# "An Emotional Support Animal, Without the Animal": Design Guidelines for a Social Robot to Address Symptoms of Depression


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## ABSTRACT

Socially assistive robots can be used as therapeutic technologies to address depression symptoms. Through three sets of workshops with individuals living with depression and clinicians, we developed design guidelines for a personalized therapeutic robot for adults living with depression. Building on the design of Therabot™, workshop participants discussed various aspects of the robot's design, sensors, behaviors, and a robot connected mobile phone app. Similarities among participants and workshops included a preference for a soft textured exterior and natural colors and sounds. There were also differences – clinicians wanted the robot to be able to call for aid, while participants with depression differed in their degree of comfort in sharing data collected by the robot with clinicians.



## CCS CONCEPTS

• **Human-centered computing** → *HCI design and evaluation methods*; • **Social and professional topics** → **User characteristics**.

## KEYWORDS

Socially Assistive Robots, Depression, Human Robot Interaction, Robot Design

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## 1 INTRODUCTION

Depression is widespread, with approximately 3.8% of the global population experiencing depression at some point in their lives [46]. Socially assistive robots (SARs) have shown promising therapeutic benefits within the context of depression, including a reduction in depression symptoms [3] and increased happiness [24]. Currently used robots, however, are commonly not personalized to the needs of individual users. People living with depression can have a wide array of personalities and preferences, and depression itself can involve various co-morbidities that make generalized design difficult. These co-morbidities can include other mental health disorders [40] or physical disabilities [8].

Co-design with adults with depression provides one way to become aware of and address personal differences in the design of new technologies for Human Robot Interaction (HRI). Researchers acknowledge that, when designing for a specialised population, involving members of that population directly in the design process can bring forward ideas and functions that may be beyond the expertise of researchers alone. This perspective views the user population as experts in their own experience [33]. However, when working with participants who live with physical or mental illness, special challenges arise - such as ensuring that the participant's well-being is forefront in the research and maintaining an inclusive recruitment process.

To better understand the potential and need for personalized design of the socially assistive robot (SAR) Therabot™[4] (see figure 1) as a companion to traditional therapy for those living with depression, we developed three related workshop series. Discussions and activities in the workshops focused on the appearance of the robot, the behaviors and sounds of the robot, the sensors onboard the robot, any privacy concerns regarding the data collected by the robot, and the usefulness of a robot connected phone app. Five participants recruited from the mental health provider Centerstone, who had a confirmed diagnosis of depression, took part in a five-part online workshop covering the above topics. While recruitment with the facility Centerstone took place, we also recruited those from outside the facility. Ten participants who self-reported a depression diagnosis took part in a one-hour-long single online workshop. By recruiting in both ways, this allowed participants who may not have an official depression diagnosis from Centerstone to participate, as well as allowed us to test a shortened version of the workshops. Finally, four clinicians participated in four online workshops in which they suggested design guidelines for SARs for those living with depression.

By working with these diverse groups of participants, we aimed to find common themes regarding the robot's design to be implemented as options for users living with depression who may receive the Therabot™ robot in their homes.

Through the robot Therabot™ we sought to explore the effects of technology as similar to the calming nature of animal assisted therapy [? ], and the ability of data collection through sensors for management depression symptoms [12]. We present those themes below, including areas of the physical design of the robot, use cases for the robot, and concerns regarding data collection. Using these themes, we further discuss how participants requests may be implemented into the robot itself.

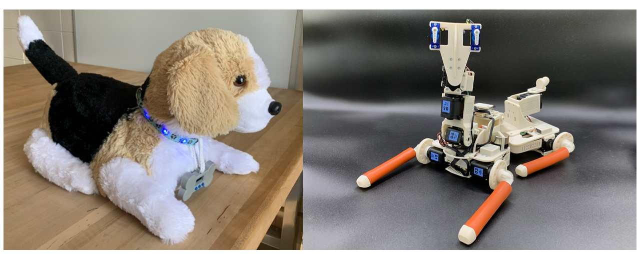

**Figure 1: Therabot with and without covering**

## 2 RELATED WORK

In the following sections, we review prior work on depression and its symptoms and common treatments, the use of SARs in mental health contexts generally and for depression specifically, and the participatory design of SARs.

### 2.1 Depression Prevalence, Symptoms and Tools

Depression is one of the leading mental illnesses in the world with approximately 280 million people living with the condition [46]. In 2021 alone, an estimated 21 million adults over the age of 18 had at least one depressive episode within the United States [35]. Depression can involve a variety of symptoms that cause both mental and physical strain on individuals, such as depressed mood, feeling worthless, suicidal ideation, and fatigue [18]. In addition to the symptoms commonly associated with depression, those who experience the illness may also experience co-morbidities brought on or exacerbated by their condition. This can include other diagnosed mental illnesses, such as generalized anxiety disorder [40] or physical conditions such as heart disease [8], which can produce difficulties in treating the individual holistically. There are many forms of treatment for depression, including working with a therapist, a psychiatrist, or a general health provider such as a primary care physician. One common therapy includes cognitive behavioral therapy which encourages cognitive restructuring and belief change [43]. Virtual sessions with a therapist have become more prominent, with an increase in individuals seeking this care [27], demonstrating its potential to make therapy more easily accessible [26]. Other therapies exist outside of a typical therapist's office or clinic, including animal assisted therapy [21], in which a non-human animal works with the individual. Animal-assisted therapy has been shown to reduce feelings of depression [25], through the encouragement of the participant to talk to the animal, and engaging in play with the animal [7].

### 2.2 Socially Assistive Robots

SARs function as robots that provide social interaction to support the user [14]. These robots have been used for a variety of applications, including motivation (encouraging the user's behaviors) [1], coaching (leading sessions) [19], and companionship [13]. The humanoid NAO robot has been used to alleviate anxiety with children in a hospitalization setting, showing a decrease in cortisol levels [39]. The NAO robot has also been used to develop and encourage communication skills with children diagnosed with autism [42].

One of the most ubiquitous SARs is the robotic seal Paro, which has been used with older adults living with dementia [44]. Paro's use led to increasing interaction between the user and their care team [41], as well as a reduction in depression and agitation [22].

As the number of uses cases for SARs grows, engaging each unique target population in the design process is important for increasing inclusiveness in robot design. Participatory design and co-design, provide a method where users are directly involved in the design process [30]. One such area is the development of a SAR to be used in education, where aspects such as communication features and appearance were explored by stakeholders [37].

Particular to depression, researchers have also completed participatory design workshops with older adults living with depression which explored the overall look of the SAR as well as potential uses [48]. These studies implemented various forms of data collection, from writing and discussion to sketching.

#### 2.2.1 *SARs used for Depression management.*

Many studies have focused on the use of socially assistive robots and their effects on depression with older adults specifically. In one study, older adults living with depression received Paro to use in their homes, while being monitored by researchers [38]. It was found that those that used Paro had a reduction in depression symptoms and the sensors placed on the robot aided in predicting depression levels [3].

Within the context of a care home in Taiwan the robot Paro also showed reduced depression and an improvement of quality of life, with participants humanizing the robot and using it as a way to engage with others [9]. Many studies focused on the SAR Paro, though less than half reported by Araujo et al. found improvement of depression symptoms [2]. Other studies, with more positive outcomes, included older adults with depression but developed a unique robot outside of what is commercially available, such as eBear [24] and found that the robot could increase the happiness of and uplift the individuals interacting with it. While one research group created Ryan, a robot for delivering cognitive behavioral therapy to older adults as an alternative to human only interaction to positive reviews [15].

## 3 CO-DESIGN WORKSHOPS

Three workshop types were conducted as part of this study, one with recruitment through Centerstone, one with those who self reported receiving a depression diagnosis elsewhere, and one with clinicians. Participants who were diagnosed with depression were recruited through flyers at the mental health facilities Centerstone and word of mouth from clinicians. Clinicians were recruited exclusively through word of mouth by office personnel who were familiar with the study. For the short form workshops, participants were recruited through Indiana University Classifieds system. Each of these workshops were approved by the Indiana University Institutional Review Board.

### 3.1 Long Form Workshops

Participants recruited through Centerstone for the long form workshops were invited to take part in five total virtual group meetings, each lasting an hour. These workshops were performed online through Zoom. Before the workshops began, participants were invited to a brief meeting with one of the researchers to discuss the study, ask any questions they may have, and to collect verbal consent, demographic data, and responses on the PhQ-9, a depression assessment questionnaire [28], from participants. The PhQ-9 rates the intensity of depression symptoms over the previous two weeks, with 5-9 being mild, 10 - 14 being moderate, 15-19 is moderately severe and over 20 is severe.

Workshop 1 provided an introduction to socially assistive robots and presented participants with two commercial robots through video (Buddy [6], and Paro[36]). They were also introduced to the robot Therabot™ that they would be focusing on during the following workshops, as well as basic sensors that may be present in the robot (such as ambient light, sound, and touch).

In workshop 2 a sketch artist from Mississippi State University joined. During this workshop sensors were reviewed, and participants were asked about their preference on the physical design and outer covering of the four-legged Therabot™ design. While participants described their desired robot covering, the sketch artist drew alongside, before showing the participants the drawing which was then altered based on participant specifications.

In workshop 3, participants were asked to sketch the layout of their home environment, how they move through their space, and where they spend the most time. They were then asked about where they thought they might use the robot the most, and why it may be used within those specific areas. Workshop 4 turned focus from the physical robot to a phone application that may be paired with the robot. Participants were asked to describe and draw what they would want to be able to do with the application, both when the robot is present and when it is not.

Workshop 5 was a final review, where participants were asked to read a brief story of an individual who lives with depression, and then re-imagine what that individual's daily life may look like with the robot that they had designed, based upon the previous 4 workshops. The prompts included one where the individual was at home, and one where the individual was in a therapy setting (such as a therapist's office). Participants were asked to write a short story using the prompt that focused on the individual in the prompt using their SAR.

In all five workshops, participants were invited to volunteer any information they thought about between sessions, and were asked to consider privacy and data collection implications when using the robot or phone application. At the end of each workshop participants were remunerated for their work.

### 3.2 Short Form Workshops

The short form workshops covered, briefly, much the same information as the long form workshops, as reported in [11]. This workshop took place over a period of an hour long video session, through Zoom. Participants were given a demographic questionnaire as well as the PhQ-9. Then, they were first introduced to SARs through Joy for All and Paro through videos, then they were introduced to Therabot™ via picture.

Focusing on the outside covering of Therabot™, participants were first asked to describe the covering of the robot based upon the skeletal structure. They were asked to draw two coverings based upon their preference, with one being focused on someone who did not like cats or dogs. Once they had chosen a covering to focus on, they were then introduced to common sensors, and asked what sensors they would prefer the robot include. Next participants were asked about the sounds and behaviors that they would want from the robot that they had designed, with specific questions focused on therapeutic tools.

Finally participants were asked about a robot connected phone app, and what capabilities they would want the app to have as well as what information they would want present. Particularly related to sensors and tracking information, participants were also asked about any privacy concerns that they may have when using the robot or the app. Last, participants were asked about any concerns they may have with using the robot.

### 3.3 Clinician Workshops

We performed four online clinician workshops in total, with the first three being attended by all clinicians and a fourth being attended only by clinicians that may spend time located in the clients homes.

Workshop 1 introduced the clinicians to socially assistive robots via description and video examples (Buddy[6], Mabu[31], Paro[36]). The clinicians were encouraged to discuss what they did and did not like about the robots for their clients, before being introduced to Therabot™. Next the clinicians were asked to play a game of "Yes, Let's..." an improvisation game where they each indicated a single aspect they wished to add to a socially assistive robot, by going around in a circle and building on the previous participants answer. This exercise was repeated twice: first, to discuss the physical design of the robot and second, to address the features they wanted the robot to sense, following a brief introduction to basic sensors.

In workshop 2 clinicians were introduced to the robot Therabot™ and its current touch sensors via video. Then they were shown robot designs from three clients that had completed the long form workshops. They were asked to give feedback on the clients' designs, as well as add what they would like to them. They were then asked questions regarding privacy and data collection with the robot, particularly in relation to sensors that they had chosen

**Table 1: Centerstone Diagnosed Demographic Data.**

| PNum | Age | Gender | Ethnicity | Education | PhQ-9 |
|---|---|---|---|---|---|
| LFP1 | 32 | Non-Binary | White | College Degree | 18 |
| LFP2 | 53 | Transwoman | White | Some College | 9 |
| LFP5 | 61 | Female | White | College Degree | 2 |
| LFP6 | 23 | Non-Conforming | White | College Degree | 21 |
| LFP7 | 21 | Female | White | High School | 6 |

**Table 2: Short Form Participant Demographic Data.**

| PNum | Age | Gender | Ethnicity | Education | PhQ-9 |
|---|---|---|---|---|---|
| SFP1 | 22 | Male | White | College Degree | 4 |
| SFP2 | 26 | Male | Asian | Post-Graduate | 12 |
| SFP3 | 25 | Male | White | College Degree | 6 |
| SFP4 | 31 | Female | White | Post-Graduate | 16 |
| SFP5 | 23 | Female | White | College Degree | 18 |
| SFP6 | 56 | Female | White | Post-Graduate | 22 |
| SFP7 | 25 | Female | Asian/Other | College Degree | 22 |
| SFP8 | 24 | Female | White | College Degree | 11 |
| SFP9 | 49 | Male | White | College Degree | 7 |
| SFP10 | 30 | Female | White | Post-Graduate | 7 |

in the previous workshop as well as more specific sensors like a camera.

In workshop 3, clinicians focused on the robot connected phone app. They were asked about their initial thoughts on the app, as well as shown a few designs from two of the client participants to discuss some of the requests from the the long form workshops. Finally, in workshop 4 only the clinicians that have spent time traveling to clients homes were included. They briefly discussed how they thought the robot might fit into the home environment of some of their clients with depression.

## 4 RESULTS

All excerpts were inductively coded by the first author, after being auto-transcribed and manually corrected from the workshops videos by a secondary member of the research team. Within the client coding, there was an 86% agreement in code application between the first author and a second research assistant who was familiar with the data. In this process the first author coded the workshops in their entirety, and then the secondary member of the research team reviewed each transcription, and excerpt for accuracy while coding. The 14% that were not in agreement were discussed between the two researchers and re-coded until codes were agreed upon. These codes were then compared to the codebook from the short form workshops to find overlaps and differences in the themes spoken about by participants, which was also confirmed by a secondary researcher. Codes which had a direct link (such as the cat form factor) were combined. Within the coding of the clinician based workshop there was a 81% agreement, with the 19% re-coded until codes were agreed upon. See appendix for codes application and explanation for each of the workshop types.

### 4.1 Participants

In the long form workshops, seven participants were recruited through Centerstone to participate. Of those seven, only five completed all five workshops, as one participant stopped attending due to scheduling constraints, and one stopped attending due to a mental health crisis (see Table 1). These five participants had a confirmed diagnosis of major depressive disorder from Centerstone clinicians, though many also had other co-morbid diagnoses. Participants 1 and 2 participated in the workshops together, participant five participated alone after the second workshop, and participant 6 and 7 participated together except for the final workshop due to scheduling constraints.

In the short form workshop, 10 participants took part in a 1 hour long workshop. These participants self-reported having a diagnosis of depression currently or in the past. Eight of the 10 completed the entire workshop, and two did not complete the phone app related portion (Table 2).

The four clinician participants were asked to describe their role at Centerstone. This group included those that worked in outpatient recovery, care coordination, dialectic behavior focused therapies, and a team leader.

### 4.2 Methodology Considerations and Comparison

Access to therapy continues to change, both due to an increase of mental health related symptoms occurring during the COVID-19 pandemic [20] and increased workload to clinicians [16]. By inviting those who have a previous depression diagnosis outside of the local mental health facility, we were able to provide greater access for this community to participate in the design of future technologies.

Despite the different participants, the core concepts within the workshops stayed the same (i.e. phsyical design of the robot, robot behaviors). However, within the short form workshops, an additional question regarding any concerns they may have regarding the use of SARs for depression was added. Within the long form workshops more time was spent going over the specific areas of the home that the robot might be used in, rather than talking about its use more generally.

Time was also an important factor in the workshops - whereas the long form workshops took place over five one-hour-long workshops where participants could focus on a singular aspect for the entire hour, in the short form workshop only one hour was allocated to cover all topics. Out of the 10 participants in the short form workshop, the time constraint prevented two participants from reporting their preferences for the robot connected app.

Overall the long form (five workshop) and short form (single workshop) workshops provided similar main themes and requests from participants for designing a socially assistive robot based on the Therabot™ form.

In the following section the outcomes of these workshops are described as the collective responses of all participants, and the similarities and differences between the three participant groups.

### 4.3 Workshops with Adults with Depression

When combining the data between both the long form and short form workshops, various design guidelines start to emerge for designing a SAR to be used in combination with other therapeutic methods. Below, "$n$" refers to all 15 participants who took part in either the long (confirmed diagnosis of depression) or short form (self-reported diagnosis of depression) workshops.

*4.3.1 Robot Physical Design and Sensors.* When discussing the robot's appearance, after previously having been shown the Therabot™ robot in its beagle form or uncovered, participants decided that a more familiar form would be preferable. The most popular was a cat ($n$ = 7), with the second overall most popular being a dog ($n$ = 4), with other variations (such as an bear) only being requested by one participant (figure 1). This could be due to the participants' previous relationships with cats and dogs.

For example, one long form workshop participant described a cat she had as a child as inspiration for her robot design (LFP1): "Very fluffy the fluff. When I was growing up as a kid, I had a cat named Lovey who was just a big fluff ball. And you know, I had a lot of emotional problems as a kid and I would like sometimes just pick her up and like her whole fluff would be against me and sometimes I would cry into her."

**Figure 2: Sketch Artist Designs**

Relatedly, natural colors were the most requested ($n$ = 12), with some participants referencing the colors of animals that they were familiar with. LFP7 explained, "I have another idea that I think I would be more interested in seeing a sketch of. OK, you know what a tortoise shell cat looks like? I love torties."

Participants also indicated that the texture of the robot was important to them, while they had different ideas on the material (such as specific types of fur) many used the term "soft" when describing their desired texture ($n$ = 9). LFP7 said, "I think that plush texture would be really important. OK. So for me, it's important to have it, you know, it's soft. The user wants to touch it." SFP8 described, "I would want it to be soft and cuddly like a Build a Bear."

The focus on a soft and touchable covering provides context for participants' most requested sensing capability, which was the robot being able to process touch ($n$ = 12). LFP6 explained, "Having something to... talk to and you know cuddle with and touch, that would be nice... Touch... kind of like interacting with it and it interacting back."

SFP7 also describe feedback through touch, "I would want them to have the touch sensor and respond to me petting them because in my mind, this is like a service animal without the actual animal component."

Other than touch, participants indicated wanting the robot to be able to have some form of visual sensor ($n$ = 9), but not a camera ($n$ = 8). The robot being able to register that someone is near it or making certain movements was of particular interest, and participants had multiple ideas of how to achieve this, such as some sort of temperature reading or infrared. SFP2 explained, "For me, if there is some sort of IR sensor or something where we don't have to have a camera, it could maybe sense if there is some sort of presence and can move accordingly."

Sensors that could detect physiological changes were not presented to participants as a part of the sensor list, but were often requested by the participants ($n$ = 7). This included aspects such as breathing or heart rate monitors. LFP5 said, "I think that's how I feel like the senses that would would pick up on physiology of the person. But kind of make a camera not so necessary in terms of picking up on mood." LFP1 also explained using these specific sensors may be used for reflection with their care team: "For example, I can see it was kind of like... I had... a blood pressure spike and then little Therabot recorded it and sent it to my doctor or my therapist and then they were like, P1, why did your blood pressure spike on this day? And it's like I saw a spider or something."

Sound sensors were presented to all participants, but overall their main interest in sound sensors was based upon the robot being able to recognize its name as given by the participant, or keywords ($n$ = 5), less focused on continuous recordings.

*4.3.2 Robot Sounds and Behaviors.* Participants were asked, once they had decided what they would like their robot to look like, to describe what sounds and behaviors the robot would be able to exhibit. Matching with the previously mentioned natural coloring, natural sounds (such as purring if they chose a cat) were requested ($n$ = 12). SFP6 gave several examples of natural sounds: "Okay, well, the cat should definitely purr you can't have a cat that doesn't purr... And some sort of like a light meow you don't want to making some crying thing but just some little, you know, how they kind of they almost kind of chirp a little bit when they get really happy."

We also asked whether participants desired the robot to have the potential of a human voice, which many participants indicated finding to be negative ($n$ = 8). SFP9 explained, "If it's just, you know, kind of just being emotional support, maybe it's better that it not say anything you would expect a human to say. Just you know, animal noises."

Participants ($n$ = 7) expressed interest in a heartbeat that they could feel and hear to calm themselves. SFP4 said the heartbeat may be useful to enact therapeutic techniques in this way, "It just came to me but like a guided meditation, sort of thing would be really cool. And so a heartbeat could be really cool there."

Physical behaviors requested by participants followed the pattern of being more natural ($n$ = 4), such as lifting the head when pet or being able to move its tail to express itself. SFP6 gave a specific example related to the tail of the cat design: "When cats are happy, their tails kind of sway and swish a little bit, they'll wrap their tail around their bodies or even over your arm or your leg or something."

However, the robot being able to express certain therapy exercises such as deep breathing or grounding ($n$ = 9) was a particular behavior participants reported as potentially useful during episodes of distress, such as experiencing ruminating thoughts. LFP1 explained, "Maybe a reminder some people get stuck in like spirals, like depressive just like that and maybe like Mr. Fluffy needing to be fed might like help you get out of that." SFP2 gave a more general example of this, "I think in terms of that having a subtle sound where the person can follow that sounds and practice the exercises."

*4.3.3 Robot Connected App Requests.* Two main points of interest emerged when discussing the robot connected phone application that could pair with Therabot™. The first was that the app could have some sort of journal or mood tracking aspect, so that the user could look back at certain dates and get context on their emotions ($n$ = 7). LFP7 said, "So here if you were going to go to log your day, you could log how you were doing emotionally, like a little journal, maybe jot some things down, just the general sort of check in. If you want to see your data, you could see all of your previous logs, but you can also see them sort of juxtaposed with the information that Therabot itself is picking up."

When discussing the app, the other interest of participants was the app presenting them with a virtual avatar (figure 3) for their robot that they could access when not physically with the robot, or to further interact with the robot in the way of caring for it ($n$ = 8).


**Figure 3: Participant App Sketch and UI concepts based on participant ideas related to the connected app design.**

SFP4 related to this to a familiar digital pet, "(Have) the avatar be like a Tamagotchi sort of thing. Where like you log that you drink water or eat food or exercise or whatever, and then your avatar gets it and like so you're taking care of the avatar creature." LFP7 gave a specific example of when they might depend on the virtual version of the robot, "Maybe I'm at the dentist office. I'm afraid of the dentist, so I'm getting stressed out. I open the Therabot app and I maybe log that I'm feeling afraid. And I do the little mindfulness exercise thing."

LFP1 gave a specific example that inspired the UI mockups of the Therabot™ app, "I think that might add a little bit of fun to it, like maybe each cat or each dog like certain foods and maybe each day they want a different food and that'll just give you extra like stimulus and be like all right And you go on your phone and you click on the food they want and then they're happy."

The ability to do therapy exercises through the app ($n$ = 5) was also of interest to participants.

*4.3.4 Robot and App Privacy Concerns.* Participants were also asked about any privacy concerns that they may have regarding data collected by the robot's sensors. Overall participants felt comfortable sharing the data that was collected with their care team, specifically their therapists ($n$ = 11). LFP7 indicated believing the robot would be connected to their care team regardless, "If this is like integrated to therapy, I would imagine that therapists would be given that information. But probably there would be like a consent thing to that."

However, being able to control what information was sent and when was critical for participants to retain the feeling of control in regard to data collection ($n$ = 8). Such as SFP3, "I think it would be good to know where the information is going to. I think personally I'd only really want it between me and my therapists and care team, but I would understand like some people are a little bit closer with their family and would also like share it with them."

LFP1 provided a specific reason to why they felt it was necessary to monitor who had access to their information as it was collected by the robot. LFP1 said, "I've had situations in the past where my mental illness was used as a way to like sort of make me feel show me as unreliable during a situation and I was just thinking of a situation where there was some type of something like a custody battle over a kid where maybe one spouse would take the robot and be like look my wife is crazy look at the dog. It like records all."

## 4.4 Workshop Differences

There were some differences within participant responses between the two workshops, perhaps related to the amount of time allotted to consider each of the different aspects of the robot and its connected app. In the following sections "$n_l$" indicates that the number of participant responses are from only the long form workshop, while "$n$" remains the total number of responses from all 15 participants.

One aspect that participants from the long form workshops were more interested in was the robot connected app being able to guide them through therapeutic techniques that they had developed with their care team ($n_l$ = 5). LFP1 gave a specific example, "But it's like remember the grounding technique, what are five things you can see, four things you can smell and it's just like that kind of thing, you know, but it's with your Therabot so."

Notably, it was the participants from the short workshops, who were not affiliated with Centerstone, that were most interested in being able to send information to their Therapist. While the long form participants ($n_l$ = 2) mentioned being comfortable sharing the data collected by the robot and app, nine participants from the short form workshop were comfortable passing along that information.

Two major differences between the workshop forms was that in the long form workshop participants were asked where they would use the robot the most, which was not included in the short form workshop due to time. Overall participants indicated wanting the robot in the bedroom ($n_l$ = 2) and the living room ($n_l$ = 2).

During the short form workshops, participants were asked if they had any concerns over using the robot overall, rather than having the focus be to voice concerns along the way such as in the long form workshop. Participants in the short form workshop voiced concerns over users becoming attached to the robot ($n_l$ = 4). Despite these differences, the two workshops engaged the participants in similar ways, and in most areas participants relayed similar ideals across the methods.

## 4.5 Clinician Workshops

Although only four clinicians participated in the workshops, there were themes that emerged based upon what aspects of the robot and the connected phone app they felt would be beneficial for their clients, those living with depression. In the following section "$n_c$" indicates a clinician participant.

#### 4.5.1 Clinician Robot and App Requests.

While clinicians overall did not seem to have a physical design they felt would be best for their clients, they did express strong feelings on certain sensors. Physiological sensors were the most common, with all four clinicians indicating wanting some sort of sensor that could read clients' body signals. Heart rate monitoring was the most specifically requested ($n_c$ = 3), with breathing patterns being important as well ($n_c$ = 2). With Clinician 4 speaking on heart rate specifically, "I'm thinking about the ways that most of the folks that I work with have like co-morbid concerns with depression and anxiety. So I thought okay increase in heart rate might be an indicator that a panic attack is coming."

Clinicians provided specific examples of when a sound sensor may be useful for the robot to respond when the participant was feeling specific emotions ($n_c$ = 3). C3 said, "Audio sensor because you could pick up on like people sighing."

Cameras were not as important to clinicians as audio sensors, as they felt that a camera being present may actually provide a barrier to the adoption of the robot by their clients ($n_c$ = 2). C1 gave an example of why this barrier may exist, "I just think again of my folks, if they have any kind of paranoia, you know, I have people that just will tape up the camera even on their cell phone. I think that could be a barrier for some folks."

One potential capability of the robot all clinicians expressed interested in was the ability to place calls from the robot. Specifically for calling for aid, either from emergency services or the clients support system ($n_c$ = 3). C2 gave an example of a client needing aid, "Yes, to be able to call emergency services is if necessary, you know, because like if we have a client who is struggling with diabetes and taking their meds, sugar bottoms out, they can feel it, but not going to have enough time, they can yell out, hey, send help."

For the robot connected app, clinicians believed the app could be a way of journaling or tracking information regarding certain experiences or feelings for their clients ($n_c$ = 2). C4 exampled, "The app should allow them to provide context if they need to like to write down like, maybe their numbers show that they had a panic attack and like it's not going to really show like what was actually going on."

An aspect that carried both between the robot and the app was the ability for clinicians clients to be able to set things such as reminders ($n_c$ = 4), specifically reminders about tools that the clients learned during therapy sessions ($n_c$ = 3). C1 said, "Like, like maybe they do like a daily breathing exercise where they have to like... there's some form of in and out like almost breathing that they sync their deep breathing with the Therabot and that's how they do like a mindfulness - like maybe deep breathing check in and they you know when the when the robot expands they breathe."

Overall, clinicians were interested in receiving the data from their clients ($n_c$ = 3) and considered that the information from this data may aid in identifying if specific clients needed more or different care. C4 indicated the data could potentially impact what interventions they use, "I was gonna say that it could help us better understand if what we're doing is working with them. So, like, we increased their sessions and maybe it didn't help. Like, maybe that was the wrong intervention. You know, maybe there were things that we were doing that was actually like, you know, triggering them in a way that wasn't beneficial to them or something like that." Or, perhaps the data collected could show that changes were occurring through the ongoing therapy, such as C3, "I feel like a lot of my clients are just consistently like, yeah, I don't feel like anything is getting better. But it'd be nice to have like some sort of like actual evidence that like, well, you know, this particular symptoms decreased over the past like month or something."

Privacy concerns extended beyond the data collected by the robot about clients and to clinicians themselves when interacting with their clients that have the robot. Three clinicians mentioned specific privacy concerns, and two specifically mention their own privacy. C3 touched on this in reference to using the robot in therapy sessions "I don't want to be recorded... And I'd be worried if there would be any way where they could like take something you said out of context and be like look at this like 2 second portion of what C3 said, you know, so it would just make me uncomfortable and I think I would be not on my best ability."

The robot having other capabilities were more divisive, such as the robot having the ability to speak, with one clinician out right saying that it would make their clients nervous, while another thought it could be beneficial for indicating reminders and similar information to clients.

#### 4.5.2 Clinician Similarities to Clients.

While clinicians and those living with depression were approaching the robot and app design from different angles, there was overlap in some of the requests. One of the most clear requests by both populations was the robot being able to detect bodily changes in the user, through some sort of physiological sensor ($n_c$ = 4, $n$ = 7).

Both clinicians and those living with depression indicated that including cameras on the robot may hinder its ability to be used in a therapeutic setting. Clinicians felt that it may adversely effect their clients ($n_c$ = 2), while those living with depression felt that it could wouldn't be necessary ($n$ = 8), particularly if there were alternatives presented.

For the robot connected app, tracking through journaling, such as a mood journal or event journal, was felt to be helpful for reflection and notification both by clinicians ($n_c$ = 2) and those living with depression ($n$ = 7). The data collected both by the robot and the app was seen as potentially useful for clinicians ($n_c$ = 3), and overall those living with depression felt comfortable sharing that information with their therapists ($n$ = 11).

## 5 DISCUSSION

While most often discussed in relation to children, the importance of touch on well-being is well documented for reducing cortisol levels and blood pressure [17]. Touch, and the softness of the robot to encourage touch, was important for those living with depression, perhaps for a similar reason. Participants preferred robots that more closely resembled pets (cats or dogs) and had more natural colors, which is consistent with traditional animal-assisted therapy. While dogs are the most common animal assisted therapy animal [32], participants overall indicated having or have had in the past, cats. Cats, while not as common, have also been used with those experiencing illnesses such as depression [45]. The desire for robots of different animal types indicates the importance of a modular and adaptable platform that can take on the characteristics of different animals by altering its appearance and behaviors.

Participants in all workshops identified features that might best be provided by a companion mobile application. Aside from providing a reliable configuration interface and settings hub for the robotic companion, an app has the potential to enhance the therapy process. An app is well-suited to serve as a link to the patient's comforting companion and simultaneously provide features that have been shown to improve therapeutic outcomes. For example, journaling, which has recognized therapeutic benefits [47], was underscored by both patients and clinicians as a valuable feature to integrate into a companion application. Combined with positive reinforcement from the patient's relationship with their robot, app-based incentives may lead to an increase in consistency of completing check-in, journal entries, and introspection activities. Regarding daily logging, clinicians indicated value in patients charting their moods and medication for review over time, as this would provide useful insights when assessing potential trends and treatment outcomes. In situations where patients experience heightened anxiety or emotional distress, an app can provide an avenue for them to document their experiences, detailing, for example, context, their primary symptoms, and duration, which would be a helpful reference in subsequent therapy sessions.

In the app, options for tailoring the robot's virtual aesthetic may foster a sense of ownership and connection. Additionally, the introduction of gamified elements could enhance user engagement, creating a mutual care dynamic between the patient and the robot. For example, when a patient logs their food and water intake, they could simultaneously address the virtual companion's needs. Linked reminder systems between the physical robot and its virtual counterpart could be established: if a patient neglects to log their meals, the robot could alert them by exhibiting signs of hunger. This not only serves as a prompt for self-care for the user but also reinforces a sense of responsibility towards their robotic companion, leveraging the concept of the "helper's high" [10]. Given that clinicians might employ the robot for diverse age groups, the application should cater to varying user preferences. For younger demographics, integrating augmented reality (AR) capabilities might be effective.

Clinicians and patients also indicated that implementing interactive exercises utilizing techniques learned in therapy sessions, such as meditation and mindfulness, would be beneficial. Considering its form factor and weight, Therabot™, when situated in a patient's lap, could serve as an excellent grounding element, providing tactile, auditory, and visual stimuli; furthermore, the robot could perform soothing haptic vibrations, adaptive throughout the duration of the guided session, configured to mimic purring, breathing. These potential uses highlight the importance of a physically embodied robot and software application working together rather than choosing one or the other.

The insights and preferences presented by participants must also be evaluated in the context of technical feasibility. Although the robot's current implementation has the exterior appearance of a dog, additional exterior coverings including those representing a cat have been prototyped and are planned to be used in upcoming design and evaluation efforts. Furthermore, the robot's underlying structure is designed in a modular fashion that supports exchanging the dog tail-wagging module for a more articulated cat tail module. We are currently conducting user evaluations of a generative audio subsystem and expanded haptic capabilities (see [5] for more details) that provide support for additional types of animal the robot can exemplify.

As most pets and support animals are able to demonstrate a multi-modal understanding of their environment, it is intuitive that participants expressed a desire for the robot to be able to recognize their presence and location in the environment. However, participants also indicated that use of a camera system creates substantial privacy concerns. In order to support a more privacy-conscious method for understanding the locations of people in the robot's environment, we are beginning technical work evaluating a variety of sensing solutions that do not include cameras. One promising option is the use of ultra-wideband (UWB) radar to understand the environment. For example, UWB-based solutions have been deployed successfully as a privacy sensitive way of monitoring patients in assisted living facilities [34]. Achieving a small form factor that can be contained on the robotic platform remains a challenge and is an area of ongoing technical development.

Participants also expressed a desire for the robot to be able to measure their physiological state (e.g., respiration or heart rate) and take appropriate actions. We are currently conducting studies evaluating the integration of a wearable PPG heart sensor, similar to those included in most smart watches and fitness trackers, to adapt the robot's simulated heartbeat in an effort to induce a helpful physiological change in the user. While common wearable consumer physiological sensors are a useful avenue towards understanding the user's state, UWB radar is also capable of tracking the respiration and heart rate of people without the need for direct contact. For example, commercially available UWB bedside units have demonstrated the ability to track heart rate, respiration, and sleep quality with clinically useful levels of accuracy [23, 29].

As our ultimate focus is on deploying a personalized robot in the homes of adults living with depression, future work will involve studying the dynamics of interactions with the robot and companion application over longer periods of time.

## 6 CONCLUSION

Overall, after the completion of the workshops, participants provided guidelines to design a socially assistive robot that they felt would aid in managing the symptoms of depression. Future work will continue to delve deeper into specific aspects of continued development of Therabot™ for this population, including further exploration into specific sensors and behaviors for supporting the user. This research supports the design of a personalizable Therabot™ and future user evaluation studies of the adaptable robot in the homes of those living with depression, to test the efficacy of this type of device on the management of depression symptoms.

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