Design and evaluation of a peer network to support adherence to a web-based intervention for adolescents

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ABSTRACT

Background: Depression during adolescence is common but can be prevented. Behavioral intervention technologies (BITs) designed to prevent depression in adolescence, especially standalone web-based interventions, have shown mixed outcomes, likely due to poor intervention adherence. BIT research involving adults has shown that the presence of coaches or peers promotes intervention use. Developmentally, adolescence is a time when peer-based social relationships take precedence. This study examines whether peer-networked support may promote adherence to BITs in this age group.

Objective: Adopting the framework of the Supportive Accountability model, which defines the types of human support and interactions required to maintain engagement and persistence with BITs, this paper presents a feasibility study of a peer-networked online intervention for depression prevention among adolescents. We described the development of the peer network, the evaluation of participant use of the peer networking features, and qualitative user feedback to inform continued BIT development.

Method: Two groups of adolescents (N = 13) participated in 10-week programs of the peer networked based online intervention. Adolescents had access to didactic lessons, CBT based mood management tools, and peer networking features. The peer networking features are integrated into the site by making use expectations explicit, allow network members to monitor the activities of others, and to supportively hold each other accountable for meeting use expectations. The study collected qualitative feedback from participants as well as usage of site features and tools.

Results: Participants logged in an average of 12.8 sessions over an average of 10.4 unique days during the 10-week program. On average, 66% of all use sessions occurred within the first 3 weeks of use. The number of "exchange comments", that is, comments posted that were part of an exchange between two or more participants, was significantly positively correlated with mean time spent on site ($r = 0.62$, $p = 0.032$), use of the Activity Tracker ($r = 0.70$, $p = 0.012$) and Didactic Lesson ($r = 0.73$, $p = 0.007$). Qualitative interviews revealed that adolescents generally liked and were motivated by the peer networking features during the first weeks of the intervention when general site use by group members was high. However, the decrease of site use by group members during the subsequent weeks negatively affected participants' desire to log on or engage with group members.

Conclusions: This pilot study highlights the potential that a BIT designed to harness the connection among a peer network, thereby promoting supportive accountability, may improve adolescent adherence to BITs for depression prevention.

1. Introduction

Adolescence is a critical developmental period for the onset of Major Depressive Disorder (MDD) and depression during adolescence is significantly correlated with other mental illness and psychosocial difficulties later in life (Thapar et al., 2012). In 2014, 11.4% of US adolescents had a Major Depressive Episode (MDE) in the past year (Center for Behavioral Health Statistics and Quality, 2015). Depression can be prevented (Beardslee et al., 2013, Rohde et al., 2015). However, traditional prevention programs, such as many school-based programs, incur substantial costs and logistical demands (Young et al., 2015, Brent et al., 2015), making it difficult for these programs to be widely implemented.

Behavioral intervention technologies (BITs) such as web or smartphone delivered mental health interventions can reach a large

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number of users in a cost effective manner, offering the promise of greater mental illness burden reduction (Kazdin and Blase, 2011). Adolescents are digital natives and naturally go to the internet for health information (Wartella et al., 2015). To date, BITs that aim to prevent depression in adolescents are typically web-based and designed as adjuncts to class curriculum or medical care, still requiring substantial in-person involvement by teachers or the medical care team just to implement them (Lillevoll et al., 2014, Saulsberry et al., 2013, Van Voorhees et al., 2009). This limits their scalability, and has not proven to be very effective at promoting engagement, as evidenced by low use rates. Outcomes for depression have been mixed, suggesting that non-use is part of the reason for their lack of effectiveness (Clarke et al., 2015).

BITs research involving adults has shown that the presence of coaches, who provide support to users via brief telephone calls or emails, can substantially increase use and improve outcomes (Christensen et al., 2009, Mohr et al., 2013, Andersson and Cuijpers, 2009). The Supportive Accountability model has been used to describe the elements of human support required to promote engagement and persistence with BITs (Mohr et al., 2011). The model focuses on use of the BIT such as log-ins, time spent on site etc., and not on adherence to behavioral prescriptions such as increase positive activities, monitoring one's mood, etc. In this model, effective human support may come from other users, lay coaches, or professionals, who are seen as trustworthy and benevolent. Accountability in this model is defined as the implicit or explicit expectation that an individual may be called upon to justify his or her actions or inactions. Thus, a peer network using supportive accountability would require visibility into the expected goals or tasks, such as logging in or completion of treatment elements, and the ability to monitor their completion. The construct of supportive accountability has been validated through a number of clinical trials (Dennison et al., 2014, Mohr et al., 2010, 2013, Ebert et al., 2014).

There is evidence that lay supporters are just as effective as mental health professionals (Titov et al., 2010), raising the question of whether peers can also provide the support required to promote persistent use and engagement. A feasibility study of a web-based intervention for mood management among cancer survivors that was embedded in a peer network showed high utilization rates compared to participants who received the intervention alone (Duffecy et al., 2013). Developmentally, adolescence is a time when peer based social relationships take precedence. Existing research suggests that use of social networking sites alone, especially unstructured, open enrollment and unmoderated groups such as listservs and bulletin boards, is not necessarily beneficial for adolescents, with both positive and adverse outcomes found (Rice et al., 2014; Ali, Farrer, Gulliver, Griffiths, 2015). In fact, the potential negative effects of internet interventions in general have not been adequately studied (Rozental et al., 2014, Hayes et al., 2016). The impact of social networking may depend on the intervention content, the user interaction, and the safety of the online environment (Rice et al., 2014). It is possible that BITs designed to promote supportive peer interactions among users of a structured online intervention may increase BITs adherence in this age group.

This paper describes a feasibility study of a peer-networked online intervention using principles of supportive accountability for depression prevention among adolescents. We examine use data, including the relationship between use of intervention elements and social elements, and report on user feedback interviews.

2. Methods

2.1. Recruitment

Adolescent participants were recruited from schools, community agencies, and word of mouth between April and September of 2013. Participants met inclusion criteria if they were between 14 and 19 years of age, they were familiar with the use of mobile phones,

computers and the internet, and able to speak and read English. We excluded individuals with severe depression (a score on the Center for Epidemiologic Studies Depression Scale (CESD) above 39), who were on an antidepressant medication, diagnosed with any medical conditions for which participation is either inappropriate or dangerous, or were suicidal (had ideation, plan, and intent). Adolescents who were older than the age of 18 provided consent, while adolescents who were under the age of 18 provided assent to participate while their parent/guardian provided consent. The Northwestern University Institutional Review Board approved study procedures.

2.2. Procedure

Two peer networked groups were run with the primary aims of 1) evaluating participant use of peer networking features, and 2) evaluating usability in order to continue the BIT development. The first group occurred in May 2013 and consisted of 5 adolescents. The second group occurred in October 2013 and consisted of 8 adolescents. While most internet-delivered interventions are designed for 5–8 weeks of use, this intervention was tested as a 10 week program, which is somewhat longer than we expected participants to stay engaged, to allow the research team to make general observations on length of engagement. Participants responded to questionnaires at baseline, week 5, and week 10 and were paid for each assessment. The first author conducted semi-structured qualitative feedback interviews with Group 1 participants after 1 week of use, and a research assistant conducted interviews with Group 2 participants at week 5 and week 10 of the intervention.

2.3. The Project TECH intervention

The intervention website is named Project TECH (Teens Engaged in Collaborative Health). It was based on moodManager, an internet-delivered intervention for depression based on cognitive behavioral therapy (CBT) that was previously validated with adults (Mohr et al., 2010, 2013). We modified moodManager to create Project TECH, based on laboratory testing sessions with 6 adolescents (Mean Age = 15.8), and where participants provided feedback on paper prototypes.

2.3.1. General design

The Project TECH intervention included didactic lessons and interactive tools designed to support the integration of behavioral activation and cognitive restructuring strategies aimed at the treatment of depression. Following the principles of supportive accountability, we embedded intervention components in a peer networking system, i.e. a closed group with a limited number of participants. This peer networking system included visible peer activity, commenting, and ability to share media such as photos and videos. The site also had a bright color scheme and an uncomplicated design, to appeal to adolescent users. Brief didactic lessons are released several times a week, and take about 5 min to read. Intervention tools take an additional minute or two to complete, depending on the user and their level of engagement. Psychologists monitored groups for safety but did not participate or intervene within the group.

2.3.2. Intervention elements: CBT tools

Fig. 1 displays the features on the Project TECH home page. The left half of the page contains tiles that access the intervention components. The "Today's Lesson" tile on the top left contains didactic information on the management of depressive symptoms. The "Activity Tracker" and "Thought Journal" ("Think & Feel") tiles on the middle row contain interactive tools designed to support users in implementing mood management skills. The Activity Tracker supports behavioral activation strategies, allowing participants to schedule and monitor positive activities. Increasing positive activities (those that provide pleasure or a sense of accomplishment) is a core component of psychological treatments for depression. The Thought Journal is a tool that supports
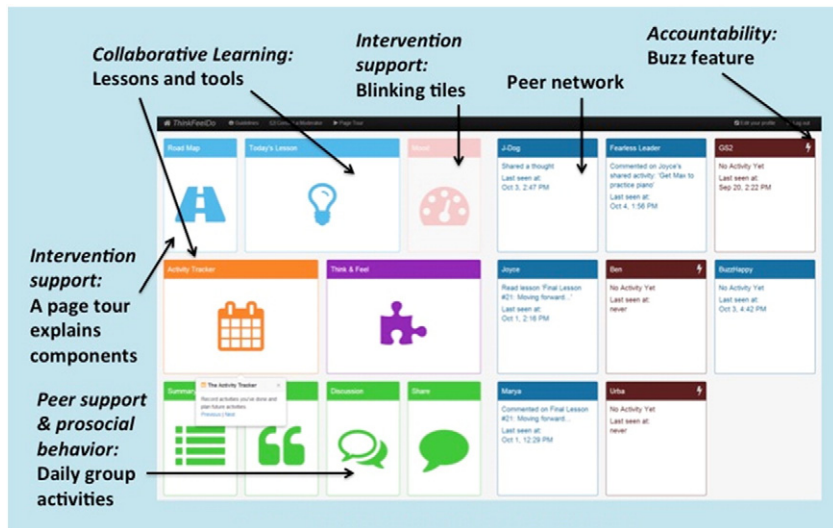
Fig. 1. Project TECH home page.

cognitive restructuring, in which participants learn how to identify and challenge negative thoughts that contribute to low mood.

2.3.3. Social elements: peer networking tools

The Project TECH program included elements that provide the opportunity for users to develop a peer network, support each other, and hold each other accountable. The green tiles on the bottom row promote interactions between participants, including commenting boards, "share" for media sharing, and "quotes" to share reactions to uplifting quotes. Tiles on the right hand of the page represent members of the peer network, and contain information about recent use of the intervention application, consistent with supportive accountability.

Supportive accountability is integrated into the site, by making expectations explicit, as well as the ability of network members to monitor the activities of others, and to supportively hold each other accountable for meeting use expectations. This is done in several ways. First, the color of the peer member tiles reflects adherence to login expectations. Tile headers are blue when the login expectations are being met, and changes to brown when a participant has not logged in for >4 days. Peers can click on a "buzz" icon in the top right hand corner, triggering the system to send a supportive email to the participant, encouraging the individual to return to the site. Interactive features, including the Activity Tracker and Thought Journal (see Fig. 2 for an example), is by default made public to the peer network, but users have the option of making them private if they wish.

At the bottom of each intervention element (i.e. Didactic Lessons, Activity Tracker, Thought Journal, "quotes") is a text field where users are encouraged to post comments. Users are also encouraged to comment on each other's posts and activities (for example, they can comment on another user's Thought Journal). This interaction promotes collaborative learning, but also makes each individual's adherence to treatment activities apparent to the peer group, and promotes reinforcement of adherence through posting. Bond is promoted through the social features and commenting, which also support off-topic discussions required to build emotional connection and trust.
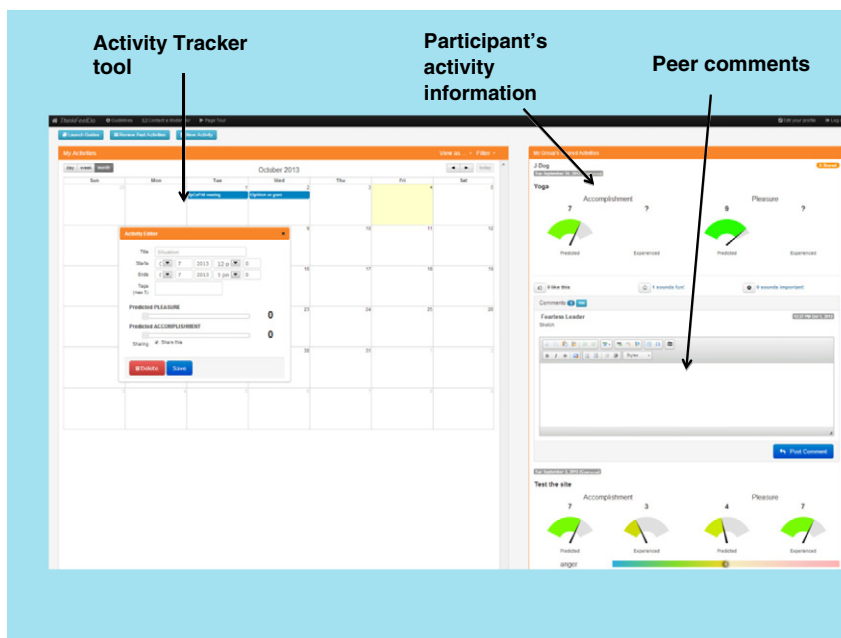

Fig. 2. Networked Activity Tracker tool.

2.4. Outcomes

For BITs in early stages of development, it is recommended that evaluation is tailored to specific intervention strategies and focuses on investigating user experiences and patterns of use rather than focusing on clinical outcomes (Klasnja et al., 2011). There are several reasons for this recommendation. Demonstrating change in clinical outcomes would require large randomized trials that are not practical or feasible at this stage in the technology development. Additionally, focusing the evaluation on clinical outcomes does not provide information regarding how or why the technology was effective, nor does it help identify which components of the design were problematic, and which were most effective in producing change (Klasnja et al., 2011). Thus, site use was our primary outcome, which allows us to gather information about the efficacy of specific intervention strategies and also allowed us to obtain more detailed information about user interaction with various components of the intervention. Outcomes included frequency and duration of overall site use, as well as use of distinct intervention elements within the site such as Didactic Lessons, Activity Tracker, Thought Journal, Mood Rating, the "like" button, and the "buzz" button. Since many of the participants logged in more than once a day, number of site use sessions was reported in addition to the number of login days and session duration. A site use session constitutes one chain of events that includes: start of session (login, opening of the browser window), session activity (activity within the site such as opening a lesson, opening a Thought Journal tool, etc.), and session end (the closing of a browser window, logout, or no activity for 20 min). Each participant's site use record was coded so as to decrease the possibility of artifacts, such as multiple logins due to the user being interrupted or connectivity problem.

Qualitative user feedback data were collected via semi-structured phone interviews. The first author and a trained research assistant asked 17 open-ended, qualitative feedback questions about the peer networked intervention. Research staff then reviewed the interview audio files and transcribed the responses. Items included questions about site-based tools (i.e. Thought Journals and Activity Tracker, lessons, and home page), peer networking features (i.e. "like" feature, profiles, and "buzz" feature), interactions of the peer group (i.e. sharing, engagement), and general usability of the site. Qualitative responses to the questions pertaining to site tools were coded into "liked", "disliked", and "neutral". Responses to questions pertaining to peer networking features were coded into "used" and "did not use". Responses to questions about peer group interactions were coded for "wanted more interaction from others" and "satisfied with group interaction". Overall themes were also derived from the qualitative responses. Two research team members coded and tallied the responses independently, and then discussed discrepancies to reach consensus.

3. Results

3.1. Sample characteristic

Thirteen adolescents, ages 15–19 (12 girls; 1 boy) were enrolled in two 10-week groups to evaluate the intervention. There were 9 White (including 2 Hispanic), 2 African American, 1 Asian, and 1 Bi-racial adolescents. One additional participant was assessed and determined eligible at baseline but dropped out of the study before using the site. This participant's data was excluded from the analysis. Because this is primarily a usability study, no specific depression severity entry criteria were used and we excluded individuals with a CESD score above 39. As a result, CESD scores were low (baseline mean = 6.43, SD = 6.15), and did not change significantly over the trial period (F (2,5) = 1.26, p = 0.361).

3.2. Site use

Initial inspection of the data revealed one participant (male, 15 years old, CESD = 0) who was an outlier, with 64 logins over the 10 weeks, and spending a total of 10.5 h on the intervention. That is twice the number of logins compared to the next most frequent user. As a result, this participant's data was excluded from all analyses. The remaining 12 participants logged in an average of 12.8 sessions (SD = 9.19, Min = 3, Max = 36), over an average of 10.4 unique days (SD = 8.34, Min = 3, Max = 31). The mean time from the first use session to the final use session was 35.3 days (SD = 24.5, Min = 3, Max = 73). The mean number of use sessions per person by week is presented in Fig. 3. On average, 66% of all use sessions occurred within the first 3 weeks of use, when many participants logged in multiple times per week. Use sessions for all but 4 participants decreased to once per week or less on average, between the 4th and 10th weeks. The mean amount of time spent on the site per session per participant was 6 min 39 s. Across the 10 week length of the study, the mean total duration each participant spent on the website is 84 min (SD = 66 min, Min = 12, Max = 243).

Regarding the specific components of the program, participants used the Mood Rating tool an average of 10.2 times (SD = 11.00, Min = 1, Max = 41, Median = 7), and viewed an average of 11.3 Didactic Lessons (SD = 12.56, Min = 0, Max = 46, Median = 6.5) out of a total of 48 lessons. The Activity Tracker (available on week 2) was used by 8 of the 12 participants, among which 5 participants used the tool between 2 and 4 times and 3 participants only used it once. Three participants used the Thought Journal (available during week 4), 2 times each.

3.3. Peer networking activity

Peers are encouraged to post comments on lessons, tools, "quotes", and other users' comments and activities. The 12 participants entered a total of 115 comments across the site. The frequency of each participants' comments varied widely. Three participants never commented, 3 participants entered 1–9 comments each, and 5 participants entered 11–27 comments.

The 115 comments were spread across 71 instances of tool use, lessons and social features. In 28 (39%) of these 71 instances, a comment received a response from another peer, meaning there were either parallel responses or exchanges between 2 or more participants. For these 28 instances where an exchange existed, there was on average 2.57 comments made per item (SD = 1.1, Range = 2–5). The majority (72.2%) of these exchanges happened between weeks 1 to 3.

Participants had the option of clicking on a "like" button, which was placed below every tool and lesson. The frequency of using this feature varied, with 6 participants never clicking "like", 4 participants using it once, and 2 participants using it 3 and 9 times respectively. Only 4 participants used the buzz feature, between 1 and 4 times each.

3.4. Correlation of peer networking activity and site use

While correlation between total number of comments and site use was not significant, the number of "exchange comments", that is, comments posted that were part of an exchange between 2 or more participants, was significantly positively correlated with mean time spent on site per use session (r = 0.62, p = 0.032, see Table 1). A trend was observed between the number of exchange comments and number of use sessions (r = 0.54, p = 0.072), as well as between the number of exchange comments and total number of days of site use (r = 0.55, p = 0.065). The number of exchange comments made was also correlated with use of the Activity Tracker (r = 0.70, p = 0.012) and accessing Didactic Lessons (r = 0.73, p = 0.007). The number of exchange comments was also significantly correlated with the use of the Thought Journal (r = 0.70, p = 0.013), but the infrequent use of this tool means that this result should be interpreted with caution.
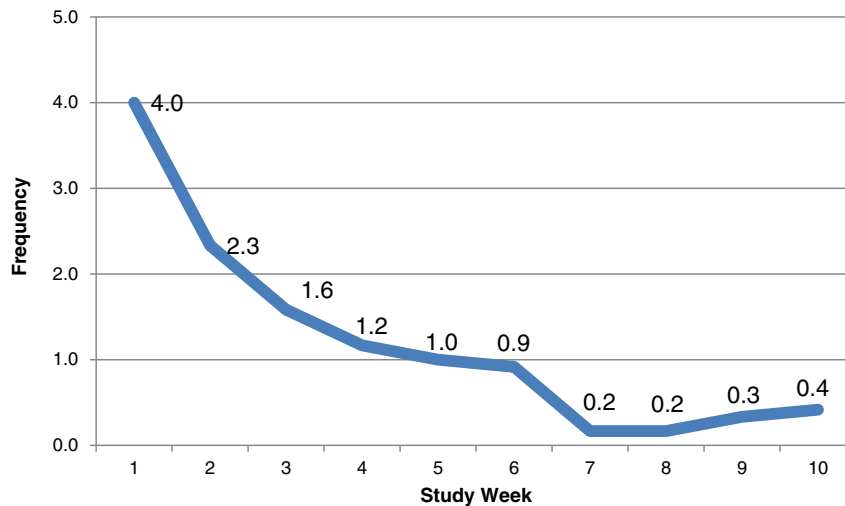
Fig. 3. Mean number of site use sessions per user by week (n = 12).

3.5. User feedback

Twelve of the 13 participants engaged in the user feedback interviews. Respondents expressed general approval for using an internet-delivered intervention for mood management. Between 8 and 10 teens liked the site design and specific components of the site including Lessons, Activity Tracker, Thought Journal, and peer networking features such as commenting and shares. The teens also liked the daily release of new materials, the ability to see other participants' activities on the site, and enjoyed peer interactions on the site. Example quotes:

> "*I liked the mood rating and mood graph because I can see the big changes and how my behaviors are changing over time.*"

> "*I liked the lessons, they gave me a chance to learn more. They seemed real, the language was easy to understand and it helped me learn about depression.*"

> "*I like that the colors and the big bubbles- makes it look easy to use.*"

However, 7 of the teens reported that they were confused about how to use the CBT tools such as the Activity Tracker and Thought Journal properly, and many wanted site features to be more apparent. For example, 5 respondents reported that they either did not use, or know about, the "like" and "buzz" features. Example quotes:

> "*I tried to put activities on the calendar but I don't understand why we are doing that. Like are we supposed to put in everything I do every day? Or just important events? Or just events I want to do?*"

> "*I didn't even know you could* "like" *things.*"

Six of the teens expressed a desire for the site to have more ways to personalize their experience, such as adding their own photos to the profile page. Seven participants indicated that they would like additional ways to interact with other group members, and asked to receive notifications when other participants posted comments. They noted that their desire to post again in the future was reduced when they did not see comments made by others, or they themselves posted comments and did not receive responses.

> "*I like that you can post opinions, quotes, information about lessons- it's easy to talk to people.*"

> "*The idea of getting to interact with other teens is good, but I wanted to see more opportunities to interact with others. Someone would comment on a lesson, and no one would say anything back, which made*

Table 1
Correlation between peer network activity and site usage (N = 12)[a].

		Peer networking activity	
		Number of comments M = 9.5, SD = 9.36	Number of exchange comments M = 7.2, SD = 5.97
Site usage			
Total use sessions	M = 12.7, SD = 9.19	0.52[†]	0.54[†]
Total number of days used	M = 10.4, SD = 8.34	0.56[†]	0.55[†]
Mean time spent on site (min)	M = 6.65, SD = 3.45	0.45	0.62*
Frequency of tool use			
Mood Rating	M = 10.2, SD = 11.00	0.44	0.46
Thought Journal	M = 0.5, SD = 0.90	0.87**	0.69*
Activity Tracker	M = 1.5, SD = 1.51	0.55[†]	0.70*
Didactic Lesson	M = 11.3, SD = 12.56	0.64**	0.73**

(All 2-tailed.)
  [a] An outlier (N = 1) was excluded from these analyses.
  [†] *p* < 0.10.
  * *p* < 0.05.
  ** *p* < 0.01.

me not want to post. I would like to get to know people better too, maybe through a survey or being able to post photos."

"I didn't have any interaction with other group members…even though I knew no one would see my comments, still made me feel good to post. Having messaging or being able to mention people would help people be engaged, you wouldn't both have to be on at same time, but you can still have a convo with them."

Finally, adolescents indicated that they do not use email or computers frequently, and that they would access the intervention more regularly if it were delivered via mobile phone, and notifications were provided by SMS messages.

"It would be nice to have it on cell phone…it was taking forever to load on the phone. Texting updates and information about the site would be a better way to communicate with each other in the group."

4. Discussion

This feasibility study reports on the adaptation and implementation of supportive accountability principles in a peer-networked online depression prevention intervention for adolescents. To our knowledge, this is the first study to use supportive accountability principles, a model initially proposed for coaching support with adults using BITs, to design a peer-networked intervention for adolescents. Adolescents in this study logged in an average of 6 min 39 s per use session, which matched our expectation that it would take between 5 and 10 min to complete the lessons and tools prescribed per session. Furthermore, the results of this feasibility study suggest that incorporation of a peer network based on supportive accountability principles may increase adolescent engagement with online interventions as demonstrated by the 12.8 mean participant logins across the groups. This is substantially greater than the average of 2 logins seen in similar standalone interventions for adults, and approximately 9 logins on average in coached interventions for adults (Andersson and Cuijpers, 2009; Christensen et al., 2009; Mohr et al., 2011). This higher number of logins is similar to that observed in a feasibility trial of a peer networked intervention for cancer survivors (Duffecy et al., 2013), suggesting that there is something unique about the incorporation of peer-networks driving the increases in logging in and subsequent engagement. Despite these promising findings regarding increase logins overall, the majority of site use was concentrated to the first 3 weeks of the intervention, limiting participants' exposure to didactic lessons and use of cognitive behavioral therapy tools such as the Activity Tracker and Thought Journal. These results suggest that the inclusion of peer support may impact engagement initially, yet not be sufficient in producing persistent engagement over the course of a 10 week program.

To better understand the impact of the peer support on engagement, we examined user interactions with the specific components of the peer networking features. While commenting alone did not appear to have an impact on site use, peer networking activity that resulted in social exchange or interaction with others in the program, as measured by the number of comments participants posted that was part of an exchange between two or more people, was significantly related to participants' use of the site during the 10-week program. In other words, participants who either commented on others' posts or received a response to their own comment were more likely to use the site. While these results could reflect these users' underlying tendency toward engagement and thus should be interpreted with caution, it is possible that such social exchanges actually promote use of the site. For example, it is possible that when participants see that their activities and comments are being commented on, that they are more likely to return to the site, or that providing support to others increases the likelihood of ongoing engagement.

The Project TECH site was explicitly designed to engender intervention-specific peer support that is synergistic, which theoretically increases adherence. The pilot nature of this study means that we cannot conclude whether Project TECH's design was really able to create this synergy, but these preliminary observations regarding the impact of supportive exchanges are encouraging. In contrast, use of the "like" and "buzz" peer networking features was minimal. On interview, the majority of participants noted that they were not aware of or did not utilize these features. The "like" and "buzz" features were included in the intervention design to promote lean supportive interactions between participants. While it is unclear why these features were not used in this study, it is possible that if utilized they could allow users to engage in more social exchanges with one another and could potentially increase social interaction and overall site use.

Our finding that adherence drops in weeks 4–10 is consistent with much of the web-based literature, in which even for coached interventions, most participants stop using web-based interventions by the 7th week (Mohr et al., 2013). This can be explained by a number of interrelated factors. First, we found that supportive accountability administered in this form through a peer network may have dual effects. During the usability interviews, participants indicated that in the early weeks of the intervention, viewing other people's activity and knowing that others are aware of their activity increased their use of the intervention. However, as some users began to reduce their engagement, or ceased altogether, this demotivated participants, possibly accelerating their shift from high use to low use or non-use. In other words, peer networks transmit information about use, which we suspect can increase use among participants with low motivation when general use among peers is high, but which may decrease use, even among highly motivated participants, when general group use declines.

Second, while participants generally liked the design of the site and the concept behind the intervention, user feedback interviews revealed a number of design flaws and opportunities for improving the site to promote peer interactions and site engagement. For example, many participants expressed overall confusion with how to use the CBT tools such as Activity Tracker and Thought Journal. In future iterations, we have included scaffolded access to tools that includes both a "wizard" version that guides the user through the tool, and an "expert" version that is efficient and without explanations. Furthermore, while participants generally expressed a strong desire to see more site participation from other group members, and a willingness to connect with others, they reported that opportunities for peer interaction were not immediately apparent. For example, comments were dispersed across tools and participants reported that they were less likely to post a comment when they did not realize that others had responded to their comment or did not realize that peers had posted. Additionally, many of participants reported that they were either not aware of or did not use the "like" or "buzz" features, which were included to promote a leaner form of social exchange. Thus, in more recent iterations of the site we have added a "Feed" that compiles all activity on the home page and notified users via text message or email when a peer responded to their posts. We have also redesigned features such as the "like" and "buzz" buttons to enhance their visibility. Future research is needed to evaluate the impact of such changes and to examine whether or not these additional opportunities for social exchange lead to greater and more persistent engagement.

Third, adolescents expressed dissatisfaction with the internet-delivered intervention via computers, as desktop or laptop computers are no longer integrated into their daily lives in the same way as smartphones. Youth indicated that they would use the program much more frequently if it were easily accessible on a mobile device. Subsequently, in the next iteration we have rebuilt the intervention so that it is responsive, allowing users to access the intervention from any mobile or desktop device. Future iterations may include native apps.

There are a number of limitations of the present research that should be considered. First, the small sample size means that there is not enough power to fully explore our research questions. Second, the CESD scores of the sample were low, so the sample does not match the target population of adolescents at risk for depression. Follow-up research that includes adolescents who are more clearly at risk for depression will be important to explore how a BIT designed to harness peer network support will impact on intervention adherence and clinical outcomes. Third, as this is a usability study, we have not compared this treatment model to non-networked interventions, and therefore cannot say definitively that this peer networking approach increases adherence. Furthermore, while the peer network was designed based on principles of supportive accountability, we cannot rule out the possibility that any effects on adherence were due to design features other than supportive accountability. Future work will be required to determine the effective components of peer-networked interventions for adolescents.

5. Conclusion

These limitations notwithstanding, the present work supports the feasibility of integrating peer networking into BITs, highlighting a potentially fruitful line of research. Even though current coaching models require limited time (typically <2 h per patient), they limit the scalability of technology-based interventions for depression, as most current healthcare delivery systems do not have personnel or reimbursement models for such services. The inclusion of a peer network designed to enhance participant engagement and a site constructed to harness that connection has the potential to improve adolescent adherence to internet-delivered, and potentially mobile interventions for depression, thereby improving their scalability.

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References

Ali, K., Farrer, L., Gulliver, A., Griffiths, M.K., 2015. Online peer-to-peer support for young people with mental health problems: A systematic review. JMIR Mental Health 2, e19.

Andersson, G., Cuijpers, P., 2009. Internet-based and other computerized psychological treatments for adult depression: a meta-analysis. Cogn. Behav. Ther. 38, 196–205.

Beardslee, W.R., Brent, D.A., Weersing, V.R., Clarke, G.N., Porta, G., Hollon, S.D., Gladstone, T.R., Gallop, R., Lynch, F.L., Iyengar, S., Debar, L., Garber, J., 2013. Prevention of depression in at-risk adolescents: longer-term effects. JAMA Psychiatry 70, 1161–1170.

Brent, D.A., Brunwasser, S.M., Hollon, S.D., Weersing, V.R., Clarke, G.N., Dickerson, J.F., Beardslee, W.R., Gladstone, T.R., Porta, G., Lynch, F.L., Iyengar, S., Garber, J., 2015. Effect of a cognitive-behavioral prevention program on depression 6 years after implementation among at-risk adolescents: a randomized clinical trial. JAMA Psychiatry 72, 1110–1118.

Center for Behavioral Health Statistics and Quality, 2015. Behavioral Health Trends in the United States: Results from the 2014 National Survey on Drug Use and Health.

Christensen, H., Griffiths, K.M., Farrer, L., 2009. Adherence in internet interventions for anxiety and depression. J. Med. Internet Res. 11, e13.

Clarke, A.M., Kuosmanen, T., Barry, M.M., 2015. A systematic review of online youth mental health promotion and prevention interventions. J. Youth Adolesc. 44, 90–113.

Dennison, L., Morrison, L., Lloyd, S., Phillips, D., Stuart, B., Williams, S., Bradbury, K., Roderick, P., Murray, E., Michie, S., Little, P., Yardley, L., 2014. Does brief telephone support improve engagement with a web-based weight management intervention? Randomized controlled trial. J. Med. Internet Res. 16, e95.

Duffecy, J., Sanford, S., Wagner, L., Begale, M., Nawacki, E., Mohr, D.C., 2013. Project onward: an innovative e-health intervention for cancer survivors. Psychooncology 22, 947–951.

Ebert, D.D., Lehr, D., Baumeister, H., Boss, L., Riper, H., Cuijpers, P., Reins, J.A., Buntrock, C., Berking, M., 2014. GET.ON Mood Enhancer: efficacy of internet-based guided self-help compared to psychoeducation for depression: an investigator-blinded randomised controlled trial. Trials 15, 39.

Hayes, J.F., Maughan, D.L., Grant-Peterkin, H., 2016. Interconnected or disconnected? Promotion of mental health and prevention of mental disorder in the digital age. Br. J. Psychiatry 208, 205–207.

Kazdin, A.E., Blase, S.L., 2011. Rebooting psychotherapy research and practice to reduce the burden of mental illness. Perspect. Psychol. Sci. 6, 21–37.

Klasnja, P., Consolvo, S., Pratt, W., 2011. How to evaluate technologies for health behavior change in HCI research. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, Vancouver, BC, Canada.

Lillevoll, K.R., Vangberg, H.C., Griffiths, K.M., Waterloo, K., Eisemann, M.R., 2014. Uptake and adherence of a self-directed internet-based mental health intervention with tailored e-mail reminders in senior high schools in Norway. BMC Psychiatry 14, 14.

Mohr, D.C., Duffecy, J., Jin, L., Ludman, E.J., Lewis, A., Begale, M., Mccarthy Jr., M., 2010. Multimodal e-mental health treatment for depression: a feasibility trial. J. Med. Internet Res. 12, e48.

Mohr, D.C., Cuijpers, P., Lehman, K., 2011. Supportive accountability: a model for providing human support to enhance adherence to eHealth interventions. J. Med. Internet Res. 13, e30.

Mohr, D.C., Duffecy, J., Ho, J., Kwasny, M., Cai, X., Burns, M.N., Begale, M., 2013. A randomized controlled trial evaluating a manualized telecoaching protocol for improving adherence to a web-based intervention for the treatment of depression. PLoS One 8, e70086.

Rice, S.M., Goodall, J., Hetrick, S.E., Parker, A.G., Gilbertson, T., Amminger, G.P., Davey, C.G., Mcgorry, P.D., Gleeson, J., Alvarez-Jimenez, M., 2014. Online and social networking interventions for the treatment of depression in young people: A systematic review. J. Med. Internet Res. 16, e206.

Rohde, P., Stice, E., Shaw, H., Gau, J.M., 2015. Effectiveness trial of an indicated cognitive-behavioral group adolescent depression prevention program versus bibliotherapy and brochure control at 1- and 2-year follow-up. J. Consult. Clin. Psychol.

Rozental, A., Andersson, G., Boettcher, J., Ebert, D.D., Cuijpers, P., Knaevelsrud, C., Ljótsson, B., Kaldo, V., Titov, N., Carlbring, P., 2014. Consensus statement on defining and measuring negative effects of internet interventions. Internet Interv. 1, 12–19.

Saulsberry, A., Marko-Holguin, M., Blomeke, K., Hinkle, C., Fogel, J., Gladstone, T., Bell, C., Reinecke, M., Corden, M., Van Voorhees, B.W., 2013. Randomized clinical trial of a primary care internet-based intervention to prevent adolescent depression: one-year outcomes. J. Can. Acad. Child Adolesc. Psychiatry 22, 106–117.

Thapar, A., Collishaw, S., Pine, D.S., Thapar, A.K., 2012. Depression in adolescence. Lancet 379, 1056–1067.

Titov, N., Andrews, G., Davies, M., Mcintyre, K., Robinson, E., Solley, K., 2010. Internet treatment for depression: a randomized controlled trial comparing clinician vs. technician assistance. PLoS One 5, e10939.

Van Voorhees, B.W., Fogel, J., Reinecke, M.A., Gladstone, T., Stuart, S., Gollan, J., Bradford, N., Domanico, R., Fagan, B., Ross, R., Larson, J., Watson, N., Paunesku, D., Melkonian, S., Kuwabara, S., Holper, T., Shank, N., Saner, D., Butler, A., Chandler, A., Louie, T., Weinstein, C., Collins, S., Baldwin, M., Wassel, A., Vanderplough-Booth, K., Humensky, J., Bell, C., 2009. Randomized clinical trial of an internet-based depression prevention program for adolescents (Project CATCH-IT) in primary care: 12-week outcomes. J. Dev. Behav. Pediatr. 30, 23–37.

Wartella, E., Rideout, V., Zupancic, H., Beaudoin-Ryan, L., Lauricella, A., 2015. In: Development, C. O. M. a. H. & Communication, S. O. (Ed.), Teens, Health, and Technology: A National Survey. Northwestern University.

Young, J.F., Benas, J.S., Schueler, C.M., Gallop, R., Gillham, J.E., Mufson, L., 2015. A randomized depression prevention trial comparing interpersonal psychotherapy-adolescent skills training to group counseling in schools. Prev. Sci.