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Article

"A Safe Space for Sharing Feelings": Perspectives of Children with Lived Experiences of Anxiety on Social Robots

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Abstract: Social robots have the potential to support health and quality of life for children experiencing anxiety. We engaged families with lived experiences of pediatric anxiety in social robot development to explore desired design features, application areas, and emotion functionalities of social robots in anxiety care. We conducted 10 online co-creation workshops with (1) children with anxiety aged 7–13 (n = 24) with their family members (n = 20), and (2) youth with anxiety aged 14–18 (n = 12). Workshop participation included a validated robot expectations scale, anonymous polls, and discussion. Transcripts and text responses were subjected to content analysis. A lived experience expert group provided feedback throughout the research. Participants desired a pet-like robot with a soft texture, expressive eyes, and emotion detection to support activities of daily living. Specific anxiety-related applications included breathing exercises, managing distressing thoughts, and encouragement. Emotional alignment, the design of a robot's emotional display, and the emotional impacts of an interaction were discussed. Privacy and the replacement of human interaction were concerns. We identify pediatric anxiety-specific design features, applications, and affective considerations for existing and future social robots. Our findings highlight the need for customizability and robust emotional functionality in social robot technologies intended to support the health and care of children living with anxiety.

Keywords: social robots; anxiety disorders; child psychology; emotional alignment; affective computing; patient engagement

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1. Introduction

Social robots are devices that can act as effective partners in an interaction with a human user [1]. They range in scale from pet- to human-sized, can be stationary or mobile, and may incorporate features like displays and functions like dispensing medication. Social robots can offer therapeutic support to children with autism spectrum disorder [2], be effective tools in education [3,4], and complement hospital operations [5–10]. Our 2021 analyses found at least 20 commercially available social robots marketed to healthcare providers and families that were available for purchase or pre-order in Canada [11], and sales of consumer robotics are expected to reach 65 million robots and 19 billion dollars by 2025 [12]. As a group, children are particularly enthusiastic about the possibility of robotic health interventions [6,8,13]. Social robots have unique potential to support users through two characteristics: their physical embodiment and their capacity for emotional alignment (the congruency between two agents in their emotional interpretation of a shared experience) [14,15].

Mental disorders among youth are relatively common, with one meta-analysis estimating a rate of 13.4% overall worldwide prevalence. Anxiety disorders represent the largest share at 6.5% and these trends are stable cross-culturally and over time [16]. Anxiety disorders are more prevalent among girls and women than boys and men [17]. Anxiety

disorders and symptoms in children in particular are often un- or under-addressed [18–23]. Therefore, the need to expand the range and availability of therapeutic tools is pressing. A recent scoping review [24] listed anxiety management as a specific example of a well-defined goal that social robot research ought to target. Existing research on social robots for anxiety management primarily focuses on temporary, situational anxiety among children and adults who have not been clinically diagnosed with anxiety disorders. For instance, social robot exposure reduced anxiety among cancer patients [25] and improved healthy children's mood but not their anxiety symptoms following a stressful experience [26]. Numerous studies have shown reductions in distress or acute anxiety symptoms during vaccine and medical procedures [5,10,27,28]. Applications of social robotics to clinical populations are in their early stages, with one robot producing significant reductions in anxiety symptoms via a deep breathing exercise among adult participants already receiving medical treatment for anxiety [29].

A central challenge to using social robots in pediatric care is that social robot development priorities are driven by commercial markets, engineering constraints, and the recommendations of healthcare experts, rather than by end users themselves [30–32]. Technically advanced products are coming to market which claim to be useful for children's mental health [11]. However, scientific evaluation of these claims is of poor quality and does not focus on the experiences and outcomes that are important to patients and their families [24,33]. An understanding of what is most important to families when it comes to social robotics and children's mental health is urgently needed to ensure these interventions are deployed in a meaningful, evidence-based, and patient-centered manner.

The aim of the present work was to understand families' needs and priorities for social robotics as supports for children with lived experience of pediatric anxiety. Using a co-creation methodology, we explored potential application areas, user perspectives on the embodied design of robots, and desired emotional dynamics for robots in the pediatric anxiety context. We focused on two exemplar robots, one with a pet-like form factor and one with a speech-capable on-screen character as well as moving parts, in order to facilitate a discussion of the wide range of appearances and functionalities that are possible for anxiety-ready social robotics. Neither robot has been empirically tested as a treatment for anxiety but both are actively being developed by research teams and are good candidates to be programmed for this type of application.

2. Materials and Methods

This work was conducted in accordance with the Declaration of Helsinki and was approved by the University of British Columbia Behavioural Research Ethics Board. Written informed consent (or, for minors, assent combined with parental consent) was obtained from all participants. An overview of the method is provided in Figure 1.

2.1. Lived Experience Expert Group

The present research was conducted in collaboration with a Lived Experience Expert Group, a panel of eight advisors aged 14–37: three teenagers presently living with anxiety, four individuals in their 20s who had experienced anxiety themselves in their childhood, and one parent with a child presently living with anxiety. The panel included a mix of diagnostic groups, including social anxiety, generalized anxiety disorder, and autism spectrum disorder with a co-morbid anxiety diagnosis. Advisors were recruited via an advertisement made by a provincial youth mental health organization and the local children's hospital. All interested participants were included. They provided input on research priorities, as well as providing feedback on workshop materials, delivery, and interpretation of results.

2.2. Co-Creation Workshops

Participants for the workshops were recruited via (1) Foundry BC, a provincial mental health resource; (2) social media posts (Twitter, Facebook) by a study-affiliated organization (e.g., Neuroethics Canada), which were recirculated organically in the community;

(3) REACH BC, an online platform for health research recruitment; and (4) emails to past participants from related work who had indicated interest in being re-contacted. Confirmation of a clinical diagnosis of anxiety was not required. We did not collect participants' medical histories. To be included, participants had to be aged 7–18 with a self-reported lived experience of anxiety or be a family member of such a participant. All participants were required to read, write, and speak in English and hold sufficient computer literacy to navigate the online format (though children could be assisted by family members). Participants were informed that they would view videos of small, child-friendly robots and were encouraged not to participate if they had a fear of robots. After a pre-workshop phone or Zoom call to review the study purpose, logistics, and consent considerations, consent and assent were obtained via an online form.

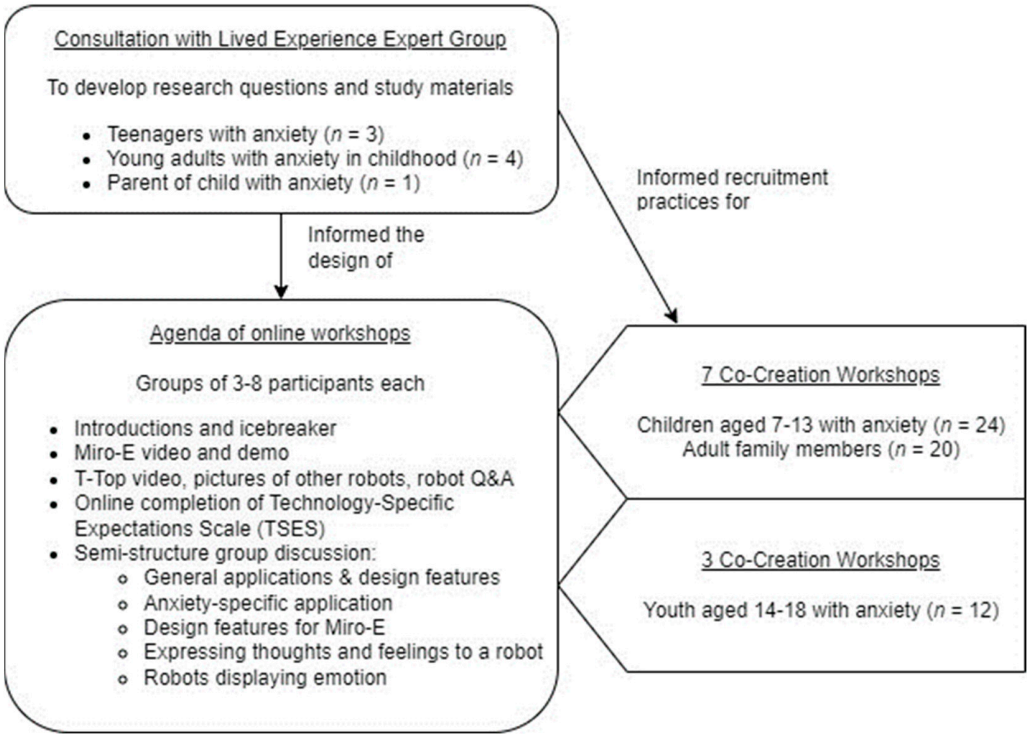

Figure 1. Overview of study method.

Our research team consisted of academic scientists and trainees affiliated with a children's hospital with experience conducting mixed-methods research on the topics of mental health and technology use among children and youth. We held 10 90-min co-creation workshops over a university-licensed Zoom platform between November 2021 and February 2022. Of these 10 workshops, seven were conducted with children (aged 7–13) and their family member(s), and three were conducted with youth (aged 14–18). Each workshop was facilitated by a research team member, with a second team member also present for technical support. Each workshop had 3–8 participants, excluding research team members. Responses were collected via Zoom audio, chat, and the Mentimeter platform [29].

Workshops began with introductions and an icebreaker activity, followed by a short video on the social robot MiRo-E [34,35] and a brief demonstration of MiRo-E by the facilitator via live Zoom video. Next, a video of T-Top, a laboratory social robot prototype [36], was shown to illustrate the range of possible applications for future social robots. Participants were then shown pictures of social robots aibo [37] and Moxie [38] and the facilitator provided a verbal summary of their features and applications. Participants were given an opportunity to ask questions and comment at all steps. Participants then completed the Technology-Specific Expectations Scale (TSES) [39] based on their perception of the

social robot examples provided. The TSES captures a respondent's expectations about what a piece of technology could achieve with 11 items such as "I think the robot will be more than a machine". Expectations are rated on a 5-point scale (very low expectations to very high expectations). The scale has two dimensions: fictional view (impressions of robots originating from science fiction), and capabilities (expectations based on the robot's abilities).

This was followed by a discussion of the group's perceptions of the robots, their potential anxiety-specific uses, and questions around emotionally engaging with a robot. Workshops then transitioned into a discussion period to address social robot uses (1. General application and design features; 2. Anxiety-specific applications; 3. Specific design features for MiRo-E as an exemplar social robot) and emotional dynamics of use (1. Expressing thoughts and feelings to a robot; 2. Social robot displays of emotion and emotional alignment).

Responses for all workshops were transcribed verbatim and analyzed using inductive content analysis. Three members of the research team reviewed data from one workshop to create an initial coding guide identifying key themes and subthemes as they emerged from the data. Another workshop was chosen at random and analyzed independently in full by two of the researchers using MAXQDA text coding software [40]. Inter-rater reliability was calculated, and any disagreements were discussed and resolved via iterative changes to the coding guide. This process was repeated for other workshops until an inter-rater reliability of 85% was achieved. All workshop data were then divided between the two researchers to code using the final coding guide. Because adult participants often shared both their own perspectives and contributed on behalf of their children (e.g., some shy children would visibly whisper to parents, or families would confer while muted and then adults would relay responses), data from all respondents were analysed as a single pool.

3. Results

Our discussion covered the physical characteristics, functions, and uses of current and future social robots for pediatric anxiety (Figure 2). Quotes from participants are labelled using a workshop number and participant code (e.g., Youth01_W09 would be participant 01, a youth participating in workshop 09). The acronym AMR is used to report anonymous Mentimeter responses.

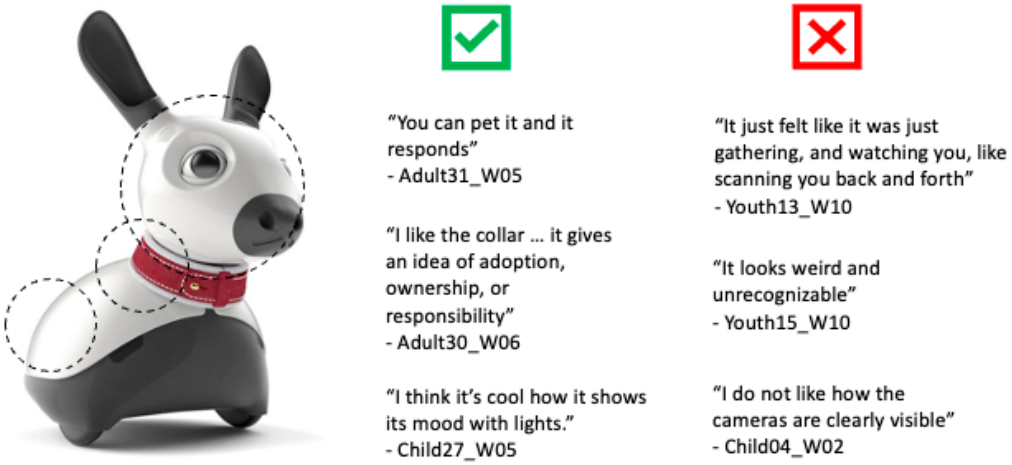

Figure 2. A sample of comments on desirable and undesirable features and functions of social robots as elicited by MiRo-E.

3.1. Workshop Participants

A total of 56 participants (24 children aged 7–13, 12 youth aged 14–18, and 20 adults) attended one of 10 workshops. Of the 24 children (mean age = 9.6, range = 7–13), their pronouns were she/her (n = 10), he/him (n = 12), and they/them (n = 2). Of the 12 youth (mean age = 15.7, range = 14–18), their pronouns were she/her (n = 5), she/they (n = 3),

he/him (n = 2), he/they (n = 1), and they/them (n = 1). Of the 20 adults (mean age = 39.8, range = 33–53), their pronouns were she/her (n = 18) and he/him (n = 2).

3.2. Expectations and Willingness to Use

Most participants anonymously indicated that they would be willing to use a social robot, either today (n = 17, 45% of responses) or in the future (n = 17, 45%). A smaller number responded that they would never use a social robot, though others might (n = 4, 10%). None selected the option "I don't think anyone would use a social robot." Many agreed that they would be comfortable or very comfortable sharing their thoughts and feelings with a social robot (n = 25, 64%), while others were neutral (n = 11, 28%), or felt that they would be uncomfortable (n = 4, 10%). Responses to the items of the TSES are given in Figure 3; "high" and "very high expectations" responses were coded as agreement, and neutral and negative responses were coded as disagreement. Expectations were generally higher for the Capabilities dimension than the Fictional View dimension.

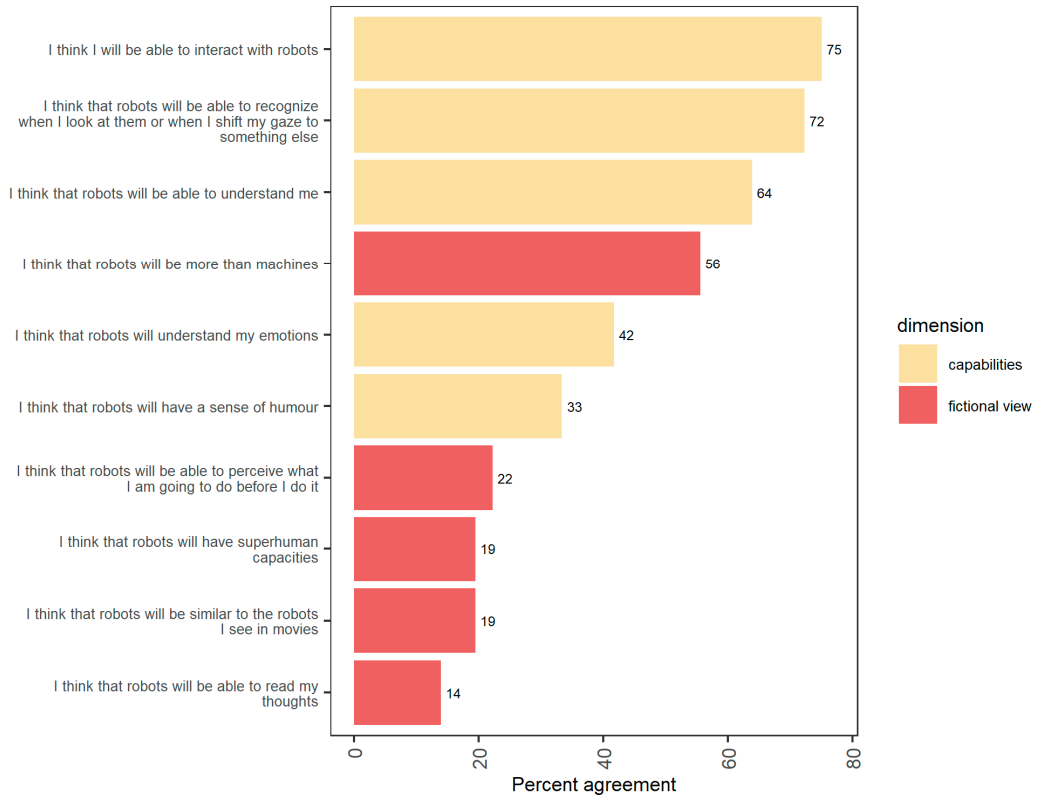

Figure 3. Agreement with the 11 items of the TSES. Responses ordered by agreement rather than order of delivery in the instrument.

3.3. Physical Characteristics

Desirable physical characteristics of a social robot were discussed (8/10 workshops), including topics such as size, material, and overall look and feel. In general, most participants expressed a desire for a small robot with a realistic pet-like appearance and a fluffy, snuggly texture. A robot's cuteness was frequently discussed, with one participant expressing that a robot "needs to be cute" (Youth08_W09). With regards to specific facial characteristics, participants generally viewed the robots' eyes as an important feature involved in expression, though preferred camera functionalities to be dissimulated. Another commonly shared desire amongst participants was to be able to move or carry a robot around with them (6/10 workshops).

3.4. Functions

3.4.1. Detecting and Identifying the User

When discussing desired functions of a social robot, participants explored the potential of a robot to have the capacity to detect and identify a range of user attributes, including their identity, voice, bodily movements, and emotions. Most participants expressed a desire for a robot to be able to read and understand facial cues, listen to a user talking and understand their tone of voice, as well as to have the capacity to sense and recognize emotions (9/10 workshops). For example, one participant noted that, "I want it to listen to how I feel" (Youth12_W10), whereas another commented, "I would want it to know how I am feeling, so if you do not want to talk, it would know and be able to help you" (Child02_W01).

3.4.2. Data and Programming Features of the Robot

With regards to programming, participants discussed the potential for robots to access, store, and share data and offer customizable functionalities (8/10 workshops). Several participants also noted that they would want to pre-set a robot to produce alarms or reminders to support them in carrying out daily activities. For example, "[the robot] could sort of fill in the executive functioning side that mom and dad support with. Things like, 'Hey, today is a school day. This is what is happening today at school.'" (Adult29_W04). Participants also explored the potential for a robot to offer tailored responses to multiple users, with one participant commenting that they would want a robot to "treat different family members individually" (Adult31_W05).

The ability of a robot to store, access, and share data generated mixed opinions amongst participants (6/10 workshops). Many expressed a desire for a robot to be connected to the internet, and to have the capacity to retrieve and store data, enabling a robot to source information or offer activities appropriate to the user's needs. The examples discussed included the potential for robots to offer safety advice, access audiobooks, or to be used to support bedtime routines to "allow your child to access four or five nighttime-appropriate calming sleep activities" (Adult29_W04). However, several participants expressed concerns about the potential for a robot to store and handle data, with one participant commenting that, "I feel like because it is a machine, I have this subconscious thought like someone could be recording, or that the information will go to someone." (Youth02_W08).

3.5. Uses

Discussion of the utility of social robots covered social and health and anxiety-specific applications. Non-social uses were also mentioned but were not our focus (Table S1).

3.5.1. Social Uses of a Social Robot

Table 1 illustrates themes relating to the social functions of a potential robot. The discussion touched on robots as supports of connection between people, as touchable objects, and as playmates. All 10 workshops considered robots as conversation and interaction partners and as sources of companionship.

3.5.2. Health and Anxiety Uses of a Social Robot

We focused the workshop discussions on health- and anxiety-specific applications of a social robot. Participants ranked which aspects of anxiety a robot could help most with (Figure 4). Their ratings revealed that social robots were seen as a promising support for worried thoughts, followed by distressing emotions and the desire to avoid anxiety triggers. Social robots were ranked least helpful for assisting with uncomfortable physical symptoms associated with anxiety.

Table 1. Social uses for a robot.

Theme	Example	Frequency
Conversation and interaction	"You want it to talk to you. You want it to be your friend and have a conversation." (Child35_W07)	10/10 workshops
Companionship	"Be a buddy, like a non-judgmental figure to confide in." (Adult30_W06)	10/10 workshops
Play with me	"You could play like catch with it, or a boardgame." (Child01_W01)	6/10 workshops
Physical touch	"You can hold it in your arms." (Youth08_W09)	4/10 workshops
Supports connection between people	"There will be times when you probably want to show it to your friends, or your family members, because it is a really cool robot." (Youth08_W09)	3/10 workshops

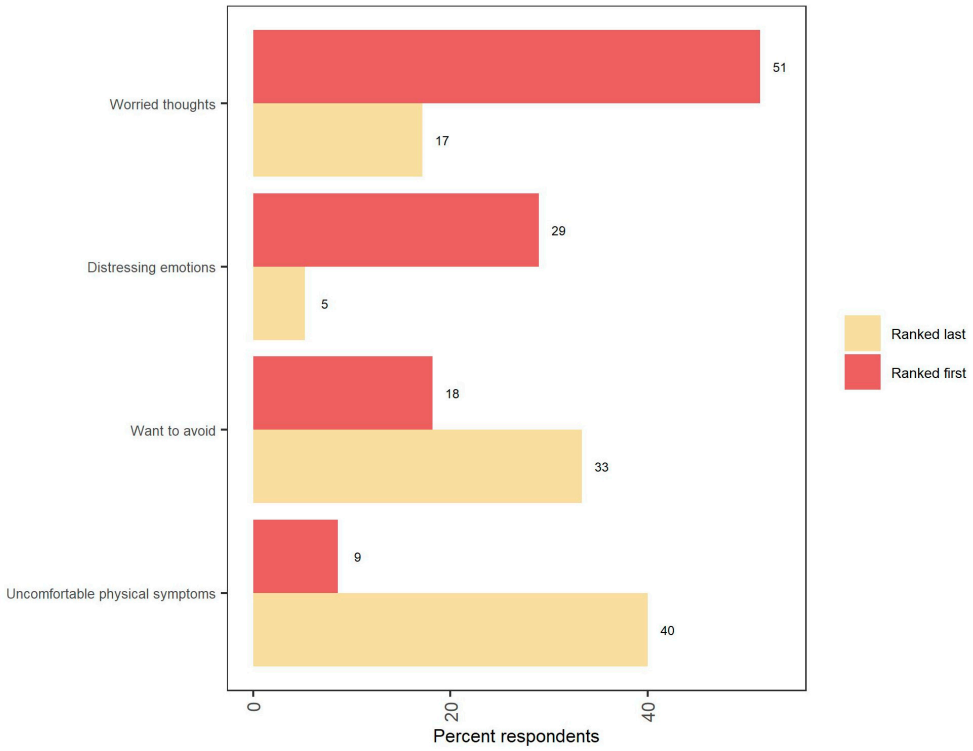

Figure 4. Results of anonymous poll given during the workshop: "Which of these aspects of anxiety could a social robot help with best?".

Participants also commented on specific ways that a robot could help with anxiety. One example that was raised several times was the ability for the robot to lead the user through a range of guided exercises (6/10 workshops). A robot could have "a progressive muscle relaxation script, or a breathing script. . .to help kids relax" (Adult15_W02), "lead a guided meditation" (AMR_W05), or "prompt breathing exercises" (Adult31_W05). Other interventions that arose included rationalizing intrusive thoughts or reassuring the user (8/10 workshops). One participant provided examples of things a robot could say to reassure them: "It could. . .talk to me and make me feel. . .calm. . .like 'it is okay', 'you can do this'" (Child37_W07). Distraction was also a commonly discussed method that a robot could use to reduce anxiety (7/10 workshops). For example, one participant explained the robot could make "certain noises, or. . .really any sort of stimulation that helps you calm down and takes your thoughts away from the issue at hand" (Youth07_W10). Finally,

participants expressed that a robot could help with anxiety by suggesting activities (e.g., comforting music) or resources to the user (3/10 workshops).

Participants also highlighted several ways in which a robot could support their general health (7/10 workshops). For example, a robot could call for help in a medical emergency, detect an allergic reaction, or provide health information to help the user navigate a new illness.

3.6. Emotionality

3.6.1. Emotions Produced by the Robot

In general, participants desired some form of emotional expression from a social robot. One participant commented on emotional display and anxiety: "The robot should be predictable in its emotions and responses so that it lessens anxiety" (AMR_W05). Another explained: "Some emotion is ok, even a lot is ok, but we don't want to be responsible for its feelings. We don't want to take care of it." (AMR_W05).

With regards to emotional range, some participants wanted the full range of emotions from a social robot (8/10 workshops). One said that a social robot should display "as much [emotion] as it can. So, it feels more like an actual animal or person rather than a device" (AMR_W04). However, some participants expressed that they would not want a social robot to display negative emotions (3/10 workshops). One participant shared that they would want "no negative emotions because the robots are supposed to be the ones on your side" (AMR_W08) while another said that they would not want a robot to become "mad or upset, that would be stressful for me" (AMR_W10).

Finally, participants discussed how a robot should display emotions, including facial expressions, sounds, colours, and body movements: "snuggle up to you for showing love" (AMR_W05).

3.6.2. Emotional Alignment

Participants also discussed the idea of emotional alignment between the robot and user (7/10 workshops). One participant described that this would be desirable for their child: "I find she is drawn to whatever is most lifelike, like humanlike, something that reacts the same as her" (Adult30_W06). Another participant said: "...if I tell a sad story, I do not want it to smile back at me" (Youth03_W08). Finally, one participant explained a case where the robot expressing opposite emotions to the user could be helpful: "Sometimes I feel like the robot could match emotion, but it could also like not match emotion and do the opposite of it to change your emotions to the better" (Youth04_W09).

3.6.3. Emotional Impacts on the User

Participants frequently discussed the potential of a robot to have a positive effect on their mood (10/10 workshops), suggesting that robot interactions could be fun, playful, exciting, or generally serve to "cheer you up" (Child02_W01). Other participants expressed a desire to use a robot that has potential to support emotional regulation: "If you are feeling sad and anxious, the robot should be a tool to help bring you back to center/neutral or towards happy" (AMR_W05). Additionally, participants suggested that a robot might have a positive influence on mood by helping them to feel safe, reduce loneliness, or provide relief from physical discomfort, with one participant sharing: "I think a robot feels like a safe space for sharing feelings, emotions, etc. for the sole reason that it's not human... it's more predictable and non-threatening" (Adult24_W05).

In contrast, some participants also discussed the potential of a robot to have a negative effect on their mood (8/10 workshops). Generally, participants expressed that a robot has the potential to make them feel uncomfortable or worried. Several participants attributed their concerns to a robot's potential to surveil and inappropriately handle personal data, whereas others suggested that negative affect may be a consequence of the human–robot interaction: "Maybe it is just me struggling with rejection dysphoria, but a robot showing negative emotion, like it kind of hurts a bit. It is different than a human showing a negative

emotion because you already expect that, but when a robot does that, it kind of seems a bit more...” (Youth06_W08).

Participants also discussed the potential for a robot to elicit both positive and negative emotions associated with judgement from others (6/10 workshops), with one participant commenting, “Talking to it [robot], or using it [robot], that would definitely be hard in public” (Youth04_W09). However, several participants also discussed that a robot has the potential to positively impact mood by offering anonymity and objectivity. One participant stated, “you could tell it anything and not have to worry about a reaction, [which] removes pressure” (Adult31_W05), and another who described the potential for a robot to be “a non-judgmental figure to confide in” (Adult30_W06).

Finally, participants described how a robot has the potential to impact their mood by calming, soothing, or comforting users (6/10 workshops), by offering simple reassurances, producing relaxing sounds, and having “a constant calm demeanor” (Adult24_W05). Others discussed the potential for a robot to provide calming sensations, saying, “Perhaps the robot can be held, weighted, and vibrate so offering a physical comfort” (Adult31_W05).

3.7. Limitations and Concerns

Throughout the workshops, participants raised a range of concerns about social robots (6/10 workshops). Their concerns included the impact on the environment, commercial marketing strategies that might be employed by social robot manufacturers, and the increasing potential for society to become over-reliant on technology. Participants also considered practicalities of using a social robot; one participant noted: “Is it going to be rolling around on those little wheels. Is it going to get caught up with hair on the floor, dog hair?” (Adult08_W03).

4. Discussion

Through co-creation workshops and partnership with lived experience experts, this project reveals application, embodiment, and affective considerations around social robot technologies from the perspectives of families living with pediatric anxiety.

In terms of anxiety applications, many participants felt that a social robot could help address both worried thoughts and physical symptoms, such as with guided breathing exercises. They also suggested functionalities such as providing distraction and companionship, helping with executive functioning, serving as sleep aids, and providing interventions or resources during moments of high anxiety. As there are no commercially available “anxiety-ready” social robots designed to meet the needs of the pediatric population at present, these findings can shape the development of solutions to address this gap.

Connecting with a robot can reduce mental and emotional distress [41,42], and robust emotional capabilities are being prioritized in social robot development [14,35]. Our participants voiced that they would feel comfortable expressing themselves emotionally to a social robot, consistent with others [43]. Participants noted that a robot can serve as a non-judgmental figure by not reacting in the same way a person might. Similarly, in a previous study, university students with social anxiety had less anticipatory anxiety when they were assigned to a robot interaction partner over a human interaction partner [44]. In terms of emotional display, many participants desired a full range of emotions, while some highlighted that negative emotions could be harmful for them. Furthermore, one participant voiced that predictable emotions would be best to not trigger anxiety. These results indicate that the ability for the user to customize emotional display is key to account for different emotional needs.

4.1. Ethics

In the present work, we asked participants to imagine contexts in which they might use social robots with anxiety-specific functionalities and to consider the potential impacts of such use. Going forward, this anticipatory ethical work can be integrated into the development of real devices. However, we expect that the implementation and testing of

real devices will reveal new dynamics and effects on users that cannot fully be explored ahead of time. Aligned with the concept of translational ethics [45–47], multiple iterations of development and user feedback, building on the data obtained at each step, will be needed to ensure that social robots for pediatric anxiety are truly aligned with the needs and values of children and families.

Participants raised ethical concerns associated with robot use throughout the workshops. These included societal implications (environmental impact, over-reliance on technological solutions to mental health problems), commercial considerations (surveillance and data security, harmful advertising), and personal experiences (judgment from others for using a robot, feeling responsible for the robot's feelings, making the robot angry, feeling rejected by the robot). These themes are consistent with those of other user groups, including older adults [14,15,24,41,48–50]. However, children and families also pointed to the unique advantages of a robots as responsive smart objects, particularly as a non-judgmental source of social support and pet-like comfort objects.

4.2. Strengths

Collaborative enquiry leads to unique insights, incorporating children as active designers of the end product [51]. Co-creation or participatory design has been emphasized as an effective method to facilitate engagement with children, a platform to offer age-appropriate discovery of technology, and an opportunity for children to express their own perspectives [43,51,52]. We emphasized co-creation from the conception of this study by collaborating with a panel of lived experience experts. This helped to ensure that our research was pertinent to the well-being of end users and sensitively designed.

Our methods were tailored to the needs of our sample, as informed by our advisory. The anonymity afforded by online communication can be useful when conducting research into sensitive topics with vulnerable [53] and pediatric populations [54] as it allows participants to feel comfortable and express their views in detail. In designing the study, we were cognizant of the importance of providing a supportive and inclusive online environment that would facilitate engagement and sharing of individual perspectives. Therefore, participants were offered a range of interaction methods: Zoom video, audio, chat, and the anonymous platform Mentimeter, and the results demonstrate that there was engagement across all platforms, with many participants choosing to share their opinions using the online tools. Using a range of response formats allowed us to gain rich qualitative insights into social robot considerations.

As there is relatively little research on social robotics for pediatric anxiety, we adopted a "wide net" approach, adopting a broad operational definition of "lived experience of anxiety" that allowed participants to self-nominate without requiring a specific clinical diagnosis. We did so in order to include the wide range of experiences with anxiety that families may experience. While we did not collect medical information, many participants shared experiences that would be consistent with an anxiety disorder diagnosis, describing panic attacks, intrusive thoughts, and running away from school.

4.3. Limitations and Future Directions

This study reflects the attitudes of a sample of Canadian families at a particular moment in time. Most of our recruitment avenues were online and the workshops were held over Zoom due to the COVID-19 pandemic. Participants were self-selected volunteers interested in an online study about robots, suggesting a level of confidence and familiarity with digital communication and a baseline openness to social robotics. Culture, socioeconomic status, the relatively small sample size, and the technological fluency of the participants are all factors that likely influenced our results. Furthermore, we chose to focus on children, youth, and families living with anxiety, but other perspectives such as those of healthcare providers, policy makers, and educators will be valuable in the development of these devices as well.

Participants were limited in their ability to comment on the physical and tactile aspects of the robots. The robot demonstrations we chose to show included social robots MiRo-E and T-Top, allowing us to feature a broad range of features and application areas. However, this choice also limits the comparability of this study to work employing different devices. Future work could also explore the roles that place of residence, ethnicity, and race play in shaping perspectives on social robotics; these were not collected as part of the present study design. Finally, we report data for child and youth workshops combined. Whilst between-group comparisons were not a focus of the present work, this has been identified as a nascent area of study [55], and therefore research would benefit from future examination using larger sample sizes.

As anxiety-ready robots become available, future research must consider the effects of interacting with these devices over the long term and as part of daily life using a variety of study designs, including longitudinal models. Consideration of policy and regulation, culture and context, and cost and access will be critical for equitable and evidence-based robotics support for children and families.

5. Conclusions

In this study, we report key application, design, and affective considerations for the design of social robots directly from the perspectives of children with lived experience of pediatric anxiety and their family members. Specifically, participants revealed social robot functionalities that could help with their anxiety, as well as their thoughts around emotional display for a social robot. Social robots should be developed in collaboration with end users to ensure that devices are well suited to their needs and priorities. This work will facilitate the development of patient-informed and effective social robotic interventions for pediatric anxiety to improve the health and well-being of children and families.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/mti7120118/s1, Table S1: Themes within the discussion of social robot uses for practical, non-social tasks.

Author Contributions: Conceptualization, methodology, funding acquisition: J.A.D. and J.M.R.; investigation, project administration: J.A.D., J.N.K. and J.M.R.; data curation, formal analysis, writing—original draft: J.A.D., J.N.K. and S.E.M.; visualization: J.A.D.; writing—review and editing: J.A.D., J.N.K., S.E.M. and J.M.R.; supervision: J.M.R. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the University of British Columbia Behavioural Research Ethics Board (H21-01402, 29 June 2021).

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