



A Pilot Study of the DBT Coach: An Interactive Mobile Phone Application for Individuals With Borderline Personality Disorder and Substance Use Disorder

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Dialectical behavior therapy (DBT) has received strong empirical support and is practiced widely as a treatment for borderline personality disorder (BPD) and BPD with comorbid substance use disorders (BPD-SUD). Therapeutic success in DBT requires that individuals generalize newly acquired skills to their natural environment. However, there have been only a limited number of options available to

achieve this end. The primary goal of this research was to develop and test the feasibility of the DBT Coach, a software application for a smartphone, designed specifically to enhance generalization of a specific DBT skill (opposite action) among individuals with BPD-SUD. We conducted a quasiexperimental study in which 22 individuals who were enrolled in DBT treatment programs received a smartphone with the DBT Coach for 10 to 14 days and were instructed to

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use it as needed. Participants used the DBT Coach an average of nearly 15 times and gave high ratings of helpfulness and usability. Results indicate that both emotion intensity and urges to use substances significantly decreased within each coaching session. Furthermore, over the trial period, participants reported a decrease in depression and general distress. Mobile technology offering in vivo skills coaching may be a useful tool for reducing urges to use substances and engage in other maladaptive behavior by directly teaching and coaching in alternative, adaptive coping behavior.

BORDERLINE PERSONALITY DISORDER (BPD) is a severe Axis II personality disorder characterized by intense and significant instability across a number of domains, including mood, interpersonal relationships, self-image, and behavioral control. While affecting less than 6% of the general population (Grant et al., 2008; National Institute for Health & Clinical Excellence, 2009) and approximately 7% in primary care settings (Gross et al., 2002), the prevalence rate is considerably higher among those who seek mental health services, up to 11% of outpatient services (Kroll, Sines, & Martin, 1981; Kullgren, 1992; Modestin, Abrecht, Tschaggelar, & Hoffman, 1997; Widiger & Frances, 1989; Widiger & Weissman, 1991), and up to 50% of inpatients (Geller, 1986; Sansone & Sansone, 2007; Surber et al., 1987; Swigar, Astrachan, Levine, Mayfield, & Radovich, 1991; Woogh, 1986). Costs associated with these services are high (Bender et al., 2001; Soeteman, Hakkaart-van Roijen, Verheul, & Busschbach, 2008; Van Asselt, Dirksen, Arntz, & Severens, 2007). In one U.S. study, the total annual cost to treat 14 BPD clients in a public sector community clinic was estimated at \$645,000, an average of \$46,701 per patient (American Psychiatric Association, 1998). A much larger recent Canadian study of 175 BPD patients estimated the average total per patient 12 months prior to treatment at \$18,744 CAD (approximately US\$18,231; Guimond et al., 2010). In the Netherlands, total bootstrapped annual cost estimates per BPD patient was calculated at 16,852 Euros (approximately US\$22,032; Van Asselt et al., 2007).

Furthermore, BPD commonly co-occurs with substance use disorders (SUDs), resulting in even greater dysfunction and risk of completed suicide (Cacciola, Alterman, Rutherford, McKay, & Mulvaney, 2001; Kosten, Kosten, & Rounsaville, 1989; Skodol, Oldham, & Gallaher, 1999; Stone and, 2009). The co-occurrence between BPD

and SUDs is second only to mood and antisocial personality disorder in comorbidity prevalence (Widiger & Trull, 1991). In their extensive review of BPD–SUD comorbidity data gathered from studies published between 1987 and 1997, Trull, Sher, Minks-Brown, Durbin, and Burr (2000) found that among individuals seeking substance abuse treatment, rates of BPD range from 5.2% (Brooner, King, Kidorf, Schmidt, & Bigelow, 1997) to 65.1% (Dejong, Van Den Brink, Harteveld, & Van Der Wielen, 1993). Conversely, prevalence of current SUDs among clients receiving treatment for BPD range from approximately 25 to 67% (Dulit, Fyer, Haas, Sullivan, & Frances, 1990).

Dialectical behavior therapy (DBT; Linehan, 1993) is a well-established efficacious treatment for BPD, including individuals with comorbid SUD. To date, four randomized controlled trials (RCTs) conducted across three research institutions support DBT's efficacy in the treatment of BPD–SUD (Linehan, 2010; Linehan et al., 1999, 2002; Van Den Bosch, Verheul, Schippers, & Van Den Brink, 2002; Verheul et al., 2003). DBT is a multimodal, principle-based behavioral treatment that includes individual therapy, skills training (to enhance the individual's capability through acquisition and strengthening of effective behavioral responses), a therapist consultation team, and as-needed phone consultation. The primary function of phone consultation is to facilitate generalization of skillful behaviors to the client's natural environment. The implicit assumption in phone consultation is that it is better for clients to contact their DBT individual therapist for skills coaching *during* a crisis and *before* engaging in dysfunctional behavior rather than *after* the crisis and (often) following dysfunctional behavior (Linehan, 1993).

Recent research has illustrated the relative importance of DBT skills training for individuals with BPD. Specifically, Koons et al. (2006) provided skills training to a group of 12 clients with BPD. Significant improvements in anger expression, control of anger expression, work role satisfaction, and number of hours worked weekly were found between pretreatment and the 6-month follow-up among the eight treatment completers (Koons et al., 2006). More recently, Neacsu, Rizvi, and Linehan (2010) examined the role of behavioral skills in improving treatment clinical outcomes in a sample of 108 BPD women participating in one of three randomized clinical trials of DBT. Skills use was assessed throughout the 12-month treatment and at a 4-month posttreatment follow-up. Participants treated with DBT reported using three times more behavioral skills by the end of treatment compared

to those assigned to a control treatment. Importantly, DBT skill use mediated the decrease in suicide attempts and depression, and the increase in control of anger, and partially mediated the decrease in nonsuicidal self-injury over time. These findings suggest that skills acquisition and practice may be an important mechanism of change in DBT.

One mechanism by which skills acquisition and generalization can occur is via mobile technology. Mobile technology is a burgeoning field and provides a multitude of opportunities for behavior therapy research and practice. It is estimated that by mid-2011, in the United States alone, there will be over 300 million mobile phone users, with half that number having "smart" phones (Rocha, 2009). Given the high prevalence of mobile phone use, the myriad of indispensable functions performed by mobile phones, and the fact that most people carry their mobile phones at all times and have immediate access to them, mobile technology is poised to become the most powerful form of media to influence clinical practice within the next several years (Fogg & Eckles, 2007). For these reasons, it seems probable that a mobile phone application could be developed as an adjunct to standard DBT with the explicit purpose of encouraging and facilitating the use of DBT skills in severely disordered individuals with BPD and SUD.

The purpose of this research was to develop and test the feasibility and outcomes of using mobile phone technology as an adjunct to standard DBT to facilitate the use of DBT skills by those with BPD and SUD within their natural environment. Specifically, we were interested in determining whether clients with BPD and SUD who are currently receiving comprehensive DBT would use a mobile phone application designed to provide DBT skills coaching, how they would react to it, and whether its use would be associated with better outcomes. Our decision to leverage mobile technology was based on the burgeoning empirical support of mobile technology to facilitate robust behavior change (Dimeff, Paves, Skutch, & Woodcock, 2010; Fogg & Eckles, 2007) and by the National Institute on Drug Abuse's (NIDA) strategic initiative to leverage technology in the dissemination of evidence-based therapies (National Institute on Drug Abuse, 2009).

The first phase of this project involved developing the DBT Coach mobile phone application using an iterative process of development. This process involved extensive feedback from DBT experts, including the treatment developer (Linehan), target end-users (individuals with BPD and SUD engaged in DBT treatment), and their DBT clinicians. The

initial DBT Coach (1.0) was designed to provide coaching in the DBT skill of opposite action (OA; Linehan, *in press*). OA, an emotion regulation skill, is a behavioral approach to changing unwanted negative emotions in the moment by behaving in ways that are counter to the emotion's action urge. Next, we conducted a within-subjects pre-post design ($n=22$) to evaluate the feasibility of the DBT Coach with BPD-SUD clients receiving comprehensive DBT. Participants were provided with a phone installed with the DBT Coach app for 10 to 14 days between evaluations. We hypothesized that participants would (a) provide high ratings of acceptability and satisfaction with the prototype, (b) report a decrease in emotional intensity and urges to use substances as a result of using the DBT Coach for in vivo skills assistance, and (c) report lower overall distress at the end of the trial.

Method

PARTICIPANTS

Participants were 22 clients currently enrolled in standard DBT outpatient treatment programs. The average age was 33.86 years ($SD=10.27$). Other demographic information is included in Table 1. Inclusion criteria for participants were as follows: met criteria for BPD and SUD (including nicotine

Table 1
Participant Demographic Information

Gender	
Female	81.8%
Ethnicity	
Caucasian	77.3%
Asian American	13.6%
Native American	9.1%
Education	
High school diploma or less	13.6%
Some college	45.4%
College degree	31.8%
Graduate or higher	4.5%
Employment	
Employed	40.9%
Annual income	
Less than 15,000	70%
15,000–30,000	15%
30,000–50,000	10%
>50,000	5%
Marital status	
Single, never married	54.5%
Married	9.1%

dependence) per clinician report¹ and aware that they had these diagnoses, had been in DBT treatment for at least 2 months, planned to remain in DBT for the next 30 days, and had been previously taught the DBT skill OA. Exclusion criteria were age under 18 years and other conditions that likely would have made them ineligible for DBT treatment in general (e.g., life-threatening anorexia, active psychotic symptoms).

RECRUITMENT

Participants were recruited from three outpatient comprehensive DBT programs in the Pacific Northwest. The research team initially oriented the clinic leader to both the DBT Coach application and the research protocol. If the clinic leader was in support of the trial and willing to participate, the research team then met with clinic therapists who were interested in supporting the study and had clients meeting inclusion criteria to orient them to the DBT Coach and the trial protocol. Therapists were then asked to distribute recruitment information via a flyer to those clients the therapist determined met inclusion criteria. Interested clients called the research office for further screening and consent procedures. All procedures were approved by a local IRB and an independent Data Safety and Monitoring Board organized by the researchers to ensure safety for participants and adherence to IRB-approved protocols.

PROCEDURES

After screening and consenting procedures were completed, participants met with a research assistant (RA) at their treatment facility to complete the baseline ("pretrial") assessment and to receive an introduction to the DBT Coach. Participants were given the DBT Coach program installed on a Nokia Series 60 platform smartphone (with all other features disabled), and instructions in its use were provided. Participants were given the phone for a period of 10–14 days and instructed to use the DBT Coach and Follow-Up DBT Coach as often as they wanted during this time. Participants were also instructed to complete a brief questionnaire on the phone each day (see Daily Assessment section, below). A second ("posttrial") assessment was scheduled and participants were instructed to call the RA if they experienced any technical problems with the phone.

¹ Diagnostic interviews were not conducted to determine SUD. In preliminary screening, 9% of the sample reported problems with alcohol, 18% reported using marijuana on a regular basis, 13.5% reported using methamphetamines and/or painkillers on a regular basis, and 72% reported regular cigarette use.

The posttrial assessment was again conducted at the participant's DBT treatment facility; participants returned the phone and completed assessment instruments. In addition, the first author called the participants' therapists each week to ensure that the addition of the phone to the clients' treatment and the implementation of the trial at the clinic were not causing any unanticipated clinical problems, such as increasing suicidality or unmanageable frustration. This procedure was included because, given the novelty of the DBT Coach and the severity of the clinical population, we wished to closely monitor the presence of any potential adverse effects.

Participants were compensated up to \$170 for participating according to the following protocol: individuals received \$150 if they completed at least 75% of the daily assessments, or \$75 if they completed less than 75%. Participants received \$20 for completing the final assessment. Finally, all payment was contingent on returning the phone. This strategy was executed in order to increase compliance with the assessments as well as to increase the likelihood that the phones would be returned. Participant payment was not contingent on frequency of use of the DBT Coach.

Finally, therapists were asked to complete a brief questionnaire about their client's behavior before and during the trial. Therapists were given the questionnaires and provided with self-addressed stamped envelopes to return to our research center. Reminder calls were made every 2 days to ensure that questionnaires were completed and returned in a timely manner.

MEASURES

DBT Coach Data

Every time the DBT Coach was activated by the user, answers to questions were recorded into a data file on the phone and downloaded at the end of the trial. Questions included ratings of emotional intensity and urges to use substances (0–10 scale) at the beginning and end of each DBT Coach session (see below). In addition, ratings of emotional intensity entered during use of the Follow-Up DBT Coach were also recorded.

Daily Assessment

Users were asked to complete a short (less than 1 minute) questionnaire at the end of each day that they had the phone. Participants were asked to rate their highest urge to use substances on that day on a 0–10 scale. In addition, they rated how helpful the DBT Coach was that day in helping them with OA and how helpful OA was that day (with or without using the DBT Coach), both on a 1–5 Likert scale where 1 (*not helpful*) and 5 (*very helpful*).

Satisfaction and Usability Survey

This face-valid 16-item instrument examines several dimensions of usability of the Coach including ease of use, appearance, overall functionality, and acceptability for people with BPD–SUD. Respondents indicate level of agreement with items on a 5-point Likert scale ranging from 0 (*not helpful or not relevant*) to 5 (*extremely helpful or extremely relevant*). This survey was administered only at posttrial and its internal consistency was $\alpha = .90$.

Behavioral Confidence Questionnaire

This 7-item self-report measure, developed by the investigators, assesses confidence in executing various components of the skill of OA (e.g., “I feel confident in my ability to identify my emotional action urges”) and was administered at both pre- and posttrial. Items are recorded along a 5-point Likert scale, where 1 (*not confident*), 3 (*moderately confident*), and 5 (*very confident*). For use in analyses, a mean confidence scale was calculated. Cronbach's α was .81 for pretrial and .90 for the posttrial.

Beck Depression Inventory

The Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) is a 21-item extensively used and validated multiple-choice self-report measure used to measure the severity of depression. The BDI was administered at pre- and posttrial assessments. Cronbach's α yielded good internal consistency: .84 at pretrial and .89 at posttrial.

Brief Symptom Inventory

The Brief Symptom Inventory (BSI; Derogatis, 1975) is a 53-item self-report instrument covering nine symptom dimensions, as well as three global indices of distress. The BSI is the short version of the SCL-R-90 (Derogatis, 1977) and was administered at both time points. The BSI had excellent internal consistency in this sample: $\alpha = .95$ at pretrial and .97 at posttrial. We used the total score, the Global Severity Index, as an indication of overall psychopathology for this study.

Therapist Questionnaire

DBT therapists with clients participating in the trial were asked to complete questions at pretrial and posttrial. Therapists were asked to rate on a Likert scale (a) their client's skill use generally, and (b) their client's use of OA specifically over the past 2 weeks (at pretrial) and since they had the DBT Coach (at posttrial), where 1 (*poor*), 3 (*average*), and 5 (*effective*). In addition, therapists were asked to provide a count of the number of phone calls they received from their client over the past 2 weeks (pretrial) and since they had the DBT Coach (posttrial).

DBT COACH APPLICATION

The DBT Coach application was installed on Nokia Series 60 platform smartphones where it appeared as a program icon on the devices' home screen. Selecting the icon via a soft-key launched the DBT Coach application on the device. The DBT Coach first assessed the clients' ratings of emotional intensity and urges to use drugs on a 0–10 scale (this constitutes the “precoach” variables referenced in analyses). Users were then asked to identify the emotion they were currently experiencing that led to an emotion-specific branching of possible responses from the DBT Coach. Next, users were asked whether they were willing to work on changing the emotion. If yes, they were directed to specific coaching in the use of OA (Linehan, in press). If no, several screens help the user evaluate the pros and cons of changing the emotion. In cases where users were still not willing to work on reducing their emotion, the program instructed them to call their therapist. Once willingness was established, users were asked to indicate a specific action urge they experienced in response to the emotion from a list of emotion-specific options. Next, an easily scrollable list of emotion-specific OA behaviors was provided and users were encouraged to choose an action. Finally, users received additional coaching and reminders on how to do OA. Before concluding use of the DBT Coach, users were instructed to again rate their emotional intensity and urges to use drugs (the “postcoach” variables in analyses). The possible number of steps users would go through for the DBT Coach session ranged from 12 to 20. See Fig. 1 for examples of “screen shots” from the application.

Additionally, the DBT Coach provided definitions and more information on key terms by means of pressing a soft-key. For example, pressing a soft-key for “effective” would produce a new screen with its definition (“an emotion is effective if having it is doing something good for you in both the short AND the long term. Sometimes an emotion can be justified but the intensity of it is too high to be effective”). These definitions were intended to complement what users had already learned in skills group, but may have forgotten.

An additional Follow-Up DBT Coach feature could also be launched via an icon on the home screen. At any point after the initial coaching, participants were encouraged to access this Follow-Up DBT Coach feature to assess their progress on applying OA and to receive additional coaching, if desired. The Follow-Up DBT Coach would again assess the user's level of emotional intensity. If the emotional intensity has decreased since the last use, a positive statement was provided (e.g., “That's

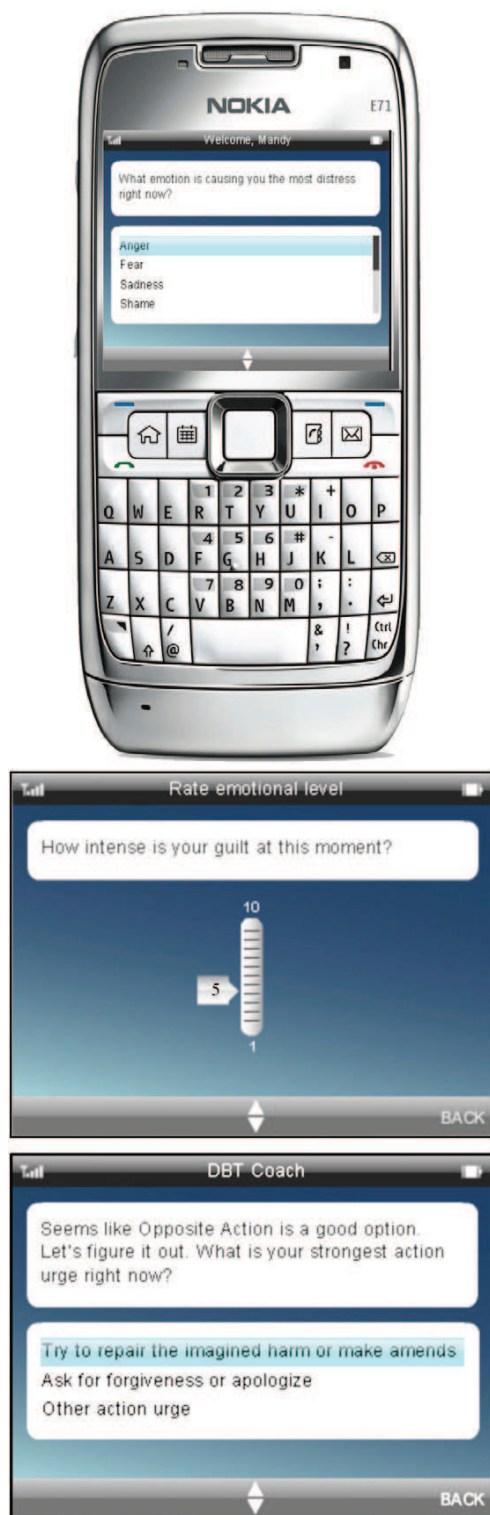


FIGURE 1 Examples of screen shots from the DBT Coach for the skill of Opposite Action.

good news” or “Great job being effective”). If the emotional intensity was equal to or higher than their initial coach use, the program would generate a statement (“So you’re still feeling [emotion]” or “Ok, it may help to try opposite action again”) and users were invited to review the OA content again. Those who opted for this review advanced to the emotion-specific OA list. If not, the program stated “Sorry this isn’t more helpful right now. Please come back if you want to try the Coach again later. You can always call your therapist for help” before exiting. Users were also asked to indicate whether the overall coaching was helpful. Due to a programming error, only emotional intensity was assessed during the Follow-Up DBT Coach session. Urges to use substances were not assessed at this time.

DATA ANALYSIS

Due to the longitudinal nature of our design, which produced a multilevel data structure (repeated measures nested within individuals), hypotheses about effects of the coaching application were tested using a random coefficients regression framework with the hierarchical linear modeling statistical package (HLM6; Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2004). Hierarchical linear modeling (HLM) allows for comparison of differences over the course of the use of the coach, after considering within-individual variability in the outcomes (Raudenbush & Bryk, 2002). These analyses offer statistical advantage over *t* tests because they use full estimation maximum likelihood (FEML) to account for missing data and because they handle unbalanced designs efficiently, which allows the number of observations to vary across participants.

The first series of HLM analyses examined the effects of the DBT Coach within the immediate coaching session, that is, does use of the coach produce an immediate effect on emotional intensity and urges to use substances? We did this by comparing the precoach ratings to the postcoach ratings. The second series of HLM analyses examined the more distal effects of the DBT Coach by comparing the precoach ratings of emotional intensity to the Follow-Up DBT Coach ratings of emotional intensity for the subset of instances in which follow-up ratings were collected. Two models were examined for each outcome. The first model was the HLM model with no predictors (null, or unconditional, model). Results from this model were used to calculate the intraclass correlation coefficient (ICC), which is the proportion of between-individual variance to the total variance. The second model included the time of the

assessment that was considered a Level 1 within-subjects variable. The time measurement used in the modeling was dummy coded so that 0 (*precoaching*) and 1 (*postcoaching*) for the within-coaching analyses. For the follow-up analyses, the time variable was dummy coded as 0 (*precoaching*) and 1 (*follow-up*). A significant negative time slope statistic indicates that there were significant improvements on that variable between the beginning and end of each coaching session. Comparisons between the two models identified the increase in proportion of variance explained in the outcome when time was added to the model. The proportion of explained variance provides an index of effect size (Kreft & de Leeuw, 1998).

Further, paired sample *t* tests were computed to determine whether scores on the BDI, BSI, Behavioral Confidence Questionnaire, and items from the Therapist Questionnaire changed from the beginning to end of the trial. For these *t* tests, an effect size (*d*) was estimated for dependent sample analyses, using the formula $d = t\sqrt{\frac{2(1-r)}{n}}$ (Devilly, 2005). Descriptive statistics of the Satisfaction and Usability Questionnaire were computed.

Results

GENERAL DBT COACH USAGE

Participants had the phone an average of 12.86 days ($SD=2.17$; range: 11–20). Overall, they had high compliance rates with the daily assessments with a mean participation rate of 85% ($SD=.14$) and a median of 91%. Of note, all participants returned the phone in a timely fashion. The average number of total coaching uses was 14.91 ($SD=8.40$, range: 3–31). Across all uses of the coach ($n=328$), the most commonly selected emotion was sadness (25.9%, $n=85$), followed by fear (20.7%), anger (18.0%), and shame (11.6%). Less commonly endorsed emotions were guilt (6.4%), disgust (4.9%), envy (4.9%), love (5.2%), and jealousy (2.4%, $n=8$).

General Usability and Satisfaction Results

Information gleaned from the Satisfaction and Usability Questionnaire is summarized in Table 2. Overall these results suggest that the DBT Coach was perceived as usable and helpful to participants. The mean ratings for all items were above the midpoint of the scale, indicating moderate to high degrees of satisfaction with the application. Of note is the ease with which users found the application to navigate. All 22 participants said that they would make use of the tool on their own initiative. Additional data on usability and satisfaction were gained via the Follow-Up DBT Coach. For the 176 uses of the Follow-Up

Table 2
Average Ratings on the Satisfaction and Usability Survey

Question	Mean (SD)
How much did you enjoy using the DBT Coach?	3.32 (1.21)
How helpful do you imagine this tool will be in your treatment?	3.80 (1.08)
How helpful do you imagine this tool will be to individuals with BPD–SUD?	3.95 (1.07)
How relevant was the tool to your current treatment?	3.72 (0.94)
How relevant was the tool to treatment of individuals with BPD–SUD?	4.00 (0.93)
How likely is it that you would use this tool in your treatment?	4.05 (0.90)
How well did the tool hold your interest?	3.84 (0.84)
How easy was the material to understand?	4.55 (0.96)
To what extent was the tool easy to use?	4.68 (0.65)
How easy was it to navigate the tool?	4.68 (0.57)
Overall rating of the tool in terms of helpfulness in assisting learning and practicing skills	3.80 (1.16)
Would you recommend that we continue to develop the tool?	4.68 (0.65)
If the tool were available for use by you in your treatment, would you make use of it on your own initiative?	100% yes

Note. All items, except last, rated on a 1–5 Likert scale, on which 1 (not enjoyable/helpful/relevant/likely) and 5 (extremely enjoyable/helpful/relevant likely).

DBT Coach, the users indicated that the OA coaching was helpful 96.8% of the time.

EFFECTS OF COACH ON RATINGS OF EMOTIONAL INTENSITY AND URGES TO USE SUBSTANCES

For the first series of HLM analyses, in which the effects of DBT Coach within the immediate coaching session were analyzed, ratings of emotional intensity were higher at the beginning ($M=6.83$, $SD=2.09$, $n=326$) versus the end ($M=5.69$, $SD=2.31$, $n=251$) of the brief coaching episode. As noted previously, the ratings were “nested” within participants. HLM analyses indicated that most variance was “within person” yet 22.85% of the total variation ($ICC=0.2285$) was “between person.” This suggested that, to appropriately test reduction in emotional intensity, within-person variability needed to be partitioned from between-person differences in ratings. Results from the HLM analyses, accounting for the dependence of observations, indicated that the reduction in emotional intensity from precoaching to postcoaching was significant, $B=-1.26$, $SE=0.20$, $t(21)=-6.17$, $p<.001$. Addition of this Level 1 measure explained 11.68% of the within-person variability.

Similarly, ratings of urges to use substances were higher at the beginning ($M=4.84$, $SD=3.23$,

$n=328$) versus the end ($M=3.95$, $SD=2.80$, $n=266$) of the DBT Coach session. The ICC was .5548, indicating that 55.48% of the total variation was “between person.” Results from the HLM analyses, accounting for the dependence of observations, indicate that this reduction in urges to use substances was also significant, $B=-0.92$, $SE=0.22$, $t(21)=-4.22$, $p<.001$. Adding the Level 1 measure of time explained 6.60% of the within-person variability.

In terms of the second series of analyses, only those instances of a completed Follow-Up DBT Coach use were included. Because urge to use substances was not assessed by the Follow-Up DBT Coach program, only changes in emotional intensity from the beginning of the first use (“precoach”) to the follow-up use were analyzed ($n=176$). Across these 176 uses, mean ratings of emotional intensity fell from 7.11 ($SD=2.00$) at the first use to a mean rating of 3.99 ($SD=2.23$) at follow-up. The between-subject variation in intensity accounted for 16.26% of the total variation in the null model ($ICC=0.1626$). Results from the HLM analyses indicate that the reduction in emotional intensity was significant, $B=-3.04$, $SE=0.34$, $t(21)=-9.06$, $p<.001$. When adding time as a Level 1 measure, 53.18% of the within-person variability was explained.

CLIENT AND THERAPIST REPORTS OF SKILLS USE

Both clients (via the daily assessment) and their therapists (via the therapist questionnaire) provided additional information regarding perceptions of skills use as a function of having access to the DBT Coach. Results indicate that clients did not change in their perception of how helpful the device was or in how helpful OA was over the course of the trial, $B=-0.02$, $SE=0.02$, $t(21)=-1.14$, $p=.269$ and $B=-0.01$, $SE=0.02$, $t(21)=0.67$, $p=.508$, respectively).

Data obtained from the therapists regarding their clients' use of skills and phone calls are reported in Table 3. There was a significant increase in therapist ratings of clients' use of OA at the end of the trial compared to the 2 weeks prior to the trial. However, there was no difference in therapist ratings of their client's overall skills use nor in their indications of frequency of phone calls received during the trial, compared to 2 weeks prior to the trial.

URGES TO USE SUBSTANCES OVER THE COURSE OF THE TRIAL

Using the daily assessment data, HLM analyses were computed to determine changes in highest daily urges to use substances over the course of the trial. Results

Table 3
Therapist Ratings of Clients' Skills Use and Phone Calls ($n=22$)

	Pretrial	Posttrial	<i>t</i>	<i>p</i>	<i>d</i>
	Mean (<i>SD</i>)	Mean (<i>SD</i>)			
Rating of client's skills use	3.83 (1.04)	4.12 (.63)	-1.06	.30	.28
Rating of client's OA use	3.45 (1.09)	4.26 (.70)	-2.79	.01	.84
# of client calls received	2.48 (6.55)	1.24 (1.95)	1.15	.26	.34

Note. OA=opposite action. Pretrial questions referenced the previous 2 weeks, posttrial questions referenced the time that the client had the DBT Coach. Ratings were made using the following scale: 1 (*poor*), 3 (*average*), 5 (*effective*).

from the HLM analyses, accounting for the dependence of observations, indicated that there was a significant reduction in urges to use over the course of the trial, $B=-0.11$, $SE=0.05$, $t(21)=-2.26$, $p=.035$.

PRE-POST TRIAL RESULTS

Participants demonstrated a significant increase in their confidence in their ability to identify the different components of OA and their ability to appropriately use OA when needed. At pretrial, the mean confidence rating was 2.86 ($SD=.67$) and at posttrial, the mean rating was 3.35 ($SD=.93$), $t(21)=2.93$, $p=.008$, $d=.59$.

Results from both measures of psychopathology indicated a significant decrease over the course of the trial. Specifically, average scores on the BDI decreased from 25.91 ($SD=9.90$) to 20.32 ($SD=10.51$), $t(21)=2.69$, $p=.014$, $d=.55$, although stayed within the moderate-severe depression range (Beck et al., 1961). Similarly, average total scores (Global Severity Index) on the BSI decreased from 1.85 ($SD=.65$) to 1.54 ($SD=.76$), $t(21)=2.49$, $p=.021$, $d=.43$. These BSI scores reflect a moderate level of symptomatology and are similar to scores obtained in other studies of BPD (e.g., Linehan et al., 2002).

Discussion

Although mobile applications with therapy-related content are a burgeoning industry, very few of the applications that currently exist have an evidence base to support their use. Thus, this study represents one of the first to empirically test the effects of the use of a mobile phone application for psychological problems. Given the ubiquitous nature of mobile phones and emerging data that support the importance of learning and using DBT skills (Neacsiu et al., 2010), we reasoned that a mobile application capable of systematically

coaching a BPD–SUD client through proper use of DBT skills could potentiate client outcomes from DBT. Toward this end, our first step was to develop and test a prototype for a specific behavioral skill, OA, in this small feasibility pilot trial to determine whether our concept held promise. The results indicate that our pilot work was successful in many respects. All three of the hypotheses were supported.

First, with regard to acceptability and satisfaction, outcomes from the study indicate that the DBT Coach was effective and engaging. Individuals in the study reported high degrees of satisfaction with the DBT Coach and generally found it usable, interesting, and relevant. These findings are notable in that this version of the DBT Coach offered help for only one, albeit important, DBT skill. Participants also reported that they were more confident in their ability to identify the steps involved in the use of OA. Although all participants had previously been taught OA, the DBT Coach appeared to help strengthen their knowledge and self-efficacy in execution of the skill. This result indicates that the DBT Coach holds promise as a successful adjunctive tool for teaching DBT skills, in addition to facilitating generalization of DBT skills.

Our second hypothesis—that use of the DBT Coach would be associated with decreases in emotional intensity and urges to use substances—was also supported. Participants used the application an average of 15 times during the course of the trial, which translates to more than once per day. Due to the nested nature of the data, multilevel modeling was used to determine whether the DBT Coach had an immediate and more long-term effect on emotional intensity and an immediate effect on urges to use substances. Use of the DBT Coach resulted in a significant decrease in the intensity of the emotion identified as causing the most distress as well as urges to use substances following completion of the coaching session. Additionally, in those instances in which participants used the DBT Follow-Up Coach, significant reductions in emotional intensity were also found between initial use and the follow-up ratings.

With respect to the third hypothesis, participants reported a decrease in overall depression symptomatology and psychological distress over the course of the trial. Furthermore, urges to use substances decreased over the course of the trial, as measured by near daily assessments. This finding is surprising given the short nature of the trial (10–14 days), the typically chronic nature of problems within BPD–SUD that may not be susceptible to short-term change (Kullgren, 1992; Pope, Jonas, Hudson, Cohen, & Gunderson, 1983), and the fact that

depression and overall distress were not specifically targeted by the application. While it is plausible that these findings were not due to the DBT Coach, it is possible that having a tool readily available for on-demand coaching helped participants behave more skillfully more often, and that this led to a greater sense of self-efficacy and reduced problems. More research is of course necessary to replicate these findings. Such research should incorporate additional measures of self-efficacy and skills use in the context of an RCT.

Several additional findings that emerged from this trial are noteworthy. First, over the course of the trial, participants reported significant gains in their confidence about effectively applying the skill of OA. Given that self-efficacy is associated with behavior change (Bandura, 1977), this is a promising outcome. Second, coaching calls to the DBT individual therapist did not significantly change over the course of the trial. This finding is of clinical relevance as it indicates that use of the DBT Coach does not appear to be disrupting the telephone consultation mode of DBT in which clients can directly call their individual therapist for as-needed skills coaching. Third, DBT individual therapists reported an increase in their clients' use of OA over the course of the trial. It is difficult to know whether this result was an artifact of this particular study (that therapists' awareness of their clients' participation in this study created a false perception of enhanced OA skill use) or an actual effect. Future trials that include greater experimental control will help shed further light.

Despite our initial concern about giving very expensive phones to individuals with BPD and SUD for fear that they would incur damage, get lost, or be sold in order to purchase drugs, all phones were returned in immaculate condition. There are a number of potential explanations for this finding. It could be due to how we structured monetary rewards for participation in research (i.e., individuals received payment only if they came to the postsession and returned the phone). Another possible explanation is that this rate of response was a fluke of our specific sample that included a high degree of involvement from their primary DBT therapist. Of course, it is also quite feasible that individuals with BPD and SUD are not in fact more likely to engage in behavior that would compromise research integrity by losing, damaging, or selling the phones. Indeed, other mobile phone research with populations with serious mental illness has indicated that such research is feasible without significant loss or damage (e.g., Freedman, Lester, McNamara, Milby, & Schumacher, 2006). Together, these results suggest that research with individuals who have

significant psychological problems should not be hampered by unsubstantiated fears about the trustworthiness of the population.

It is important to note that the DBT Coach was not developed to replace the function or the role of the individual therapist. Neither the research design nor findings from this study address the issue of whether the DBT Coach could be used as a sole replacement for the DBT mode of phone consultation, or whether it could be used as a stand-alone self-help device. However, results from this pilot study do demonstrate how such a tool may be helpful as an adjunct to standard DBT. Since it is always available to the client, it could be an effective mechanism for a client to handle a difficult situation when he or she can't get in contact with the therapist, or when making a phone call might not be possible or preferable (e.g., at a party, in the middle of the night).

Several limitations associated with this study merit discussion. First, given the pilot nature of testing a novel intervention with a severely disordered population, we used a quasiexperimental design that limits the internal validity. In the absence of a control condition, it could be that any improvements in emotional intensity, urges to use, and psychological distress were due not to the DBT Coach but were simply a function of passage of time, distraction by doing something other than engaging in urge, other interventions that occurred in that time, or a placebo effect. Second, our sample was limited to 22 predominantly female participants in comprehensive outpatient DBT programs. Further, since individual therapists did the primary recruiting by giving fliers to potential participants, it is possible that the therapists selected clients that are not representative of the larger target group. Thus, it is unclear how these results would generalize to larger, more diverse (in terms of demographics and settings) populations. Future studies should make use of a control condition and a more diverse sample. Third, although the research procedures occurred in naturalistic treatment settings, our concern about safety resulted in the inclusion of several actions that may have also influenced the outcomes. Specifically, the fact that one of the principal investigators called therapists weekly to assess whether there had been any adverse events or to discuss implementation problems, may have inadvertently led to changes in therapist behavior that in turn may have affected their assessment of safety issues or clients' use of the DBT Coach. Most of these calls were less than 2 minutes long and consisted of the therapists informing the investigator that there had been no issues. Nevertheless, it is important to consider the

role of such research procedures in further work. Finally, this application included only one particular DBT skill, OA. It is unclear whether an application that includes multiple skills would be more or less effective. Further work is currently in progress to develop and test an expanded coach that includes more DBT skills.

The speed with which the field of mobile technology is advancing is staggering, as is our dependence on mobile phones. With this acceleration will no doubt come increased opportunities to further leverage and expand the possible uses of mobile technology in the service of behavior change. Results from this feasibility trial of DBT Coach are encouraging, as even those with severely disordered behaviors, such as BPD and SUD, like and can benefit from a mobile phone-based psychological intervention. The challenge, as we look to the future, will be ensuring that the rigorous scientific investigation of cutting edge mobile innovations keeps pace with this rapidly changing and accelerating technology (Dimeff et al., 2010).

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