skills was the fact that it contained a variety of skills from which they could choose. Seventeen participants said the clear options Pocket Skills provided helped them make good choices about what skills to implement when. For example, one of the aspects *P14* liked most about Pocket Skills was "*learning different ideas to self soothe*". The ability to see and access such a wide range of options was particularly helpful when people were experiencing emotional distress. *P5* mentioned: "*[the 'Skill Practice' section was] a place I could go to find a skill that might help me when I was feeling badly or having an emotional issue and I couldn't think about what skill was the best. I could be reminded by seeing its name*". By providing options of coping mechanisms when participants were struggling, Pocket Skills helped them learn how to apply the skills when they most needed them.

The availability of Pocket Skills was also key in enabling participants to implement DBT skills. Because Pocket Skills was available whenever participants had access to their phone and the Internet, participants could practice on the go, which helped keep the skills more prominently in their mind. Forty-one participants mentioned the importance of the availability of the app. *P58* explained that its availability was the link between learning DBT skills and implementing them:

> Having something to explain [the skills] and refer back to in the moment anytime I want or need was an invaluable resource ... The app allows you to practice in the moment, every day, any skill and have quick access right at your fingertips, since you always have a phone (but don't always have a worksheet say). So it decreases the barriers and burden of practicing which is great.

Participants also felt that the ability to use their DBT skills *in context* was important; what *P28* liked most about Pocket Skills was "*The security of having the app readily available to help [her] if a crisis arose*". Similarly, 23 participants mentioned the importance of being able to access their skills in context, when they most need them. *P46* explained: "*It's useful with the app to be able to scroll through and pick out quickly what skill I need to practice. Without it, it can be hard (especially in distress) to remember what my options are*". By allowing people to access their skills in the right context (e.g., when they were in distress), Pocket Skills helped them learn how to implement those skills in their daily lives.

Implementation Enables Results and Self-Efficacy
Participants felt implementing DBT skills in context helped them see the results of using those skills. On top of the significant results we found via the scales, 32 participants explained that they saw concrete results in their lives. For example, *P2* felt Pocket Skills helped improve her relationships: "*I think there were a number of times that I would not have been as successful in interactions with my friends and family [had I not had Pocket Skills these past 4 weeks]. Just thinking about DBT on a daily basis helped keep my skills in the forefront!*". *P27* saw a difference in her distress when she used Pocket Skills to apply her DBT skills: "*When I actively used Distress Tolerance skills I was able to reduce my SUDS [(Subjective Units of Distress Scale)] score*". Pocket Skills also helped some participants change their behaviors. For example, *P47* said if she had not had Pocket Skills, she "*Likely would have used SIB [(Self-injurious behavior)] More frequently*". Thus, not only did the scales show reduced depressive and anxiety symptoms, but the qualitative results also illustrated that participants felt Pocket Skills helped them see significant improvement in their lives.

Participants also described feeling an increased ability to change after using Pocket Skills. Prior research suggests self-efficacy is important for positive symptom outcomes to using a mental health app for depression [18, 24], and as discussed above, our own results similarly showed a significant negative correlation between self-efficacy and general dysfunctional coping. Sixteen participants mentioned using Pocket Skills increased their self-efficacy. *P1* explained Pocket Skills helped her realize she was capable of using DBT skills: "*They helped me break down something that seemed overwhelming into manageable bits I could do on my own*" Similarly, *P46* said:

> [Pocket Skills gave me] increased independence. I used it during moments of distress when I might otherwise have called someone for help. Phoning friends/family/doctors often leaves me feeling embarrassed after I've calmed down. It is rewarding to feel like I can make it through intense moments with a little more independence, and Pocket Skills was helpful with that.

Increasing self-efficacy can in turn enable future skill implementation. *P22* explained, "*I think that I would feel less confident in my ability to use DBT skills now if it weren't for Pocket Skills*". Because she has more confidence in her ability to implement DBT skills, *P22* felt more likely to continue to

do so in the future. Over time, we hope Pocket Skills can reinforce the cycle of implementing skills, seeing concrete positive results, and increasing self-efficacy to change.

LIMITATIONS
Our recruitment method introduced some limitations. As we used a DBT listserve, all participants were at least somewhat familiar with DBT, and all participants but one were either currently enrolled in DBT or had been in the past. We therefore cannot say whether people with no DBT experience would have found Pocket Skills as beneficial as our participants.

Another limitation was the fact that all participants were currently enrolled in psychotherapy, due to legal and ethical considerations. Although our team included a clinical psychologist, we wanted participants to have a therapist to whom they could reach out in a psychological crisis. As we did not have the resources to offer that support, participants needed to have a personal therapist. However, the fact that all participants were enrolled in psychotherapy meant that we do not know whether Pocket Skills could support someone who is not in therapy. In addition, while we observed significant improvements on all clinical measures of interest and participants described positive results after using Pocket Skills, we did not have a control group that did not receive the intervention, nor did we have groups with subsets of the interaction features. We therefore cannot comment on the clinical efficacy of Pocket Skills versus normal therapy, nor the effectiveness of specific interaction features, given the lack of distinct comparison groups. Such an evaluation of clinical efficacy is an opportunity for future research, informed by the feasibility results we currently present, which is consistent with best practices in health-related research in HCI [36].

Finally, a limitation to our methods is the fact that we did not measure self-efficacy in the intake survey. We therefore cannot quantify change in self-efficacy over the course of the study. Prior work has described improved self-efficacy after using systems for mental health (e.g., [14]), and some participants reported increased self-efficacy in the open-ended questions. We plan to study self-efficacy more thoroughly in the future.

DISCUSSION AND FUTURE WORK
We discuss design implications for technologies supporting mental health. We also discuss how Pocket Skills could better support people and their therapists in the future.

Model Implications: Need for Availability & Engagement
Our model of how Pocket Skills supported DBT reveals the importance of allowing people to access skills in context, to help bridge the gap between *practicing* DBT skills and *implementing* those skills in their daily lives. The importance of *availability* suggests technologies designed to support mental health should have mobile components, especially if the mental health intervention includes skill implementation.

Our model also supports the importance of *engagement* for mental health technology, as prior work has also found (e.g., [5, 22, 23, 49, 50]). One of the prominent ways participants found Pocket Skills engaging was the strong, trusted conversational agent. Participants appreciated the appearance

of actively speaking to someone to learn material and complete skills, finding the conversational interface more engaging and thought provoking than passively completing worksheets. In the future, we hope to incorporate machine learning to make *eMarsha* even more engaging. For example, "she" could suggest skills based on what has worked well in the past, or even based on what works well for other people with the same disorders.

We were surprised to see so little difference between semi-personalized and non-personalized messages, as we expected semi-personalized messages to increase engagement. Participants described paying little attention to the content of the messages, simply treating them as a reminder. In this context, message content may therefore be immaterial. However, the fact that participants in the semi-personalized messages condition practiced more skills and had faster rates of change in the OASIS and PHQ-9 suggests personalization may be more significant over a longer time period. Future work will investigate whether more personalized content could better support engagement with the app, and will assess the effects of different messaging types on longer-term engagement.

Visualizing History and Improvement
Participants discussed appreciating the ability to see the difference Pocket Skills made in their behaviors and emotional regulation. However, although Pocket Skills collects data on skills practice sessions and diary cards, it does not currently fully support people who want to reflect on and learn from that data. People can access past diary cards, which some participants mentioned finding useful; what *P8* liked most about Pocket Skills was *"Watching the change in [her] diary cards"*. However, Pocket Skills does not currently let people see their conversational history with *eMarsha* or any data aggregations or visualizations over time. Prior work has discussed the importance of visualizations of self-assessment data in a system designed for people with bipolar disorder [5]. By including ways for people to visualize their behaviors and emotions over time, they could better understand the results of using Pocket Skills. In addition, allowing people to access histories of their conversations with *eMarsha* could allow them to view the evolution their skill use and remember which skills have been helpful for them in the past.

Considering Therapist Needs
Pocket Skills was designed by an interdisciplinary team that included a clinical psychologist. However, Pocket Skills focuses on supporting individuals enrolled in therapy, and does not currently support therapist needs. Health provider needs are often overlooked in tools for mental health, but providers generally have a strong interest in having such tools [70]. A number of features could help Pocket Skills better support therapists. For example, four participants mentioned wishing they could print or email their diary cards or skill practice history so they could show them to their therapists. By designing ways to share such data with therapists, Pocket Skills could help people and their therapists collaboratively review their progress and make decisions regarding future treatment.

Pocket Skills could also support collaborative use. The current design assumes that a single person pursuing DBT is using the app, but three participants mentioned using Pocket Skills with their therapists. Furthermore, a therapist to one of the participants reached out to us via email praising Pocket Skills, mentioning that it was *"[v]ery helpful in stimulating great discussions today about mindfulness"* in her group DBT session. By including designs for use alone, with a therapist, and in a group setting, Pocket Skills could better support the myriad ways people would like to use it. In the future, we hope to investigate exactly how people and therapists would like to use Pocket Skills, both individually and collaboratively.

Supporting People Without Access to Therapy
Due to ethical considerations, our study only included people currently enrolled in psychotherapy. However, many people who would benefit from psychotherapy cannot access it [39, 79], due to factors such as cost [75] and stigma [46, 83]. Ultimately, we want Pocket Skills to not only support people who are in therapy, but also to provide help to those who cannot access it. As Pocket Skills provides holistic support for DBT, including educational materials explaining its principles and skills, it may include sufficient information to help people who are unfamiliar with DBT. However, participants felt Pocket Skills still might be confusing or uninteresting to someone with no DBT background. *P73* explained that *"it is important to have a base knowledge of the stuff so an individual knows how to appropriately engage"*. Pocket Skills currently assumes people understand enough about DBT to know they want to pursue it. To support people with no DBT experience, we may need to include information about why DBT was developed and who and how it helps. As people who do not know what DBT is will not be familiar with Dr. Linehan, we would also need to provide enough information about her to help them develop the same level of trust in *eMarsha* that participants reported feeling.

CONCLUSION
We created Pocket Skills, a mobile web app designed to support Dialectical Behavioral Therapy (DBT). Pocket Skills guides people through DBT education and skills practice via *eMarsha*, a conversational agent modeled on Marsha Linehan, the developer of DBT. We conduced a 4-week field study of 73 participants to test the feasibility of using Pocket Skills to support DBT. After the study, all participants showed significant improvement in depression, anxiety, and DBT skills use. In addition, we contribute a model of how Pocket Skills supported DBT based on our qualitative analysis of open-ended questions in the exit survey. Participants reported that Pocket Skills helped them *engage* both in the app and in DBT in general. This engagement helped them *learn* the principles and *practice* the skills in context, helping them *implement* those skills in their everyday lives. Participants were therefore able to see the *concrete results* of implementing their DBT skills and improve their *self-efficacy*. We discussed the necessity of technology being available and engaging to support mental health treatment, as well as the importance of visualizing history and improvement, considering therapist needs, and supporting people without access to in-person therapy. This work therefore motivates future study, design, and development of tools to support mental health.

REFERENCES

1. 2002. *Guidance on the Use of Computerised Cognitive Behavioural Therapy for Anxiety and Depression*. National Institute for Clinical Excellence.

2. Adrian Aguilera and Clara Berridge. 2014. Qualitative Feedback from a Text Messaging Intervention for Depression: Benefits, Drawbacks, and Cultural Differences. In *JMIR mHealth and Uhealth*. https://doi.org/10.2196/mhealth.3660

3. Adrian Aguilera, Emma Bruehlman-Senecal, Orianna Demasi, and Patricia Avila. 2017. Automated Text Messaging as an Adjunct to Cognitive Behavioral Therapy for Depression: A Clinical Trial. In *Journal of Medical Internet Research*. https://doi.org/10.2196/jmir.6914

4. Nazanin Andalibi, Pinar Oxturk, and Andrea Forte. 2017. Sensitive Self-Disclosures, Responses, and Social Support On Instagram: The Case of #Depression. In *Proceedings of the ACM Conference on Computer-Supported Cooperative Work and Social Computing*. https://doi.org/10.1145/2998181.2998243

5. Jakob E Bardram, Mads Frost, Károly Szántó, Maria Faurholt-Jepsen, Maj Vinberg, and Lars Vedel Kessing. 2013. Designing Mobile Health Technology for Bipolar Disorder: A Field Trial of the Monarca System. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2627–2636. https://doi.org/10.1145/2470654.2481364

6. Dror Ben-Zeev, Susan M Kaiser, Christopher J Brenner, Mark Begale, Jennifer Duffecy, and David C Mohr. 2013. Development and Usability Testing of FOCUS: A Smartphone System for Self-Management of Schizophrenia. *Psychiatric Rehabilitation Journal* 36, 4 (2013), 289. http://doi.org/10.1037/prj0000019

7. Dror Ben-Zeev, Emily A Scherer, Rui Wang, Haiyi Xie, and Andrew T Campbell. 2015. Next-Generation Psychiatric Assessment: Using Smartphone Sensors to Monitor Behavior and Mental Health. *Psychiatric Rehabilitation Journal* 38, 4 (2015), 313–313. https://doi.org/10.1037/prj0000130

8. Timothy Bickmore, Amanda Gruber, and Rosalind Picard. 2005. Establishing the Computer-Patient Working Alliance in Automated Health Behavior Change Interventions. *Patient Education and Counseling* 59, 1 (2005), 21–30. https://doi.org/10.1016/j.pec.2004.09.008

9. Timothy W. Bickmore, Kathryn Puskar, Elizabeth A. Schlenk, Laura M. Pfeifer, and Susan M. Sereika. 2010. Maintaining Reality: Relational Agents for Antipsychotic Medication Adherence. *Interacting With Computers* 22 (2010), 276–288. https://doi.org/10.1016/j.intcom.2010.02.001

10. Nataly Birbeck, Shaun Lawson, Kellie Morrissey, Tim Rapley, and Patrick Olivier. 2017. Self Harmony: Rethinking Hackathons to Design and Critique Digital Technologies for Those Affected By Self-Harm. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 146–157. https://doi.org/10.1145/3025453.3025931

11. Amelia J Birney, Rebecca Gunn, Jeremy K Russell, and Dennis V Ary. 2016. Moodhacker Mobile Web App With Email for Adults to Self-Manage Mild-to-Moderate Depression: Randomized Controlled Trial. In *JMIR mHealth and Uhealth*. https://doi.org/10.2196/mhealth.4231

12. Anthony S Bryk and Stephen W Raudenbush. 1992. *Hierarchical Linear Models for Social and Behavioral Research: Applications and Data Analysis Methods*. Newbury Park, CA: Sage.

13. Nigel E Bush, Steven K Dobscha, Rosa Crumpton, Lauren M Denneson, Julia E Hoffman, Aysha Crain, Risa Cromer, and Julie T Kinn. 2015. A Virtual Hope Box Smartphone App as an Accessory to Therapy: Proof-of-Concept in a Clinical Sample of Veterans. *Suicide & Life-Threatening Behavior* 45, 1 (2015), 1–9. http://doi.org/10.1111/sltb.12103

14. Nigel E Bush, Derek J Smolenski, Lauren M Denneson, Holly B Williams, Elissa K Thomas, and Steven K Dobscha. 2017. A Virtual Hope Box: Randomized Controlled Trial of a Smartphone App for Emotional Regulation and Coping With Distress. *Psychiatric Services* 68, 4 (2017), 330–336. https://doi.org/10.1176/appi.ps.201600283

15. Andrew C Butler, Jason E Chapman, Evan M Forman, and Aaron T Beck. 2006. The Empirical Status of Cognitive-Behavioral Therapy: A Review of Meta-Analyses. *Clinical Psychology Review* 26, 1 (2006), 17–31. https://doi.org/10.1016/j.cpr.2005.07.003

16. Brianne Campbell, Kelly Caine, Kay Connelly, Tom Doub, and April Bragg. 2015. Cell Phone Ownership and Use Among Mental Health Outpatients in the USA. *Personal and Ubiquitous Computing* 19, 2 (2015), 367–378. https://doi.org/10.1007/s00779-014-0822-z

17. Munmun De Choudhury, Emre Kiciman, Mark Dredze, Glen Coppersmith, and Mrinal Kumar. 2016. Discovering Shifts to Suicidal Ideation From Mental Health Content in Social Media. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/2858036.2858207

18. Janine Clarke, Judith Proudfoot, Mary-Rose Birch, Alexis E Whitton, Gordon Parker, Vijaya Manicavasagar, Virginia Harrison, Helen Christensen, and Dusan Hadzi-Pavlovic. 2014. Effects of Mental Health Self-Efficacy On Outcomes of a Mobile Phone and Web Intervention for Mild-to-Moderate Depression, Anxiety and Stress: Secondary Analysis of a Randomised Controlled Trial. In *BMC Psychiatry*. https://doi.org/10.1186/s12888-014-0272-1

19. Kate Davidson, John Norrie, Peter Tyrer, Andrew Gumley, Philip Tata, Heather Murray, and Stephen Palmer. 2006. The Effectiveness of Cognitive Behavior Therapy for Borderline Personality Disorder: Results From The Borderline Personality Disorder Study of Cognitive Therapy (BOSCOT) Trial. *Journal of Personality Disorders* 20, 5 (2006), 450–65. `https://doi.org/10.1521/pedi.2006.20.5.450`

20. Munmun De Choudhury, Michael Gamon, Scott Counts, and Eric Horvitz. 2013. Predicting Depression Via Social Media. *ICWSM* 13 (2013), 1–10.

21. Linda Dimeff and Marsha M Linehan. 2001. Dialectical Behavior Therapy in a Nutshell. *The California Psychologist* 34, 3 (2001), 10–13.

22. Gavin Doherty, David Coyle, and John Sharry. 2012. Engagement With Online Mental Health Interventions: An Exploratory Clinical Study of a Treatment for Depression. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. `https://doi.org/10.1145/2207676.2208602`

23. Stefan Rennick Egglestone, Sarah Knowles, Gill Toms, Penny Bee, Karina Lovell, and Peter Bower. 2016. Health Technologies 'In the Wild': Experiences of Engagement With Computerised CBT. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. `https://doi.org/10.1145/2858036.2858128`

24. Martin Fitzgerald and Tracy McClelland. 2017. What Makes a Mobile App Successful in Supporting Health Behaviour Change? *Health Education journal* 76, 3 (2017), 373–381. `https://dx.doi.org/10.2196%2Fmental.4984`

25. Kathleen Kara Fitzpatrick, Alison Darcy, and Molly Vierhile. 2017. Delivering Cognitive Behavior Therapy to Young Adults With Symptoms of Depression and Anxiety Using A Fully Automated Conversational Agent (Woebot): A Randomized Controlled Trial. In *JMIR Mental Health*. `https://doi.org/10.2196/mental.7785`

26. Centers for Disease Control and Prevention. 2015. 10 Leading Causes of Death By Age Group, United States, 2015. (2015).

27. Agency for Healthcare Research and The Department of Health & Human Services Quality. 2009. HCUP Facts and Figures: Statistics On Hospital-Based Care in the United States, 2009. (2009). `https://www.ncbi.nlm.nih.gov/books/NBK91984/`

28. Joseph C Franklin, Kathryn R Fox, Christopher R Franklin, Evan M Kleiman, Jessica D Ribeiro, Adam C Jaroszewski, Jill M Hooley, and Matthew K Nock. 2016. A Brief Mobile App Reduces Nonsuicidal and Suicidal Self-Injury: Evidence From Three Randomized Controlled Trials. *Journal of Consulting and Clinical Psychology* 84, 6 (2016), 544–57. `https://doi.org/10.1037/ccp0000093`

29. Lina Gega, Isaac Marks, and David Mataix-Cols. 2004. Computer-Aided CBT Self-help for Anxiety and Depressive Disorders: Experience of a London Clinic and Future Directions. *Journal of Clinical Psychology* 60, 2 (2004), 147–57. `https://doi.org/10.1002/jclp.10241`

30. Itzhak Gilat, Yishai Tobin, and Golan Shahar. 2011. Offering Support to Suicidal Individuals in An Online Support Group. *Archives of Suicide Research : Official Journal of the International Academy for Suicide Research* 15, 3 (2011), 195–206. `https://doi.org/10.1080/13811118.2011.589675`

31. Marianne Goodman, Uday Patil, Lauren Steffel, Jennifer Avedon, Scott Sasso, Joseph Triebwasser, and Barbara Stanley. 2010. Treatment Utilization By Gender in Patients With Borderline Personality Disorder. *Journal of Psychiatric Practice* 16, 3 (2010), 155–63. `https://doi.org/10.1097/01.pra.0000375711.47337.27`

32. Jan Horsfall, Michelle Cleary, Glenn E Hunt, and Garry Walter. 2009. Psychosocial Treatments for People With Co-Occurring Severe Mental Illnesses and Substance Use Disorders (dual Diagnosis): A Review of Empirical Evidence. *Harvard Review of Psychiatry* 17, 1 (2009), 24–34. `http://doi.org/10.1300/J374v01n02_05`

33. Anna Huguet, Sanjay Rao, Patrick J Mcgrath, Lori Wozney, Mike Wheaton, Jill Conrod, and Sharlene Rozario. 2016. A Systematic Review of Cognitive Behavioral Therapy and Behavioral Activation Apps for Depression. *PLOS One* 11, 5 (2016), E0154248. `https://doi.org/10.1371/journal.pone.0154248`

34. Neil S Jacobson and Paula Truax. 1991. Clinical Significance: A Statistical Approach to Defining Meaningful Change in Psychotherapy Research. *Journal of consulting and clinical psychology* 59, 1 (1991), 12. `https://www.ncbi.nlm.nih.gov/pubmed/2002127`

35. Sooyeon Jeong and Cynthia Lynn Breazeal. 2016. Improving Smartphone Users' Affect and Wellbeing With Personalized Positive Psychology Interventions. In *Proceedings of the Fourth International Conference On Human Agent Interaction*. ACM, 131–137. `http://doi.org/10.1145/2974804.2974831`

36. Predrag Klasnja, Sunny Consolvo, and Wanda Pratt. 2011. How to Evaluate Technologies for Health Behavior Change in HCI Research. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 3063–3072. `https://doi.org/10.1145/1978942.1979396`

37. Kenneth A. Kobak, James C. Mundt, and Betsy Kennard. 2015. Integrating Technology Into Cognitive Behavior Therapy for Adolescent Depression: A Pilot Study. In *Annals of General Psychiatry*. `https://doi.org/10.1186/s12991-015-0077-8`

38. Rafal Kocielnik and Gary Hsieh. 2017. Send Me A Different Message: Utilizing Cognitive Space to Create Engaging Message Triggers. In *Proceedings of the ACM Conference on Computer-Supported Cooperative Work and Social Computing*. `https://doi.org/10.1145/2998181.2998324`

39. Robert Kohn, Shekhar Saxena, Itzhak Levav, and Benedetto Saraceno. 2004. The Treatment Gap in Mental Health Care. *Bulletin of the World health Organization* 82, 11 (2004), 858–866. https://doi.org/S0042-96862004001100011

40. K Kroenke, R L Spitzer, and J B Williams. 2001. The Phq-9: Validity of a Brief Depression Severity Measure. *Journal of General Internal Medicine* 16, 9 (2001), 606–13. https://www.ncbi.nlm.nih.gov/pubmed/11556941

41. Marsha Linehan. 1993. *Cognitive-Behavioral Treatment of Borderline Personality Disorder*. Guilford Press.

42. Marsha Linehan. 2014. *DBT Skills Training Manual*. Guilford Publications.

43. M M Linehan, H L Heard, and H E Armstrong. 1993. Naturalistic Follow-Up of a Behavioral Treatment for Chronically Parasuicidal Borderline Patients. *Archives of General Psychiatry* 50, 12 (1993), 971–4. https://www.ncbi.nlm.nih.gov/pubmed/8250683

44. Christine L. Lisetti, Reza Amini, Ugan Yasavur, and Naphtali Rishe. 2013. I Can Help You Change! An Empathic Virtual Agent Delivers Behavior Change Health Interventions. *ACM Trans. Management Inf. Syst* 4 (2013), 19:1–19:28. https://doi.org/10.1145/2544103

45. Gale M. Lucas, Jonathan Gratch, Aisha King, and Louis-Philippe Morency. 2014. It's Only A Computer: Virtual Humans Increase Willingness to Disclose. *Computers in Human Behavior* 37 (2014), 94–100. https://doi.org/10.1016/j.chb.2014.04.043

46. Christina Lyons, P Hopley, and J Horrocks. 2009. A Decade of Stigma and Discrimination in Mental Health: Plus ça Change, Plus C'est La Même Chose (the More Things Change, The More They Stay The Same). *Journal of psychiatric and mental health nursing* 16, 6 (2009), 501–507. https://doi.org/10.1111/j.1365-2850.2009.01390.x

47. Lydia Manikonda and Munmun De Choudhury. 2017. Modeling and Understanding Visual Attributes of Mental Health Disclosures in Social Media. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3025453.3025932

48. Gloria Mark, Shamsi Iqbal, Mary Czerwinski, and Paul Johns. 2014. Capturing the Mood: Facebook and Face-to-Face Encounters in the Workplace. In *Proceedings of the ACM conference on Computer supported cooperative work & social computing*. ACM, 1082–1094. https://doi.org/10.1145/2531602.2531673

49. Mark Matthews, Gavin Doherty, David Coyle, and John Sharry. 2008. Designing Mobile Applications to Support Mental Health Interventions. In *Handbook of research on user interface design and evaluation for mobile technology*. IGI Global, 635–656. http://doi.org/10.4018/978-1-59904-871-0.ch038

50. David C Mohr, Michelle Nicole Burns, Stephen M Schueller, Gregory Clarke, and Michael Klinkman. 2013. Behavioral Intervention Technologies: Evidence Review and Recommendations for Future ResearchÆŠMental Health. *General Hospital Psychiatry* 35, 4 (2013), 332–338. https://doi.org/10.1016/j.genhosppsych.2013.03.008

51. David C Mohr, Kathryn Noth Tomasino, Emily G Lattie, Hannah L Palac, Mary J Kwasny, Kenneth Weingardt, Chris J Karr, Susan M Kaiser, Rebecca C Rossom, Leland R Bardsley, Lauren Caccamo, Colleen Stiles-Shields, and Stephen M Schueller. 2017. IntelliCare: An Eclectic, Skills-Based App Suite for The Treatment of Depression and Anxiety. *Journal of Medical Internet Research* 19, 1 (2017). https://dx.doi.org/10.2196%2Fjmir.6645

52. Frederick Muench and Amit Baumel. 2017. More Than A Text Message: Dismantling Digital Triggers to Curate Behavior Change in Patient-Centered Health Interventions. In *Journal of Medical Internet Research*. https://doi.org/10.2196/jmir.7463

53. Frederick Muench, Katherine Van Stolk-Cooke, Alexis Kuerbis, Gertraud Stadler, Amit Baumel, Sijing Shao, James R Mckay, and Jon Morgenstern. 2017. A Randomized Controlled Pilot Trial of Different Mobile Messaging Interventions for Problem Drinking Compared to Weekly Drink Tracking. In *PLOS One*. https://doi.org/10.1371/journal.pone.0167900

54. Frederick Muench, Katherine Van Stolk-Cooke, Jon Morgenstern, Alexis N Kuerbis, and Kendra Markle. 2014. Understanding Messaging Preferences to Inform Development of Mobile Goal-Directed Behavioral Interventions. *Journal of Medical Internet Research* 16, 2 (2014). https://dx.doi.org/10.2196%2Fjmir.2945

55. Andrada D Neacsiu, Shireen L Rizvi, and Marsha M Linehan. 2010a. Dialectical Behavior Therapy Skills Use as a Mediator and Outcome of Treatment for Borderline Personality Disorder. *Behaviour Research and Therapy* 48, 9 (2010), 832–9. https://doi.org/10.1016/j.brat.2010.05.017

56. Andrada D Neacsiu, Shireen L Rizvi, Peter P Vitaliano, Thomas R Lynch, and Marsha M Linehan. 2010b. The Dialectical Behavior Therapy Ways of Coping Checklist: Development and Psychometric Properties. *Journal of clinical psychology* 66, 6 (2010), 563–582. https://doi.org/10.1002/jclp.20685

57. Sonya B Norman, Laura Campbell-Sills, Carla A Hitchcock, Sarah Sullivan, Alexis Rochlin, Kendall C Wilkins, and Murray B Stein. 2011. Psychometrics of a Brief Measure of anxiety to Detect Severity and Impairment: The Overall Anxiety Severity and Impairment Scale (OASIS). *Journal of psychiatric research* 45, 2 (2011), 262–268. https://dx.doi.org/10.1016%2Fj.jpsychires.2010.06.011

58. Sonya B Norman, Shadha Hami Cissell, Adrienne J Means-Christensen, and Murray B Stein. 2006. Development and Validation of an Overall Anxiety Severity and Impairment Scale (oasis). *Depression and Anxiety* 23, 4 (2006), 245–9. https://www.ncbi.nlm.nih.gov/pubmed/16688739

59. National Institutes of Health: National Institute of Mental Health. 2015. Any Mental Illness (AMI) Among U.S. Adults. (2015). https://www.nimh.nih.gov/health/statistics/prevalence/any-mental-illness-ami-among-us-adults.shtml

60. Mark Olfson, Ramin Mojtabai, Nancy A Sampson, Irving Hwang, Benjamin Druss, Philip S Wang, Kenneth B Wells, Harold Alan Pincus, and Ronald C Kessler. 2009. Dropout From Outpatient Mental Health Care in the United States. *Psychiatric Services* 60, 7 (2009), 898–907. https://doi.org/10.1176/ps.2009.60.7.898

61. Pablo Paredes, Ran Gilad-Bachrach, Mary Czerwinski, Asta Roseway, Kael Rowan, and Javier Hernandez. 2014. PopTherapy: Coping with Stress Through Pop-Culture. In *Proceedings of the International Conference on Pervasive Computing Technologies for Healthcare*. Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, 109–117. https://doi.org/10.4108/icst.pervasivehealth.2014.255070

62. Judith Proudfoot, Janine Clarke, Mary-Rose Birch, Alexis E Whitton, Gordon Parker, Vijaya Manicavasagar, Virginia Harrison, Helen Christensen, and Dusan Hadzi-Pavlovic. 2013. Impact of a Mobile Phone and Web Program On Symptom and Functional Outcomes for People With Mild-to-Moderate Depression, Anxiety and Stress: A Randomised Controlled Trial. In *BMC Psychiatry*. https://doi.org/10.1186/1471-244X-13-312

63. Paul Quinnett, Philip Batterham, Wouter Van Ballegooijen, Ursula Whiteside, Anita Lungu, Julie Richards, Gregory E Simon, Sarah Clingan, Jaeden Siler, Lorilei Snyder, and Evette Ludman. 2014. Designing Messaging to Engage Patients in An Online Suicide Prevention Intervention: Survey Results From Patients With Current Suicidal Ideation. In *Journal of Medical Internet Research*. https://doi.org/10.2196/jmir.3173

64. Derek Richards and Thomas Richardson. 2012. Computer-Based Psychological Treatments for Depression: A Systematic Review and Meta-Analysis. *Clinical Psychology Review* 32, 4 (2012), 329–42. https://doi.org/10.1016/j.cpr.2012.02.004

65. Shireen L Rizvi, Linda A Dimeff, Julie Skutch, David Carroll, and Marsha M Linehan. 2011. A Pilot Study of the DBT Coach: An Interactive Mobile Phone Application for Individuals With Borderline Personality Disorder and Substance Use Disorder. *Behavior Therapy* 42, 4 (2011), 589–600. https://doi.org/10.1016/j.beth.2011.01.003

66. Shireen L Rizvi, Christopher D Hughes, and Marget C Thomas. 2016. The DBT Coach Mobile Application as an Adjunct to Treatment for Suicidal and Self-Injuring Individuals With Borderline Personality Disorder: A Preliminary Evaluation and Challenges to Client Utilization. *Psychological Services* 13, 4 (2016), 380–388. https://doi.org/10.1037/ser0000100

67. Caryn Kseniya Rubanovich, David C Mohr, and Stephen M Schueller. 2017. Health App Use Among Individuals With Symptoms of Depression and Anxiety: A Survey Study With Thematic Coding. In *JMIR Mental Health*. https://doi.org/10.2196/mental.7603

68. Randy A Sansone and Lori A Sansone. 2011. Gender Patterns in Borderline Personality Disorder. *Innovations in Clinical Neuroscience* 8, 5 (2011), 16–20. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3115767/

69. Jeff Sauro. 2011. Measuring Usability With The System Usability Scale (SUS). (2011). https://measuringu.com/sus/

70. Stephen M Schueller, Jason J Washburn, and Matthew Price. 2016. Exploring Mental Health Providers' Interest in Using Web and Mobile-Based Tools in Their Practices. *Internet Interventions* 4, 2 (2016), 145–151. https://doi.org/10.1016/j.invent.2016.06.004

71. Colleen Stiles-Shields, Enid Montague, Emily G Lattie, Mary J Kwasny, and David C Mohr. 2017. What Might Get in the Way: Barriers to the Use of apps for Depression. *Digital Health* 3 (2017). https://doi.org/10.1177%2F2055207617713827

72. Anselm Strauss and Juliet Corbin. 1967. *Discovery of Grounded Theory*. Citeseer.

73. Victor J Strecher, Matthew Kreuter, Dirk-Jan Den Boer, Sarah Kobrin, Harm J Hospers, and Celette S Skinner. 1994. The Effects of Computer-Tailored Smoking Cessation Messages in Family Practice Settings. *Journal of Family Practice* 39, 3 (1994), 262–270. https://www.ncbi.nlm.nih.gov/pubmed/8077905

74. Anja Thieme, John Mccarthy, Paula Johnson, Stephanie Phillips, Jayne Wallace, Siân Lindley, Karim Ladha, Daniel Jackson, Diana Nowacka, Ashur Rafiev, Cassim Ladha, Thomas Nappey, Mathew Kipling, Peter Wright, Thomas D Meyer, and Patrick Olivier. 2016. Challenges for Designing New Technology for Health and Wellbeing in a Complex Mental Healthcare Context. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2136–2149. https://doi.org/10.1145/2858036.2858182

75. SM Turner, DC Beidel, SA Spaulding, and JM Brown. 1995. The Practice of Behavior Therapy: A National Survey of Cost and Methods. *Behaviour Therapist* 18 (1995), 1–1.

76. G Verbeke and G Molenberghs. 1997. *Linear Mixed Models in Practice: a SAS-Oriented Approach*. Vol. 126. Springer-Verlag New York, LLC, New York, NY.

77. John T Vessey and Kenneth I Howard. 1993. Who Seeks Psychotherapy? *Psychotherapy: Theory, Research, Practice, Training* 30, 4 (1993), 546. `http://doi.org/10.1037/0033-3204.30.4.546`

78. Bruce E Wampold and Zac E Imel. 2015. *The Great Psychotherapy Debate: The Evidence for What Makes Psychotherapy Work*. Routledge.

79. Philip S Wang, Michael Lane, Mark Olfson, Harold A Pincus, Kenneth B Wells, and Ronald C Kessler. 2005. Twelve-Month Use of Mental Health Services in the United States: Results From The National Comorbidity Survey Replication. *Archives of General Psychiatry* 62, 6 (2005), 629–640. `https://doi.org/10.1001/archpsyc.62.6.629`

80. Rui Wang, Andrew T Campbell, and Xia Zhou. 2015. Using Opportunistic Face Logging from Smartphone to Infer Mental Health: Challenges and Future Directions. In *Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers*. ACM, 683–692. `https://doi.org/10.1145/2800835.2804391`

81. Tyler Watson, Scot Simpson, and Christine Hughes. 2016. Text Messaging Interventions for Individuals With Mental Health Disorders Including Substance Use: A Systematic Review. *Psychiatry Research* 243 (2016), 255–62. `https://doi.org/10.1016/j.psychres.2016.06.050`

82. Joseph Weizenbaum. 1966. ELIZA - A Computer Program for The Study of Natural Language Communication Between Man and Machine. *Commun. ACM* 26 (1966), 23–28. `https://doi.org/10.1145/365153.365168`

83. Kathleen M Wright, Oscar A Cabrera, Paul D Bliese, Amy B Adler, Charles W Hoge, and Carl A Castro. 2009. Stigma and Barriers to Care in Soldiers Postcombat. *Psychological Services* 6, 2 (2009), 108. `http://doi.org/10.1037/a0012620`