Machine learning for Precise Targeting of a Mobile Dialectical Behavior Therapy Skills Training Application

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ABSTRACT

A formative study of a mobile application for introducing skills related to Dialectical Behavior Therapy (DBT) is reviewed with an eye toward next iteration design. DBT is considered the gold standard for the treatment of suicide and borderline personality disorder, among other complex behavioral disorders. A multidisciplinary design team took licensed material from the creator of DBT, Marsha Linehan, and appropriated it for the mobile phone format and context of use. We walk through the design of the application including a conversational agent ("eMarsha"), videos of Dr. Linehan discussing therapeutic concepts and skills, and a module focusing on Mindfulness training. Initial evaluation of the app was encouraging with almost all users liking the flow and conversational user interface. In this paper, we focus on future work and the use of machine learning for precision psychology.

Author Keywords

Clinical psychology; therapy; mobile applications; suicide prevention; gamification; evaluation.

ACM Classification Keywords

H.5.1. Multimedia Information Systems; H.5.2. User Interfaces.

INTRODUCTION

Over the past 30 years, numerous evidence-based treatments (EBTs) have emerged for various psychological disorders. However, consumers of mental health treatments rarely receive these interventions as they were intended—if at all, Wang, [1], Kohn [2]. For example, 5.2 million Americans in need of psychological services did not receive treatment in 2010, based on a report from the Substance Abuse and Mental Health Services Administration (SAMHSA) [3]. There are numerous reasons for this science-to-service gap, which include, dearth of practitioners trained in EBTs, expense of logistics of transitioning an EBT from the research lab to community practice, the high cost of face-to-face psychotherapy, high cost of maintaining fidelity of to the treatment model, and stigma that keep people from professional help, Lyons [4], Wright, [5].

Technology delivered treatments have emerged as a potential solution to reduce the aforementioned barriers to dissemination. Interventions delivered through technologies can have several advantages, such as requiring little training, being less tiring, remaining at fidelity, and being available to anyone with a computer or mobile device with an Internet connection, Richards, [6], Ybarra, [7]. Furthermore, for the consumer, interventions delivered through technological devices offer relative anonymity, potentially increasing uptake, Whiteside [8], as well as more reliable and honest disclosure, Classen, [9], Gega [10], Gilat, [11].

Despite the potential of technology delivered treatments, there are considerable pitfalls. For example, treatment attrition has been found to be particularly high for Internet-delivered cognitive behavior therapy (CBT) in which clients are self-directed without therapist support or coaching, Aboujaoude [12]. In addition, the bulk of computer delivered psychotherapy is formatted very similarly to face-to-face psychotherapy, in which clients sit in front of their computers once a week and go through a guided module of psychotherapy. Technology delivered treatments have the capacity to be much more flexible in terms of accessibility and usability (i.e., behavior change in all relevant environmental contexts). One solution has been to further adapt interventions that can be delivered via mobile devices (e.g., Mobile health or mHealth). Taken together, technology assisted and delivered treatments shows great promise in reducing psychological distress; however, greater innovation and flexibility is needed to increase its potential.

The bulk of computerized interventions are modeled from CBT [x], which is a good fit for computerization due to its

protocoled nature, didactic focus, and large evidence-base. While CBT has a strong evidence base for a variety of disorders including anxiety, depression, and even addictive behavior, it is only designed to treat individuals with very little clinical complexity or severity. Dialectical behavior therapy, DBT; Linehan, [13], on the other hand, is a modular, transdiagnostic treatment originally developed for complex, difficult-to-treat, and highly suicidal individuals. DBT is hierarchical such that treatment is tailored to prioritize clinical targets based on risk and severity; therefore, treatment can encompass very complex and high risk clients as well as low risk, single disordered clients.

Since its inception, DBT has been applied to individuals who meet criteria for borderline personality disorder (BPD), addictive behavior, treatment resistant depression, and so on. A growing body of research on individuals with high emotion dysregulation supports the DBT skills deficit model, which suggests that the absence of or inability to emit critical skills leads to and/or maintains dysfunctional behavior. This model has been supported in research that has identified DBT skills use as a mediator for improvements in suicidal behavior, expression of anger, and interpersonal problems in BPD, Neacsiu [14]. An important question that still needs to be addressed more fully is whether a mobile treatment that focuses on emotion regulation and behavioral skills acquisition is acceptable and feasible among individuals enrolled in DBT.

PocketSkills Program

The PocketSkills program was developed by an interdisciplinary design team including clinical psychologists, HCI experts, mobile app developers and designers. The content was broadly sampled from Linehan's DBT Skills training manual and workbooks, Linehan [14], which was licensed to us for the application development of PocketSkills. For this initial usability iteration, only the Mindfulness module and the Diary Card from DBT were included in the application.

PocketSkills is built as a web application designed for the small screens of mobile devices. Being built solely from HTML, JavaScript, and CSS allows it to be reachable by a wide variety of devices (iPhones, Android phones, Windows phones, tablets, etc.) without requiring a separate app download from the respective App Stores. Being a web application also has the benefit of allowing us to make instant updates to the app without relying on end-users to update anything on their phones, which is especially important given the sensitive nature of our content and audience. The only real drawback of being a web application is that it requires an Internet connection from the users' mobile device; however, we did not see this as an unreasonable expectation.

Behind the scenes, we are using Windows Azure to host the web application server and the database storing the app content and user data. All of the content in Pocket Skills is stored in this database (such as everything the conversational

agent says and all of the videos), which allows our designers to make changes to the content without having to rebuild/redeploy the app. Users are required to sign in with a Windows Live ID (a.k.a. Microsoft Account), as well as to have an invitation code to access the app. The Live IDs and invitation codes were kept separate, so that the clinician giving out the invitation codes doesn't know the user's Live ID in the database, and the developer(s) with access to the database also did not know who received which invitation codes.

User Interface Design

We decided to use a very simple, clean, navigation model for the user interface, so that users could always easily find their way back to the initial home screen, or hub. The user was represented by an avatar of their own choosing, and the conversational agent used was always an image of Dr. Marsha Linehan.

We decided to use a conversational user interface with "eMarsha", an avatar in the image of Marsha Linehan. We made this choice because we wanted the user experience to feel similar to therapy---not to replace therapy but more be an extension of it. Figure 1 is an example of the conversational flow used in the user interface.
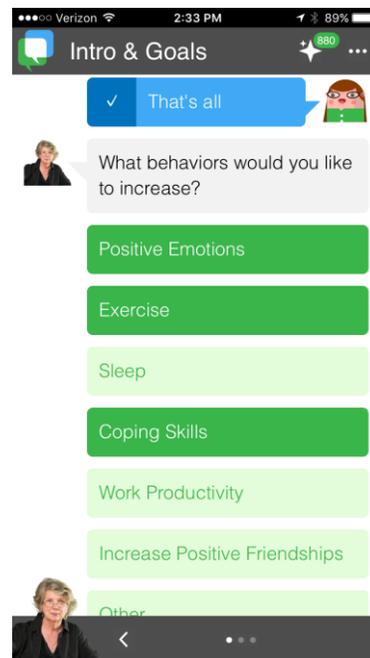

Figure 1. An example of the conversational flow used in the user interface. The user often simply had to make choices from a list to indicate which skills they wanted to work on.

For this version of the app, only the Mindfulness module was used. For example, for the skill Observe, users could choose between observing visuals, sounds or breathing. An example screenshot of preparing to Observe Visuals and the accompanying visual cue are provided in Figure 2.
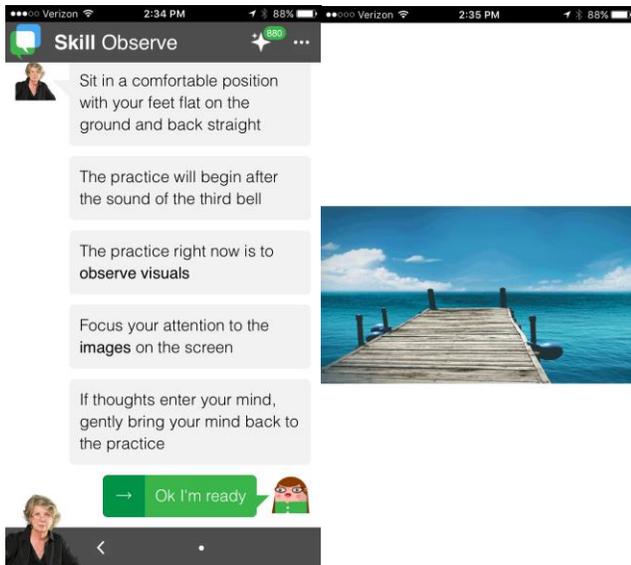
Figure 2. An example screenshot of the Observe Visual dialog and imagery.

The Diary Card, a key design element for PocketSkills and DBT, is shown in Figure 3. Participants were encouraged to fill out their Diary Cards every day. The Diary Card allowed users to rate their emotions on a 10-point scale. It also allowed them to track progress against the behaviors that they wanted to increase and/or decrease (based on their choices in their first "Intro & Goals" conversation with eMarsha). The participants were able edit their daily diary card as often as they wished each day, but a new diary card was created every 24 hours. Feedback from some users suggested that it may have not been clear that editing a diary card was possible, or whether going back to the diary card in the app constituted a new diary card or not. Despite these usability issues, each edit to the diary card was logged as a separate event in our database whether it was used once daily or multiple times per day, and the clinician was able to monitor this data in real-time.

FUTURE DIRECTIONS

Given the substantial treatment gap for individuals in need of empirically supported treatment, the development and implementation of mobile tools to augment and even supplant treatment can reduce the burden by increasing access to treatment tools. Nonetheless, research is needed to better understand how technology can be deployed to ease the burden, particularly for individuals diagnosed with complex emotional and/or behavioral disorders. While we saw trends of decreased emotional intensity as reported on the daily diary card, we need better methods of evaluating the state and trait level reductions in emotion dysregulation on a larger sample of participants. Along those lines, we are interested in deploying PocketSkills to a larger and more heterogeneous audience, including individuals with differing clinical diagnoses and enrolled and not enrolled in therapy. A larger deployment will enable us to investigate several new directions for the technology.

Tracking: In addition to gathering data from diary entries we can use free sensing techniques from the phone (e.g., GPS, phone activity, human movement, physiology etc.) to quantitatively measure changes in behavior. Data such as this could be useful to both patients and clinicians. For example, as someone progresses through, and practices, the DBT skills their condition will hopefully improve and result in more frequent interactions with people or trips out of the house. We could give participants a choice to track trends in their behavior to help inform them of their progress. They may choose to share this data with their clinician to help with the treatment plan--some may even want to share this type of data with loved ones. We can develop visualizations around these signals to make them more interpretable and informative.

Insights: Once we have these data we can then leverage machine learning techniques to see which aspects of DBT work for which people in which contexts. Further, we can begin to be able to make predictions about how a user is feeling in a given context, or even predict when they are about to do something—positive or negative. Machine learning methods may be able to detect complex combinations of behaviors (features) that would be difficult for a clinician to identify, especially given the heterogeneous nature of depression. Longitudinal, person-specific models are likely to be necessary.

Interventions: We will evaluate psychometrically validated clinical outcomes to determine the initial clinical efficacy of PocketSkills. Since the goals users provide in the app are around behaviors they would like to increase or decrease, we may be able to employ just in time interventions that help them reach their goals. For example, notifying a participant of a relevant intervention when they are predicted to do something negative in the future or reinforce a positive behavior that they are starting to exhibit more frequently.

CONCLUSION

We introduced PocketSkills, a mobile application to assist DBT patients in practicing their skills when they are outside of the therapist's office. In a formative usability study over two weeks, we observed how patients used the application and collected their usability issues, as well as what they did and did not like about the application. Overall, users found the application to be useful and were satisfied with the clinical utility of the tool. However, users indicated that they wanted more direct access to specific skills and videos. To that end, enabling non-conversational navigation options might also be necessary, depending on the user. For our next design iteration, we are adding the Emotion Regulation module and Addiction skills from the Distress Tolerance module of DBT, and resolving the usability issues.

In the next iteration, we plan to integrate more in-depth logging of signals and introduce tracking and predictive tools that leverage machine learning techniques to help users gain greater insights into their treatment. In the future, this will allow us to personalize the timing of interventions and help

people reach their goals more quickly. It will also help us to determine which aspects of DBT are helping which people and in what contexts, over time.
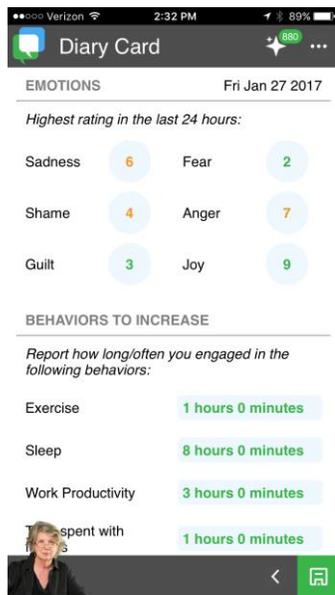

Figure 3. An example screen shot of the Diary Card, which users were encouraged to fill out daily (they could fill it out multiple times per day if they wanted).

In summary, PocketSkills appears to be a promising tool to increase coping skills in a clinical population enrolled in DBT. Future research is needed in order to evaluate the clinical efficacy of PocketSkills as well as increase its applicability and usefulness as a clinical tool.

ACKNOWLEDGMENTS

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