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ARTICLE

Robot-mediated interventions for youth mental health

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ABSTRACT

Evidence-based therapies have proven effective in treating the mental health of adolescents. However, these interventions are not without shortcomings: therapies are costly and not accessible for everyone who needs them; psychologists are scarce, with more adolescents needing support than therapists available. We contribute to mental health support tools with a digital robot agent that delivers micro-interventions to adolescents. Our key insight is that translating therapies traditionally provided in a physical workbook format to an interactive robot uncovers therapeutic mechanisms that promote healing. We present our translation process from workbook to robot-mediated therapy, which include the co-design of a robot with adolescents and heuristic evaluations with evidence-based clinical psychologists. This work presents a preliminary study with adolescents in which they used both the workbook (traditional medium) and the digital robot (interactive medium) during two consecutive weeks. Results show both a preference for the robot and more engagement of this treatment delivery option.

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Introduction

Translating evidence-based mental health interventions to digital versions, such as internet websites, mobile apps, wearable devices and video games, is becoming increasingly popular (Schueller and Torous 2020). Examples include self-guided internet-based Cognitive Behavioural Therapy (CBT) programs like Beating the Blues and MoodGYM.

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We introduce a social robot app that delivers micro-interventions to our target audience, namely, youth between the ages of 15–18 years old. Micro-interventions are defined as short interactions that have an immediate positive effect in our mood, emotion, or behaviour. Thus, we detail the design process, implementation and preliminary evaluation of our robot app. This robot was designed and developed using participatory design techniques, such as co-design and heuristic studies with both youth/users and clinical psychologists who used it to ensure adoption, engagement and therapeutic efficiency. We compare robot-mediated interventions to traditional ones delivered by workbook. Our key insight is that robots can be powerful therapeutic tools for mental health coaching since they provide a non-judgmental space for adolescents to express their feelings and concerns and learn techniques for mental health self-care.

Related work

Benefits of digital evidence-based interventions

Engaging with interactive evidence-based digital interventions that have been translated from traditional workbook formats is known to contribute to reduced depression symptoms (Schueller and Torous 2020). The versatile functionalities of modern technological devices have also helped make these interventions more accessible, cost-effective and user-friendly (Schueller and Torous 2020). Incorporating user feedback into these interventions is necessary to ensure positive outcomes and ongoing user engagement (Howells, Ivtzan, and Eiroa-Orosa 2016).

Providing CBT interventions using mobile health technologies lets patients receive care either without physically visiting the clinicians' office or via combining technology with clinician's personal care to create a hybrid form. Through the digital transformation of evidence-based interventions, technology can do far more than merely digitize current practices; it can improve such practices by leveraging artificial intelligence, chatbots and mobile sensing to create scalable, personalized and context-aware interventions (Schueller and Adkins 2019).

Shortcomings of digital evidence-based interventions

Despite its many benefits, digital interventions for mental health care have drawbacks, too, which include the lack of face-to-face interaction in non-hybrid systems; a potential lack of compatibility between the user's device and website content, a low battery or poor internet connectivity (Howells, Ivtzan, and Eiroa-Orosa 2016); and participant's potential distraction or lack of interest in non-human interactions (Borghouts et al. 2021). Our work

addresses the lack of face-to-face interaction by implementing evidence-based interventions in a virtual robot agent. With supported versions running on mobile phone and desktop computer platforms, we largely overcome device compatibility issues.

Furthermore, our work uses a human-centred approach to design and develop the robot, making it very relatable and appealing to users, who enjoy interacting with it. We incorporated facial expressions, text, images, emojis, gifs, icons and different colours to sustain user interest. We also provide necessary clarification of interventions as well as options for users to pose questions, which helps them clarify content and next steps. User retention is a problem often faced in this regard (Borghouts et al. 2021). We design our interventions at micro-scale so users can complete them in relatively short time periods and replicate them in the future whenever needed.

Other limitations of current digital mental health care delivery include concerns about data privacy, user safety and the lack of evaluation after implementing the translated evidence-based interventions (Nicholas et al. 2017). We store limited user data which was reported in our study was a benefit of our approach, showing how our designed robot interactions make users feel safe in the context of mental health care.

Evidence-based interventions for youth

We base our study on two styles of evidence-based interventions proven to be successful with youth (Hayes and Ciarrochi 2015; McCredie, Quinn, and Covington 2017): Acceptance and Commitment Therapy (ACT) and Dialectical Behavioural Therapy (DBT). Both therapies fall under the umbrella of CBT (Twohig 2012). We very briefly review these approaches below.

Acceptance and commitment therapy (ACT)

In layman's terms, the aim of ACT is to 'maximize human potential for a rich and meaningful life, while effectively handling the pain that inevitably goes with it' (Harris 2019). ACT promotes greater mindfulness and thought acceptance instead of direct challenging thoughts, as espoused in traditional CBT (Halliburton and Cooper 2015). It focuses on the workability of strategies and psychological flexibility by encouraging clients to cede control and coexist with problematic thoughts and emotions. ACT has proven to be more effective than control conditions, including waitlist controls, treatment as usual and placebos. In addition, brief ACT interventions seem to be no less effective than long-term ones (Halliburton and Cooper 2015). Many previous works have adapted ACT for use with adolescents since it can be adapted to their developmental needs and is applicable to typical, low-distress adolescent problems (Coyne et al. 2011; Halliburton and Cooper 2015; Hayes and

Ciarrochi 2015). The current literature on using ACT techniques with youth provides guidance for translating ACT protocols used with adults to a younger population and widening the scope of their use (Halliburton and Cooper 2015).

Dialectical behavioural therapy (or DBT)

DBT is an evidence-based intervention that combines education and therapy for developing skills to manage stress, regulate emotions and improve relationships with others (Linehan 1987). Traditional DBT programs involve one-on-one therapy, phone coaching, skill practice within training groups and individual homework. While DBT was originally developed for chronically suicidal adults with borderline personality disorder and emotion disregulation, positive outcomes with adults have prompted researchers to adapt this approach for use by adolescents, who share the common underlying dysfunction in emotion regulation (MacPherson, Cheavens, and Fristad 2013). DBT principles remain the same across gender, race, age, etc., with an emphasis on acceptance-oriented strategies, including rapport building, radical genuineness and validation (Rathus et al. 2015). Previous research has focussed on adapting DBT techniques and principles for various adolescent problems (Koerner and Dimeff 2007; Van Dijk 2013).

Contribution

Adolescents, a unique and vulnerable population, can be severely affected by stress and mental health issues (American Psychological Association 2014; Gunnell, Kidger, and Elvidge 2018). Although therapies are available, they are expensive and not readily accessible to those in need (Okamura et al. 2017; Haga et al. 2018). In addition, the high demand for therapists makes it extremely difficult to find the right therapist, or indeed any therapist, in time of crisis (O'Connor et al. 2018). Furthermore, given that most youth still economically depend on their parents to access therapy, they must disclose their need for help to their parents, who must in turn be willing and able to support the goals, costs and commitment of therapy (Wisdom, Clarke, and Green 2006).

Our work leverages computers and smartphones as ubiquitous devices in the lives of youth. Adolescents generally use their devices to connect with others (e.g., via social media), to do homework, or to gather information (using search engines such as Google). We extend the use of these same devices to improve their mental wellbeing. To do so, *we translate evidence-based therapies that are traditionally delivered via physical workbooks to a digital, accessible format*. These interventions are based on ACT and DBT, proven to have positive results for youth, including decreased depression,

anxiety and suicidal tendencies and increased emotional regulation (Miller et al. 2007; Miller, Rathus, and Linehan 2006; Van Dijk 2011; Coyne, McHugh, and Martinez 2011; Hayes and Ciarrochi 2015). In addition, *we create a digital interactive social robot app to deliver the interventions to the adolescents* (Boniel-Nissim and Barak 2013).

This work makes two contributions to the usability research computing community. First, we present the complete design and development process of robot-mediated mental health therapies. Second, we provide results from a preliminary evaluation study of youth who used our intervention and a workbook over a two-week period for their mental health care.

Design process for robot-mediated interventions

We used a multi-staged design process to translate traditional evidence-based interventions of ACT and DBT to digital form.[1] In this section, we present our design and development of a digitally rendered social robot that delivers mental health micro-interventions to adolescents based on the ACT and DBT evidence-based therapies. We applied a participatory design process accomplished via iterative interactions with clinical psychologists and adolescents.

Our design process featured three main stages: (1) selecting the micro-interventions to include in the study, (2) translating the selected micro-interventions into a social robot app and (3) eliciting input via participatory design with adolescents and clinical psychologists. We detail these stages below (see visual on Figure 1).

Stage 1: selecting micro-interventions

Our goal at this stage was to *select the interventions to translate into youth-robot therapeutic interactions*. To begin doing so while drawing from both ACT and DBT, we needed to understand how a therapist would perform the intervention (i.e., in a human-to-human interaction). For this, we referred to the following resources: 'The Big Book of ACT Metaphors: A Practitioner's Guide to Experiential Exercises and Metaphors in Acceptance and Commitment Therapy' (Stoddard and Afari 2014) and 'DBT Therapeutic Activity Ideas for Working with Teens: Skills and Exercises for Working with Clients with Borderline Personality Disorder, Depression, Anxiety, and Other Emotional Sensitivities' (Lozier 2018). Both workbooks are accepted in psychology literature as landmarks for ACT and DBT practitioners.

First, we focussed on interventions that needed a higher degree of *participant vs robot/therapist interactions*. Our rationale was that we wanted to maintaining enough interactivity between the youth and the robot to keep adolescents engaged. Second, we choose *interventions that were possible to*

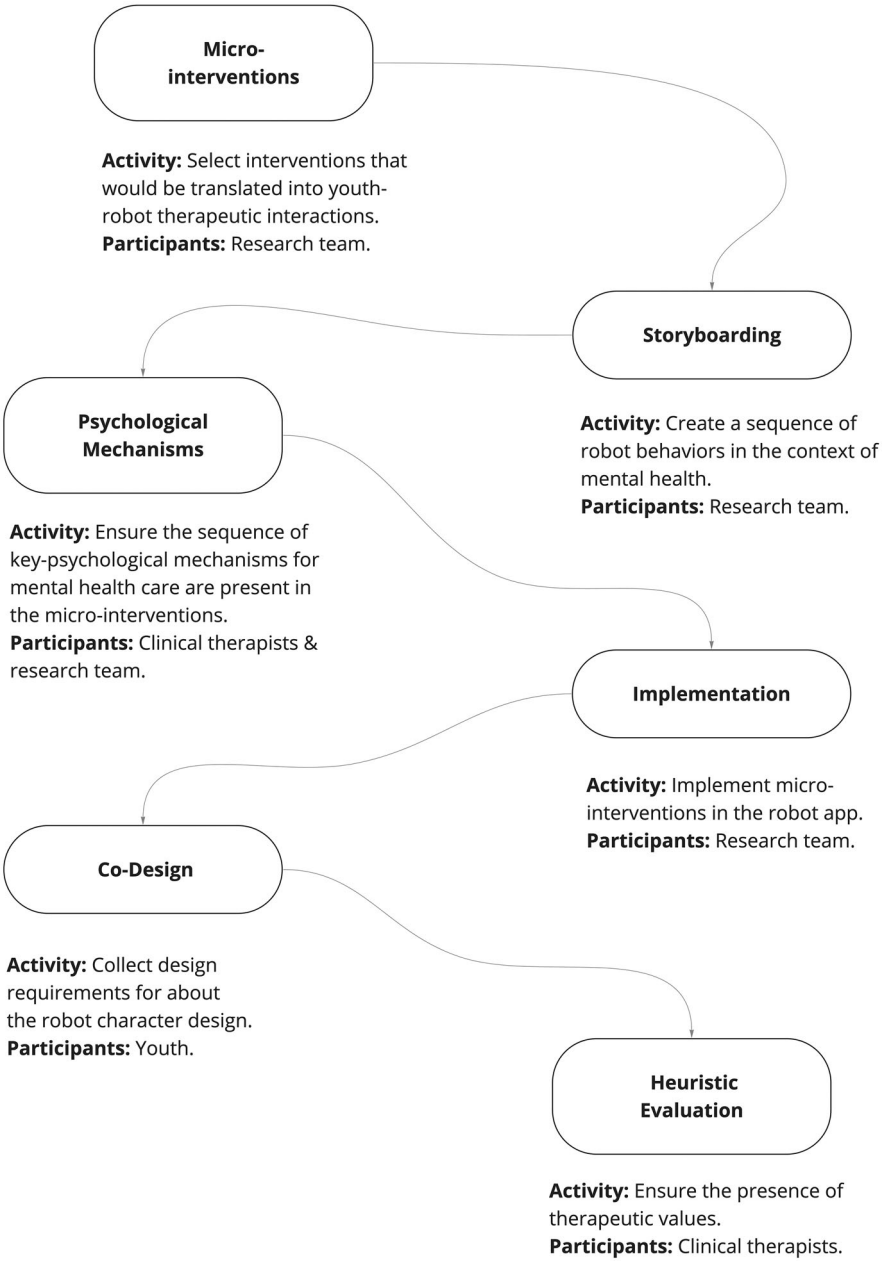


Figure 1. Design flow for creating youth–robot interactions for mental health care.

perform in short time periods (approx. 3–5 min): we wanted to promote easier and earlier moments of mental health release rather than offering more demanding exercises that could initially be challenging to incorporate into daily routines. Therefore, the chosen interventions were *micro* in the sense that all were easy to understand and could be performed in short time periods. Third, we chose *interventions that could promote different types of*

Table 1. Robot-delivered micro-interventions, organized by category and corresponding mental health information.

Categories	Definition	Micro-interventions	Evidence-based practices
Stay Present	Brings users back to the present moment and helps them gain perspective, re-centre and promote self-soothing feelings	• 'Notice Five Things' • 'Hands as Thoughts' • 'Five Senses'	• ACT • ACT • DBT
Calm Down	Supports relaxation, a decrease in anxiety and stress levels and promote interior focus	• 'Notice Five Things' • 'Hands as Thoughts' • 'Dandelion'	• ACT • ACT • ACT
Know Your Emotions	Reframes negative events, helps to name emotions and promotes reflection and space to experience feelings	• 'Lemonade' • 'Yes and No' • 'Emotional Clarity'	• DBT • ACT • DBT
Reflection	Provides opportunities to clarify personal values, discover new ways of being and redirect focus towards personal goals	• 'Compass' • 'Opposite Action' • 'Emotional Clarity'	• ACT • DBT • DBT
Skill Building	Helps users learn new interpersonal skills, identify mistakes and take responsibility for their actions	• 'Opposite Action' • 'Compass' • 'Making Repairs'	• DBT • ACT • DBT
Survival Kit	Offers immediate and fast coping mechanisms for strong emotions, promotes interior focus and helps reframe negative events	• 'Five Senses' • 'Dandelion' • 'Lemonade'	• DBT • ACT • DBT

Notes: Each micro-intervention corresponds to an evidence-based practice. DBT: dialectical behavioural therapy; ACT: acceptance and commitment therapy.

benefits, with some targeting a moment of mindfulness and relaxation and others targeting skill building, e.g., learning to apologize and to identifying emotions. It was important to have a flexible library of micro-interventions to implement in the robot given the multiple needs that the youth have; Table 1 presents the chosen interventions and their corresponding definitions. In sum, we selected a total of 10 micro-interventions, from which 5 are from ACT and the other 5 from DBT.

Stage 2: translating micro-interventions into a social robot app

This stage aimed to *develop interactions between the user and the robot that captured the psychological mechanisms of the intervention*. To accomplish this,

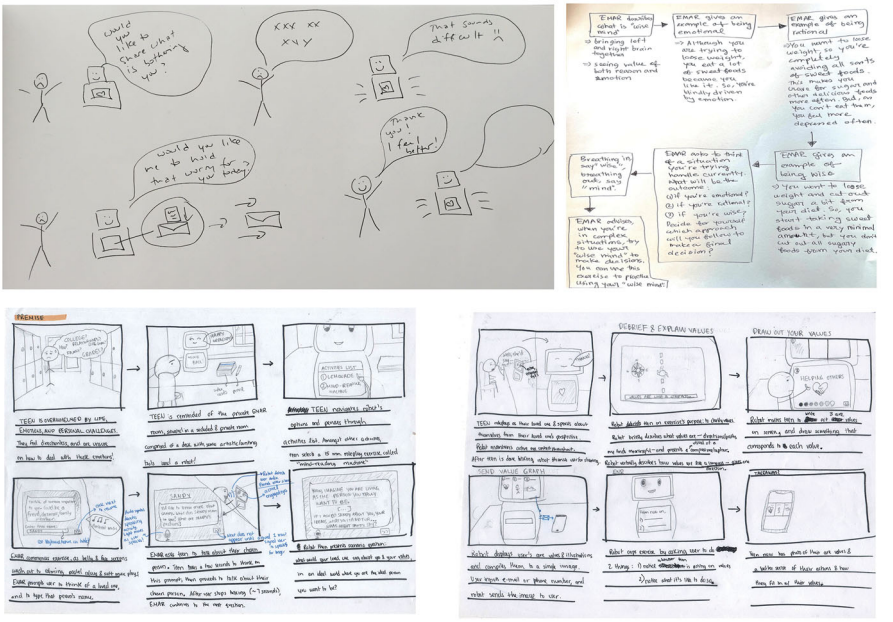


Figure 2. Examples of storyboards created by the research team to explore the behaviour of the robot during micro-interventions with the youth.

we conducted three types of design activities: (1) storyboarding to envision the youth-robot intervention, (2) defining intervention states to ensure the presence of key psychological mechanisms that make the micro-interventions beneficial to mental health and (3) implementing the robot system.

Storyboarding to design youth–robot interactions

We created storyboards so robot–youth interactions would have a tangible sequence, taking into consideration the sensing and behavioural capabilities of the robot (see Figure 2). *Storyboarding* is a technique that has been successfully used in the fields of human–computer interaction (HCI) and human–robot interaction (HRI) to envision future interactions between users and devices (Guo and Goh 2016; Truong, Hayes, and Abowd 2006; Tonkin et al. 2018). Storyboards captured the essence of interactions during a micro-intervention, providing a sequential logic to the interaction.

Defining intervention states for psychological mechanisms

This stage sought to define the different robot-youth intervention states *while ensuring the presence of key psychological mechanisms proven to be effective in mental health care*. To achieve this, we used Finite State Machines (FSM), which consist of a computational model for simulating sequential logic, i.e., representing and controlling execution flow of the robot-adolescent interactive intervention (see Figure 3). We explored the intervention in greater detail, giving attention in the FSM to each state in a sequential

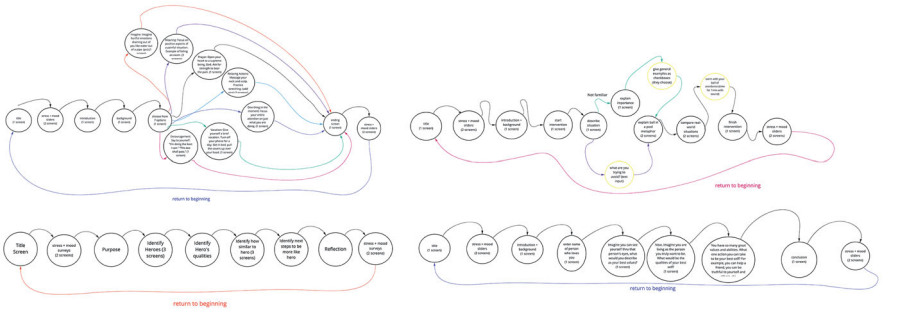


Figure 3. Examples of FSM developed before implementation. These examples show four micro-interventions with different levels if complexity of the interaction between the youth and the robot.

manner and created the bigger picture of the intervention. Thus, this procedure of transforming storyboards into FSM allowed small but crucial details to be added to the intervention, such as key sentences that the robot would say to facilitate relaxation, skill building, or reflection.

Implementing the robot app

Here, the goal was to *code the intervention into the robot app*. We designed a system that incorporated End-User programming (EUP) for rapid and easy computational prototyping and design. EUP is custom, web-based robot programming software created using JavaScript, HTML, CSS and the Firebase real-time database. Importantly, the EUP tool has a rendered display through which coders can change the robot's facial expressions and interactive behaviours (including sounds, displayed text and other interactive features). The robot was thus able to display multiple adolescent-friendly communication modalities, including colours, gifs and sounds. The result was a set of ACT and DBT interventions that the robot could deliver to adolescents.

Stage 3: involving youth and clinical psychologists

We conducted co-design sessions with the youth and evaluations of heuristis with the clinical psychologists, which we detail below.

Co-designing with youth for robot agent

Here, we aimed to *confirm our design assumptions and collect new requirements for the robot's character design, including its interaction capabilities and aesthetics*. It was essential that the robot interact in a youth-centric way. Additionally, we wanted the robot's aesthetics to suit the preferences of adolescent users to be motivating and appealing. To achieve this, we conducted a series of virtual design sessions with adolescents where several robot prototypes were shown and improved upon using their input.

A total of 30 adolescents participated in co-design sessions. Inspired by the work of Björling and Rose (2019), we created activities that included ideation, brainstorming and prototyping to engage adolescents in robot character design. We used Zoom breakout rooms, where small groups of adolescents used different versions of the robot. At the conclusion of these sessions, we collected their feedback and used it to refine the robot's design. We scheduled a total of six design sessions, which were completed within six weeks (one session per week, to allow time to improve the robot before its next use).

These co-design sessions helped us improve many aspects of the robot's design. For example, users noted that they were not ready right away to enter a micro-intervention and would appreciate some 'small talk' with the robot before doing so. Therefore, to ease the youth into the micro-interventions, we added a few moments of light conversation and rapport building, where the robot asked them how they were doing both at the beginning and the end of the micro-interventions to allow for easier segues. Users also wanted some information about the intervention before engaging in it; therefore, we added a short introduction, where the robot explains its purpose and sets expectations for the interaction.

In terms of robot aesthetics, users consistently preferred a robot with pastel colours to facilitate a serene environment for their interactions. They also noted that the robot occasionally talked 'too much', so we substantially decreased its verbosity: users wanted to do the talking and wanted the robot to listen, a not unimportant aspect of any therapeutic interaction.

Evaluating heuristics with clinical psychologists

During this stage, we wanted to *improve the interventions delivered by the robot to ensure the presence of the psychological mechanisms that provided healing*. We conducted two heuristic review sessions via Zoom, one with an ACT and another with a DBT expert (Nielsen and Molich 1990). We showed each intervention with the robot using activities from the ACT and DBT workbooks to gain their perspective. Their feedback was essential to ensure therapeutic value from the interventions; with their input, we developed the following template for therapeutic values that grounded our design of micro-interventions:

- **Orientation.** Orient the youth to the intervention by stating what type of activity they will perform, e.g., mindfulness or physical activity.
- **Value.** Explicitly state the benefit of the micro-intervention they will engage in, e.g., 'You will have the opportunity to learn how to apologize for mistakes', or 'You will learn relaxation techniques'.

- **Intervention time.** Relate the time needed to perform the intervention and guide users through every step to teach them how to do it.
- **Practice to empower.** Close the micro-intervention with a summary of how they can use the activity in their daily lives and how they can continue practicing it alone or with friends, e.g.,before going to bed or when they feel anxious.

We used the therapeutic values uncovered by these evaluations to refine and guide the design of all the micro-interventions implemented in the robot.

The robot app

This section highlights features of the final robot app that emerged after the design studies described previously. We specify the micro-interventions delivered by the robot and the aesthetics and interaction qualities that made this robot an engaging intervention tool for its users.

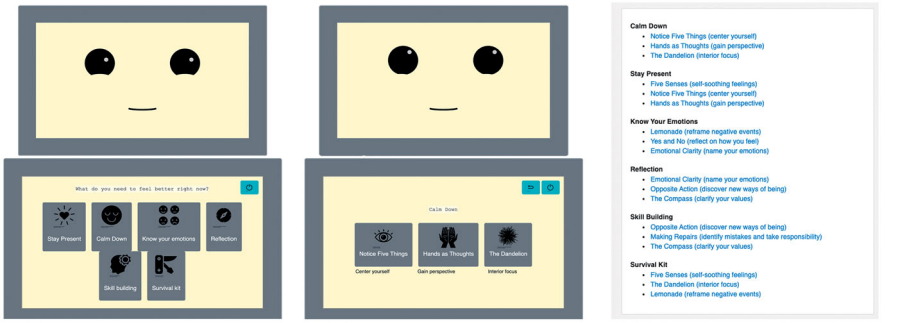
Youth–robot interaction

The robot can be accessed using a web app for which each adolescent creates an account. They access the app using either a computer or their smartphone. When accessing the robot, users are greeted and invited by the robot to choose a category that contains several mental health options they choose from on the Navigation Panel, e.g., the category 'Calm Down'. After choosing, they enter a second menu with specific activities to choose from. Each activity corresponds to a micro-intervention inspired by either ACT or DBT evidence-based practices. See Figure 4(a,b) for visuals on the app interface.

The robot has interaction capabilities that sustain engagement during a micro-intervention, such as eye blinking, other movements and sounds. While the robot's eye blinking behaviour is random and does not change according to user input, it still offers a powerful interaction modality that signals being present and attentive, both appropriate for a short micro-intervention. Additionally, we used the B.E.S.T. sound corpora (Hastie et al. 2016) for robot vocalizations during the interventions. This sound corpora was extensively studied and validated for HRI, and it contains sound-emotions the robot makes throughout an intervention.

Micro-interventions

The final robot system consists of 10 micro-interventions, divided into 6 categories that correspond to various mental health benefits. Table 1 shows the



(a) Robot navigation panel **(b)** Micro-interventions **(c)** Digital workbooks

Figure 4. App for youth mental health care. (a) Robot navigation panel with six categories of interventions users can choose from according to their mental health need, eg 'Calm Down'; (b) three sample micro-interventions part of the category 'Calm Down', including 'Notice Five Things', 'Hands as Thoughts', and 'Dandelion'. Users can select a micro-intervention by clicking on the corresponding icon, and a simple description about the benefits of the intervention is provided, eg The micro-intervention 'Notice Five Things' is about centring oneself; (c) digital workbooks with micro-interventions. This is the traditional therapy format.

full list. The categories are not mutually exclusive: one intervention can be part of more than one category, e.g., the micro-intervention 'Know Your Emotions' is present in the categories of 'Reflection' and 'Know Your Emotions' since this vital activity is intended to educate users about their emotions while concurrently promoting reflection and space for change. Each micro-intervention was designed to occur within a short time period; the mean time of the interventions is 3 min. However, the activities are self-paced, so users can choose to dedicate more or less time to them.

Evaluation study: robot vs workbook

We conducted a preliminary study to collect insights on youth preferences when using the robot and the digital workbooks for mental health support. For this, the youth ('users') engaged in a two-week study; they used the robot system (week 1) and the digital workbook (week 2) (see Figure 5 for a visual representation of the overall study procedure). The main goal of this study was to elicit user impressions about potential mental health benefits of using robot-mediated versus traditional workbook-delivered interventions.

Sample

Our sample consisted of 19 participants (11 females, 8 males) who ranged in age from 15 to 18 years old ($M = 16.05$, $SD = 1.03$). Participants were recruited using an online flyer shared on social media websites. Only adolescents whose parents signed the consent form were included in the study, which was approved by the University of Washington IRB.

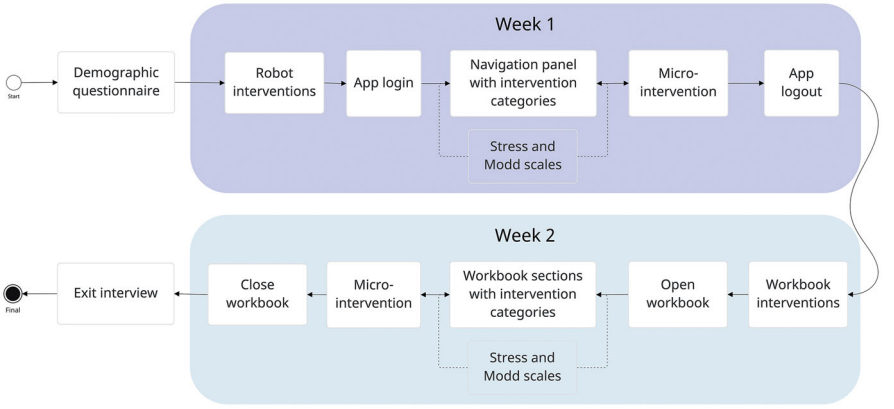


Figure 5. Study flow. Participants included in Group 1 started the study using the robot-based interventions (week 1) and then performed the workbook-based interventions (week 2). Participants included in group 2 inverted this process, starting week 1 with the workbook-based interventions and week 2 with the robot-based interventions. Randomization of the study flow was performed to avoid result bias due to order effects. All participants started the study with a demographic questionnaire and finished it with an exit interview.

As an inclusion criterion, participants needed to have access to a smartphone/computer with internet access since this was needed to run the robot system *and* review the digital workbooks during the study. Self-reported ethnicity identified 42.11% of our participants as Asian, 36.84% as Caucasian, 21.05% as Hispanic and 15.79% as Hawaiian/Pacific Islander. As compensation for their time, study participants received a $20 gift card.

Procedure

Participants started the study by filling out an online intake demographics survey. After completion, an online session with researchers was held via Zoom to explain the study procedure. Each participant was part of this study for two consecutive weeks. Figure 5 shows the study flow, and a video explaining the study procedure is included as Supplementary Material for this submission.

Participants were divided into two groups. Group 1 started week 1 using the robot system to engage in micro-interventions for mental health care. When the first week ended, this group progressed to week 2 use of the digital workbooks. Group 2 started week 1 with the digital workbook and progressed to week 2 with the robot. We randomized the study flow to decrease result bias due to order effects (Perreault 1975).

For each week of the study, participants were instructed to (1) use the robot or digital workbooks at least three times per week and (2) perform at least two activities per day. This minimum usage rule was set to ensure

ongoing engagement in the study and active participation. Participants were invited to use the robot/workbooks more frequently than the minimum usage rule; however, doing so was optional.

At the end of the two weeks, participants completed a usability questionnaire about the robot and the workbook and were invited to participate in an exit interview. Participants received one compensation gift card at the end of week 1 (first gift card of $10) and the second after the exit interview (last gift card of $10).

Materials

Mental health care app

We developed an app for this study to provide user access to the robot system and the digital workbooks. Each user received login information to the app to ensure privacy. After entering the app, users chose either robot-based or the digital version of the workbook-based interventions. If the former, users saw a digitally rendered social robot that engaged with them in mental health activities (see Figure 4(a,b) for a visual). When entering the digital workbook, users saw a list of activities names to select and perform (see Figure 4(c) for a visual).

Stress and mood scales

Before and after each micro-intervention, participants were asked to report their stress and mood levels using a sliding scale. Stress was reported from 'No Stress' to 'Extremely Stressed', and mood was reported from 'Negative Mood' to 'Positive Mood'. We collected this data as part of our Ecological Momentary Assessment of Stress and Mood, where data is collected at the time of intervention; this approach has proven effective with the adolescent population (Heron et al. 2017).

Exit interview

We conducted an exit interview to collect in-depth insights about the workbook and the robots usability. The full exit interview content, included in the Supplementary Materials, was the basis for our report on qualitative results.

Results

We now present the quantitative results from the Stress and Mood Scales as well as the qualitative results from the exit interviews, both of which enriched our understanding of app usability.

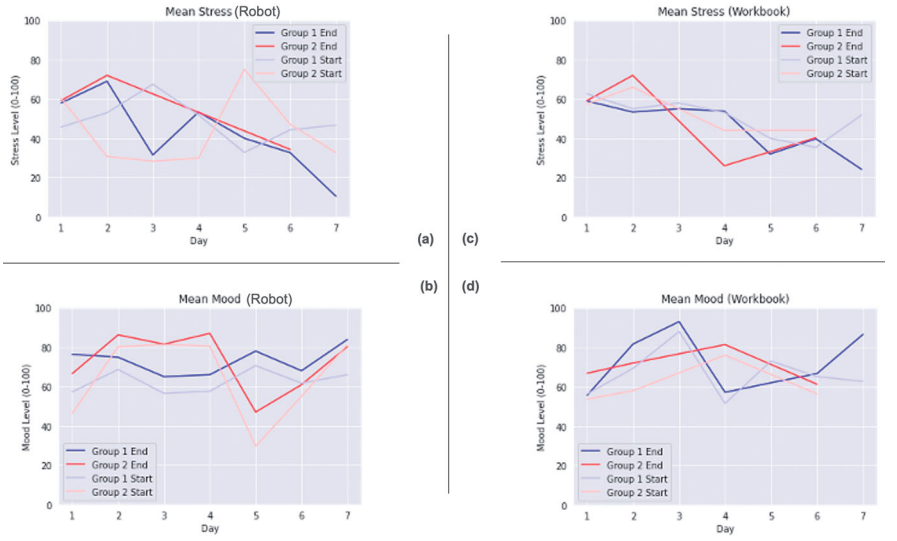


Figure 6. Mean values of the ecological momentary assessment of stress and mood while using the robot (see (a) and (b)) versus the workbook (see (c) and (d)).

Ecological momentary assessment of stress and mood

Figure 6 shows that user stress levels decreased over time, both when using the robot (pre micro-interventions: $M = 46.95$; SD = 24.07; post micro-interventions: $M = 40.96$; SD = 27.44) and using the workbook (pre micro-interventions: $M = 49.11$; SD = 23.11; post micro-interventions: $M = 44.28$; SD = 23.82). Mood levels fluctuate in the graphs, for both robot (pre micro-interventions: $M = 61.87$; SD = 21.83; post micro-interventions: $M = 72.84$; SD = 18.26) and workbook usage (pre micro-interventions: $M = 49.11$; SD = 23.11; post micro-interventions: $M = 68.89$; SD= 8.95), with tendencies to decrease and increase. Mood variability in adolescent years is considered normative since its fluctuations are a consequence of a variety of factors, both physical and emotional (Maciejewski et al. 2015).

While quantitative results can show general user trends in stress and mood levels, they do not reveal the full picture for two reasons. First, our sample size was small, so we did not perform comparative statistical analysis of the data. Second, we need more detailed qualitative interview data to give perspective to these trends.

Qualitative analysis

We anchored our data analysis in qualitative research methods, which are suitable for exploratory studies such as ours that support inductive practices; these methods can lead to prominent emerging themes without existing prior hypotheses (Sofaer 1999). This approach was compatible with our study

goal, i.e., enriching our understanding of youth preferences towards robot-based micro-interventions for mental health care.

We uploaded transcribed interviews to Miro Board, an online collaborative whiteboard suitable for research analysis that enables visual organization of data and exploration of prominent themes. Three researchers collaboratively coded the data. Two researchers independently organized interview materials into emerging themes.

To ensure consistency across coders, calibration exercises were performed until stability was reached (Krippendorff 2009). After coding 30% of the data, the two coders met to resolve discrepancies (Campbell et al. 2013); they compared their coding schemes to ascertain concordances (i.e., alignment in definitions, language and coding logic). When discrepancies arose, a 'negotiation agreement' was used, whereby they verbally discussed differences with a mutual effort to reconcile disagreements and divergence (Hoyle, Harris, and Judd 2002; Garrison et al. 2006). The third coder joined the discussion when 50% and 100% of the data was coded to help disambiguate negotiations. We used an affinity diagram approach to code and organize the data (Kawakita 1991); affinity diagramming is used to externalize, make sense of and organize large amounts of unstructured, far-ranging and possibly dissimilar qualitative data (Hartson and Pyla Pardha 2012). We now present the major theme areas and topics from this process.

Socio-emotional benefits

Help in calming down and reducing stress. The youth explicitly expressed that performing the activities helped them to calm down and reduce stress. In one example, a user mentioned that *'when I first started it, I think I was mad, and it caused stressed feeling…'* (P12, Female, 18 yo); that user continued: *'it helped me feel way better than when I started it'*. The activities also showed the potential to help users relieve other negative feelings. One user (P18, Male, 16 yo) mentioned that the robot helped when they were feeling down. *'For a couple of times I wasn't feeling as good and then by the end, it actually changed, not a huge amount, but a noticeable amount'*. Some users also indicated how the activities helped calm them, saying that the activities helped them to *'really understand your surroundings'* and *'force you to understand that you are in the moment'*, (P3, Female, 7 yo) and *'focus on my things'* (P3, Female, 7 yo).

Help in managing emotions. During the interviews, users mentioned the potential of micro-interventions to make them more aware of their emotions and develop skills to manage emotions. One user noted that

> *The reflective pondering with the activities was good for me because it helped me realize like, okay, these are things that I did during the day that made others feel*

> *uncomfortable or made me feel uncomfortable by the way I approached it, or these are things I did good, that I should keep working on and get better at*. (P16, Male, 16 yo)

Another user also mentioned that the activities *'in general just make you more proactive in terms of you as a person, how you're feeling and how you actually are reacting to your own emotions'* (P16, Male, 16 yo).

Opportunity for interpersonal connection. Users mentioned that they had opportunities to connect and show care to other people during the micro-interventions. Although they were never asked to share activities with others, one user told her friend about an activity because she thought it might be helpful; she then did the activity together with her friend (P2, Female, 16 yo). A second adolescent also told her sister to try two of the activities because they worked for her (P8, Female, 17yo). Even users who did not share the activities expressed the willingness to do so: *'I would like to share some activities with a friend that would help them'* (P3, Female, 17 yo). Besides sharing the activities, one user also mentioned his experience of laughing and having fun with his friend while they were doing an activity together (P6, Male, 16 yo).

Creating a routine for mental health care

Encouraging a self-care routine. The micro-interventions demonstrated the potential to encourage users to build self-care routines. Many users indicated a preference for doing the activities at night to help them take a break from school work or reflect on their day. One mentioned that she did some activities before an exam to help her relax (P8, Female, 17yo). Another mentioned *'that was probably just like every Friday, if I did it [an activity], that was probably the best part for me'* (P16, Male, 16 yo). The mental health care routine became more comfortable as users became more familiar with the app. One user noted that the

> *first time, I did it in like 30 minutes, but the other times I did them in more like 45 minutes to an hour to work on, to do more activities and also to reflect on myself because I feel like that's important part of the day*. (P16, Male, 16 yo Ethan)

Support reflecting on the past, present and future. Once a self-care routine was established, users noted the benefits of regular reflections on their days or weeks. Many users expressed that those reflections help them to be more clear-headed and focussed. One noted that *'the workbook and the robot version help me rethink my days and reflect on them, and then just keep in mind what's in right now, and don't get too frustrated with things that are going on'* (P16, Male, 16 yo Ethan). Another also indicated that the activities helped him to *'actually take time to know what the problem is and knowing what to*

do next' (P5, Male, 16 yo). The reflection was also helpful for users to ponder '*who do you want to be… whether it's in a year, whether it's in a day, whether it's in a week*' (P4, Male, 14 yo).

About robot-based interventions

A preference for the robot. Mental health micro-interventions were delivered via an online workbook and a robot app, as mentioned in the procedure. Users noted the benefits of each media but emphasized their preference for the robot. They liked the workbook for its well-organized structure, allowing them a holistic view of all the micro-interventions and easy navigation (P8, Female, 17 yo). However, the workbook reminded some users of the dull paperwork they frequently do as part of their school work. '*I preferred the robot more just because with the workbook is a bit. I don't wanna say harsh but it's super straightforward*' (P2, Female, 16 yo). The majority of users liked the robot's interactivity, which helped to ensure the effectiveness of the micro-interventions. For example, one user mentioned that

> *I think I liked the robot more just because it was more interactive, and it would give me like timers for each activity, and it would be like, ok, 'take 1 min and you can't move on until you finish it,' so it forces you to do it instead of just skipping through it*. (P3, Female, 17 yo)

The robot makes sounds during certain activities, which some users also found helpful to '*pace things out*' (P2, Female, 16 yo). Some also appreciated its blinking eyes and '*cute and cozy look*' (P3, Female, 17 yo). Beyond its favourable look and behaviours, the robot also made the experience more 'realistic', mimicking a real paced interaction (P16, Male, 16 yo Ethan), and '*it feels like a bit more of a connection*' (P15, Male, 16 yo).

Describing the robot to a friend. We asked the users to describe the robot to a friend to gather ideas about what they would highlight. Some referred to the robot as a tool for centring. For example, one user described the robot as helping to '*clear your thoughts out more, clarify things and gain a better perspective*' (P5, Male, 16 yo). Another described it as

> *a tool to help like, manage your emotions and stress, and just a way to like, kind of escape. . I mean, some of the activities to escape from like your life and… the stress of your life. And… even if it's for like only a couple minutes … then that could help your overall stress throughout the day*. (P18, Male, 16 yo)

The robot also helped that user improve his day.

> *I would probably tell my friend, let's say, there's this really cool program where you get to; it's kind of like a meditation or self-reflection basis, where you can think about aspects of life and ponder how you would handle them and … how you would want to steer yourself better by expressing your emotions, and … gives you a chance to*

kind of vent frustrations and express joyful things that allow you to make your days better.

Non-judgmental nature of the robot. Another theme commonly mentioned was the non-judgemental nature of the robot and the ability to maintain privacy and build trust. For example, one user said: *'I think the way I would like to phrase it is that you're talking to someone who does not necessarily understand what you're saying, but there's zero judgement because they don't understand what you're saying. Right? It's a robot!'* (P6, Male, 16 yo). Another participant used the phrase *'venting out'* to describe the robot interactions: *'I'd describe it as a robot that you could vent to … this is probably be the most simple way of explaining it just feels like someone to, yeah, vent to'* (P16, Male, 16 yo). One user also mentioned that *'Some people have trust issues. So it's like you could tell them that is between you and the robot'* (P19, Female, 15 yo).

Discussion

This paper presented the design, development and preliminary evaluation of a robot-mediated intervention for mental health care across the adolescent population. Our work involved a total of 49 adolescents (30 involved in the co-design study and 19 in the validation study) and 2 evidence-based clinical psychologists. We applied participatory design practices, such as co-design and evaluations of heuristics, to improve and develop our robot. A few features of this work require further elaboration and reflection, which we note below.

Supplement versus replacement

While our work has impact in the field of healthcare robotics, our intention is not to replace human therapy. Instead, we sought to develop a new tool that youth could access to supplement existing practices or to launch a new and convenient practice of mental health care. While existing tools for youth mental health involve physical books with exercises or smartphone apps, our work presents a new media to deliver interventions using an interactive robot, in which its interactivity is essential to promote engagement in mental health routines.

Furthermore, our robot was designed with therapeutic principles, which is not the case for most of the current apps, making it a trustworthy tool for health care. This makes our robot a viable supplement to youth mental health care without replacing existing human therapies. Indeed, this robot shows that there is a design space where new tools for mental health that enable self-care. Our robot makes use of accessible language and micro-

interventions that target common youth needs, being a tool they can use while no other service is available.

We strongly recommend that youth who suffer from major mental health problems should not solely rely on this tool, and additional professional support would be needed. We believe that a tool that can promote and extend meaningful relational connection is valuable, as we saw from our qualitative results.

The power of interactivity and non-judgement

Adolescents recognized the robot as an entity that was not particularly intelligent (i.e., it could not understand them). However, because of this, they felt safe in sharing information and knowing the robot would not judge them. Although at different stages of this project we intended to create a more intelligent robot, during the design sessions and the evaluation study, adolescents never showed a desired for a smarter robot. Instead, they enjoyed its simple design and behaviour, which we intend to keep in future iterations of this work.

The design requirement of simple robot embodiment and behaviour relates to discussions about privacy of mental health data. While more complex robots can have more options of interaction compared to our robot, the acceptance of such high-intelligence robots can be low due to perceived privacy breaches. Because our robot is not collecting information about a particular user, we believe that worries about privacy will not be in the way of using the robot for mental health care. In particular, we envision this robot as a community tool that can be shared between youth, e.g., they can share the robot with a friend that might be in need of extra support and because no individual data is store, youth privacy is kept safe. We intend to study in future work perceptions of privacy in robots with simple behaviours.

Because youth had to interact with the robot systematically when performing a micro-intervention, they made time to connect and set a pace for the practice. They mentioned that this type of practice offers greater benefit compared to a workbook style, where they could skip through harder parts of the intervention or neglect others. Therefore, the robot's power of interactivity offers one of the main factors for engagement and willingness to return to mental health care practices.

Limitations and future work

We acknowledge the following study limitations. While we contributed to the translation of evidence-based therapies to a digital format, we did not fully uncover the psychological mechanisms that make these therapies effective. In other words, we understood the sequence of content to present

to app users but were unable to model it computationally. This is both a limitation and future work we are currently exploring.

Furthermore, although we used an interactive social robot to deliver these interventions, we could not isolate which aspects of the robot might have contributed to higher adolescent engagement. In light of this, more research is needed in terms of sample description, including controlling variables, such as previous or ongoing exposure to psychological therapies and levels of depression and anxiety, among others.

Our last limitation concerns sample size. As noted previously, since we had a relatively small sample, it was not possible to conduct statistical tests to understand the effectiveness of using a robot vs. using traditional workbooks in the mental wellbeing of our adolescent users. While this was an important and essential study to investigate the acceptance, adoption and engagement of adolescents using a digital robot for their mental health, our current contributions are to usability research, not experimental research. Since we now know that adolescents are interested and willing to engage in interventions on their own with a digital robot, more research is needed to understand the effectiveness of these interventions in ongoing mental health efforts of broader population.

Note

1. Traditionally, ACT and DBT exist as physical workbooks that adolescents work through to improve their mental health. Examples of these workbooks include the 'Dialectical Behaviour Therapy Skills Training with Adolescents: A Practical Workbook for Therapists, Teens & Parents' (Eich 2015), 'Implementing Dialectical Behaviour Therapy Skills Training for Emotional Problem Solving for Adolescents (DBT STEPS-A) in a Low-Income School' (Chugani et al. 2022), 'ACT for Adolescents: Treating Teens and Adolescents in Individual and Group Therapy' (Turrell and Bell 2016) and 'The Thriving Adolescent: Using Acceptance and Commitment Therapy and Positive Psychology to Help Teens Manage Emotions, Achieve Goals, and Build Connection' (Hayes and Ciarrochi 2015). Work in the field of digital health, such as mHealth, has found that digital interventions are extremely desirable and effective among adolescents (Anderson-Lewis et al. 2018; Jeminiwa, Hohmann, and Fox 2019).

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References

American Psychological Association. 2014. *Stress in America 2013 Highlights: Are Teens Adopting Adults' Stress Habits*.

Anderson-Lewis, Charkarra, Gabrielle Darville, Rebeccah Eve Mercado, Savannah Howell, and Samantha Di Maggio. 2018. "mHealth Technology Use and Implications in Historically Underserved and Minority Populations in the United States: Systematic Literature Review." *JMIR mHealth and uHealth* 6 (6): e8383. doi:10.2196/mhealth.8383.

Björling, Elin A, and Emma Rose. 2019. "Participatory Research Principles in Human-centered Design: Engaging Teens in the co-Design of a Social Robot." *Multimodal Technologies and Interaction* 3 (1): 8. doi:10.3390/mti3010008.

Boniel-Nissim, Meyran, and Azy Barak. 2013. "The Therapeutic Value of Adolescents' Blogging about Social–Emotional Difficulties." *Psychological Services* 10 (3): 333–341. doi:10.1037/a0026664.

Borghouts, Judith, Elizabeth Eikey, Gloria Mark, Cinthia De Leon, Stephen M. Schueller, Margaret Schneider, Nicole Stadnick, Kai Zheng, Dana Mukamel, and Dara H. Sorkin. 2021. "Barriers to and Facilitators of User Engagement with Digital Mental Health

Interventions: Systematic Review." *Journal of Medical Internet Research* 23 (3): e24387. doi:10.2196/24387.

Campbell, John L., Charles Quincy, Jordan Osserman, and Ove K. Pedersen. 2013. "Coding In-depth Semistructured Interviews: Problems of Unitization and Intercoder Reliability and Agreement." *Sociological Methods & Research* 42 (3): 294–320. doi:10.1177/0049124113500475.

Chugani, Carla D., Courtney E. Murphy, Janine Talis, Elizabeth Miller, Christopher McAneny, Daniel Condosta, Julie Kamnikar, Edward Wehrer, and James J. Mazza. 2022. "Implementing Dialectical Behavior Therapy Skills Training for Emotional Problem Solving for Adolescents (DBT STEPS-A) in a Low-income School." *School Mental Health* 14 (2): 391. doi:10.1007/s12310-021-09472-4.

Coyne, Lisa W., Louise McHugh, and Evan R. Martinez. 2011. "Acceptance and Commitment Therapy (ACT): Advances and Applications with Children, Adolescents, and Families." *Child and Adolescent Psychiatric Clinics of North America* 20 (2): 379–399. doi:10.1016/j.chc.2011.01.010.

Coyne, Sarah M., Laura M. Padilla-Walker, Laura Stockdale, and Randal D. Day. 2011. "Game on Girls: Associations between Co-playing Video Games and Adolescent Behavioral and Family Outcomes." *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine* 49 (2): 160–165. doi:10.1016/j.jadohealth.2010.11.249.

Eich, Jean. 2015. *Dialectical Behavior Therapy Skills Training with Adolescents: A Practical Workbook for Therapists, Teens & Parents*. Eau Claire, Wisconsin: PESI Publishing & Media.

Garrison, D. Randy, Martha Cleveland-Innes, Marguerite Koole, and James Kappelman. 2006. "Revisiting Methodological Issues in Transcript Analysis: Negotiated Coding and Reliability." *The Internet and Higher Education* 9 (1): 1–8. doi:10.1016/j.iheduc.2005.11.001.

Gunnell, David, Judi Kidger, and Hamish Elvidge. 2018. *Adolescent Mental Health in Crisis. BMJ*.

Guo, Yan Ru, and Dion Hoe-Lian Goh. 2016. "From Storyboard to Software: User Evaluation of an Information Literacy Game." In *Proceedings of the 31st Annual ACM Symposium on Applied Computing*, 199–201. Pisa, Italy: ACM.

Haga, Egil, Eline Aas, Berit Grøholt, Anita J. Tørmoen, and Lars Mehlum. 2018. "Cost-Effectiveness of Dialectical Behaviour Therapy vs. enhanced Usual Care in the Treatment of Adolescents with Self-Harm." *Child and Adolescent Psychiatry and Mental Health* 12 (1): 22. doi:10.1186/s13034-018-0227-2.

Halliburton, Amanda E, and Lee D. Cooper. 2015. "Applications and Adaptations of Acceptance and Commitment Therapy (ACT) for Adolescents." *Journal of Contextual Behavioral Science* 4 (1): 1–11. doi:10.1016/j.jcbs.2015.01.002.

Harris, Russ 2019. *ACT Made Simple: An Easy-to-read Primer on Acceptance and Commitment Therapy*. Oakland, CA: New Harbinger Publications.

Hartson, Rex, and S. Pyla Pardha. 2012. *The UX Book: Process and Guidelines for Ensuring a Quality User Experience*. Waltham, MA: Elsevier.

Hastie, Helen, Pasquale Dente, Dennis Küster, and Arvid Kappas. 2016. "Sound Emblems for Affective Multimodal Output of a Robotic Tutor: A Perception Study." In *Proceedings of the 18th ACM International Conference on Multimodal Interaction*, 256–260. Tokyo, Japan: ACM.

Hayes, Louise L, and Joseph V. Ciarrochi. 2015. *The Thriving Adolescent: Using Acceptance and Commitment Therapy and Positive Psychology to Help Teens Manage Emotions, Achieve Goals, and Build Connection*. Oakland, CA: New Harbinger Publications.

Heron, Kristin E., Robin S. Everhart, Susan M. McHale, and Joshua M. Smyth. 2017. "Using Mobile-technology-based Ecological Momentary Assessment (EMA) Methods with Youth: A Systematic Review and Recommendations." *Journal of Pediatric Psychology* 42 (10): 1087–1107. doi:10.1093/jpepsy/jsx078.

Howells, Annika, Itai Ivtzan, and Francisco Jose Eiroa-Orosa. 2016. "Putting the 'App' in Happiness: A Randomised Controlled Trial of a Smartphone-based Mindfulness Intervention to Enhance Wellbeing." *Journal of Happiness Studies* 17 (1): 163–185. doi: 10.1007/s10902-014-9589-1.

Hoyle, Rick H., Monica J. Harris, and Charles M. Judd. 2002. *Research Methods in Social Relations*.

Jeminiwa, Ruth N., Natalie S. Hohmann, and Brent I. Fox. 2019. "Developing a Theoretical Framework for Evaluating the Quality of Mhealth Apps for Adolescent Users: A Systematic Review." *The Journal of Pediatric Pharmacology and Therapeutics: JPPT: The Official Journal of PPAG* 24 (4): 254–269. doi:10.5863/1551-6776-24.4.254.

Kawakita, Jiro 1991. *The Original KJ Method*. Tokyo: Kawakita Research Institute 5.

Koerner, Kelly, and Linda A. Dimeff. 2007. *Overview of Dialectical Behavior Therapy*. Guilford Press.

Krippendorff, Klaus. 2009. *The Content Analysis Reader*. Thousand Oaks, CA: Sage.

Linehan, Marsha M. 1987. "Dialectical Behavioral Therapy: A Cognitive Behavioral Approach to Parasuicide." *Journal of Personality Disorders* 1 (4): 328–333. doi:10.1521/pedi.1987.1.4.328.

Lozier, Carol 2018. *DBT Therapeutic Activity Ideas for Working with Teens: Skills and Exercises for Working with Clients with Borderline Personality Disorder, Depression, Anxiety, and Other Emotional Sensitivities*. Philadelphia, PA: Jessica Kingsley Publishers.

Maciejewski, Dominique F., Pol A. C. van Lier, Susan J. T. Branje, Wim H. J. Meeus, and Hans M. Koot. 2015. "A 5-Year Longitudinal Study on Mood Variability across Adolescence Using Daily Diaries." *Child Development* 86 (6): 1908–1921. doi:10.1111/cdev.12420.

MacPherson, Heather A., Jennifer S. Cheavens, and Mary A. Fristad. 2013. "Dialectical Behavior Therapy for Adolescents: Theory, Treatment Adaptations, and Empirical Outcomes." *Clinical Child and Family Psychology Review* 16 (1): 59–80. doi:10.1007/s10567-012-0126-7.

McCredie, Morgan N., Colleen A. Quinn, and Mariah Covington. 2017. "Dialectical Behavior Therapy in Adolescent Residential Treatment: outcomes and Effectiveness." *Residential Treatment for Children & Youth* 34 (2): 84–106. doi:10.1080/0886571X.2016.1271291.

Miller, Alec L., Jill H. Rathus, Anthony P. DuBose, Elizabeth T. Dexter-Mazza, and Arielle R. Goldklang. 2007. "Dialectical Behavior Therapy for Adolescents." *Dialectical Behavior Therapy in Clinical Practice: Applications across Disorders and Settings*: 245–263.

Miller, Alec L., Jill H. Rathus, and Marsha M. Linehan. 2006. *Dialectical Behavior Therapy with Suicidal Adolescents*. Spring Street, NY: Guilford Press.

Nicholas, Jennifer, Andrea S. Fogarty, Katherine Boydell, and Helen Christensen. 2017. "The Reviews Are in: A Qualitative Content Analysis of Consumer Perspectives on Apps for Bipolar Disorder." *Journal of Medical Internet Research* 19 (4): e105. doi:10.2196/jmir.7273.

Nielsen, Jakob, and Rolf Molich. 1990. "Heuristic Evaluation of User Interfaces." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, edited by Jane Carrasco Chew and John Whiteside, 249–256. Seattle, WA: ACM.

O'Connor, Marianne, Katy E. Morgan, Suzanne Bailey-Straebler, Christopher G. Fairburn, and Zafra Cooper. 2018. "Increasing the Availability of Psychological Treatments: A

Multinational Study of a Scalable Method for Training Therapists." *Journal of Medical Internet Research* 20 (6): e10386. doi:10.2196/10386.

Okamura, Kelsie H., Courtney L. Benjamin Wolk, Christina D. Kang-Yi, Rebecca Stewart, Ronnie M. Rubin, Shawna Weaver, Arthur C. Evans, Zuleyha Cidav, Rinad S. Beidas, and David S. Mandell. 2017. "The Price per Prospective Consumer of Providing Therapist Training and Consultation in Seven Evidence-based Treatments within a Large Public Behavioral Health System: An Example Cost-analysis Metric." *Frontiers in Public Health* 5: 356. doi:10.3389/fpubh.2017.00356.

Perreault, William D. 1975. "Controlling Order-effect Bias." *The Public Opinion Quarterly* 39 (4): 544–551.

Rathus, Jill, Bevin Campbell, Alec Miller, and Heather Smith. 2015. "Treatment Acceptability Study of Walking the Middle Path, a New DBT Skills Module for Adolescents and Their Families." *American Journal of Psychotherapy* 69 (2): 163–178. doi:10.1176/appi.psychotherapy.2015.69.2.163.

Schueller, Stephen M., and Elizabeth C. Adkins. 2019. "Mobile Health Technologies to Deliver and Support Cognitive-behavioral Therapy." *Psychiatric Annals* 49 (8): 348–352. doi:10.3928/00485713-20190717-02.

Schueller, Stephen M., and John Torous. 2020. "Scaling Evidence-based Treatments through Digital Mental Health." *The American Psychologist* 75 (8): 1093–1104. doi:10.1037/amp0000654.

Sofaer, Shoshanna 1999. "Qualitative Methods: What Are They and Why Use Them?" *Health Services Research* 34 (5 Pt 2): 1101–1118.

Stoddard, Jill A, and Niloofar Afari. 2014. *The Big Book of ACT Metaphors: A Practitioner's Guide to Experiential Exercises and Metaphors in Acceptance and Commitment Therapy*. Oakland, CA: New Harbinger Publications.

Tonkin, Meg., Jonathan Vitale, Sarita Herse, Mary-Anne Williams, William Judge, and Xun Wang. 2018. "Design Methodology for the ux of Hri: A Field Study of a Commercial Social Robot at an Airport." In *Proceedings of the 2018 ACM/IEEE International Conference on Human-Robot Interaction*, 407–415. Chicago, IL: ACM.

Truong, Khai N., Gillian R. Hayes, and Gregory D. Abowd. 2006. "Storyboarding: An Empirical Determination of Best Practices and Effective Guidelines." In *Proceedings of the 6th Conference on Designing Interactive Systems*, 12–21. University Park, Pennsylvania, USA: ACM.

Turrell, Sheri L, and Mary Bell. 2016. *ACT for Adolescents: Treating Teens and Adolescents in Individual and Group Therapy*. Oakland, CA: New Harbinger Publications.

Twohig, Michael P. 2012. *Acceptance and Commitment Therapy: Introduction*. *Science Direct* 19 (4).

Van Dijk, Sheri 2011. *Don't Let Your Emotions Run Your Life for Teens: Dialectical Behavior Therapy Skills for Helping You Manage Mood Swings, Control Angry Outbursts, and Get along with Others*. New Harbinger Publications.

Van Dijk, Sheri 2013. *DBT Made Simple: A Step-by-step Guide to Dialectical Behavior Therapy*. New Harbinger Publications.

Wisdom, Jennifer P., Gregory N. Clarke, and Carla A. Green. 2006. "What Teens Want: Barriers to Seeking Care for Depression." *Administration and Policy in Mental Health* 33 (2): 133–145. doi:10.1007/s10488-006-0036-4.