Beyond the Session: Centering Teleoperators in Socially Assistive Robot-Child Interactions Reveals the Bigger Picture

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Socially assistive robots play an effective role in children's therapy and education. Robots engage children and provide interaction that is free of the potential judgment of human peers and adults. Research in socially assistive robots for children generally focuses on therapeutic and educational outcomes for those children, informed by a vision of autonomous robots. This perspective ignores therapists and educators, who operate these robots in practice. Through nine interviews with individuals who have used robots to deliver socially assistive services to neurodivergent children, we (1) define a dual-cycle model of therapy that helps capture the domain expert view of therapy, (2) identify six core themes of teleoperator needs and patterns across these themes, (3) provide high-level guidelines and detailed recommendations for designing teleoperated socially assistive robot systems, and (4) outline a vision of robot-assisted therapy informed by these guidelines and recommendations that centers teleoperators of socially assistive robots in practice.

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1 INTRODUCTION

Socially Assistive Robots (SARs), robots that provide assistance through social interaction [33], have shown much success across research domains like education [6, 8, 65] and therapy [11, 14, 16, 39, 51, 57]. SARs have shown particular success in interactions with children [57, 65], as they can engage children as peers without the threat of judgment or ostracism that may accompany interactions with adult authority figures [15]. Children often find robots engaging and are therefore highly receptive to interactions with robots. It is thus crucial to understand how robots can be best designed to provide social assistance to children.

SAR researchers often focus on the efficacy of robots as a social assistance tool, measuring therapeutic efficacy or educational outcomes with the aim of making the case for robot adoption. This research is essential to ensure these child-robot interactions are effective, and to help us understand how best to design and develop robots to ensure this

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effectiveness. However, this research often assumes that SARs should be autonomous, eliding critical questions as to how these robots are (and should be) operated, and by whom.

Recent research suggests, in fact, that SARs may need to be teleoperated for both practical and ethical reasons [31]. SARs are often used with vulnerable populations in critical tasks where accountability is crucial. In domains with these characteristics, teleoperation is typically recommended, since human control and supervision allow a responsible individual to intervene, and allow humans to readily identify the causes of adverse events and quickly head them off. SARs used with young children in education and therapy are especially likely to have these characteristics, and in these domains teleoperation is typically necessary not only for safety and accountability, but to keep power in the hands of trained professionals who are best equipped to provide therapy or education.

Indeed, in contrast to the assumptions of most SAR research, robots used with children in therapy and education are often teleoperated in practice [12, 32, 43]. Based on the success of SARs in laboratory-based child-robot interaction experiments [29, 55–57], therapists have begun using SARs in their therapeutic practice, and many organizations are working to make these robots more widely accessible [37, 49, 60]. Due to the complexity of real-world therapeutic contexts relative to controlled laboratory environments, therapists have needed to – and desired to – use these new robotic tools in a teleoperated manner. Unfortunately, the current tools available to therapists and educators to teleoperate SARs in accordance with their needs and wishes offer extremely limited and rudimentary control. Moreover, because most SAR researchers have historically assumed that SARs should be autonomous, it is unclear how tools should be designed to best support therapists and educators in their use of teleoperated robots. In this work, we thus aim to develop this necessary and foundational understanding, with special attention to the domain of therapy.

In this paper, we share the results of 9 interviews with individuals who have used robots in their daily practice to deliver therapy or other socially assistive services to neurodivergent children. We then use a grounded theory approach to analyze these interviews and uncover patterns across our participants' experiences. We share stories of how these individuals prepare to work with robots, learn which activities engage children, maintain awareness of a diverse set of environmental factors, and adapt quickly in the moment. Based on this analysis, we produce (1) a characterization of therapists' experience of therapy as a dual-cycle; (2) six themes of teleoperator needs and a set of patterns that recur across those themes; (3) high-level guidelines and detailed recommendations for designing SAR systems that center teleoperators; and (4) a vision for the future of robot-assisted therapy that is informed by these guidelines and recommendations, and that centers the individuals who operate socially assistive robots in practice.

2 RELATED WORK

In this section, we provide necessary background information about neurodiversity, the goals of therapy for neurodivergent children, robots' appeal to children, and the impact of robots in therapy.

2.1 Neurodiversity

Neurodiversity is the perspective that individuals possess neurological differences that ought to be respected and appreciated, similar to other individual differences in human variation [3]. This perspective offers a social model of disability that aims to de-pathologize individuals while maintaining that neurological classification may still be useful and meaningful [19]. Neurodivergent features include autism, attention-deficit / hyperactivity disorder (ADHD), dyslexia, Down's syndrome, bipolar disorder, and others [2]. Autistic individuals have been a fairly vocal group advocating for the acceptance of neurodiversity [44]. Importantly, a significant portion of Socially Assistive Robot research focuses on assistance for autistic individuals, particularly autistic children [29, 55–57].

Historically, neurodivergent features were treated as mental health illnesses that resulted in institutionalization. From a medical perspective, neurodivergent features have often been treated as illnesses in search of a cure. Neurodivergent individuals were required to change their behaviors to fit in a society that did not accept them. Yet recently, and thanks in large part to autistic self-advocates, the neurodiversity movement has instead chosen a social model for disability[1]. From the social perspective, the neurodiversity movement asks society to accept disabled individuals without an attempt to cure them [48]. Instead, the neurodiversity movement asks communities to support disabled individuals. Some have proposed alternatives to the social model [28], however, the social model for disability remains the more commonly accepted model [3, 13, 19] and the preferred model by autistic self-advocates [48].

Neurodivergent individuals may require special support or care to navigate the world. Since society often sets an expectation of neurotypical behavior, neurodivergent people often benefit from learning to adapt their behaviors to have an easier time going about their lives. Under the guidance of their parents, neurodivergent children commonly begin therapy and other services at a young age to learn to communicate effectively, unlearn certain self-injurious behaviors, or receive other forms of support to meet their individual needs.

2.2 Goals of therapy for neurodivergent children

Because therapy for neurodivergent children depends on the individual's particular therapeutic needs, a variety of therapeutic modalities are commonly used. These modalities include speech and language pathology (SLP) to improve speech and communication, occupational therapy (OT) to improve movement, and applied behavior analysis (ABA) therapy to improve social and communication skills. Within these modalities, therapists may choose from a variety of experiential approaches to engage with their clients, such as art therapy, music and dance therapy or robot-assisted therapy.

Personalization is critical for therapy, both to determine the desired outcomes and metrics of success, and to select the specific interventions to encourage those outcomes. Meta-analysis of personalization in therapy has shown that personalizing the goals of therapy to the specific needs of individual clients leads to better overall outcomes [63]. As such, aligning on goals by collaborating with clients and achieving consensus has been shown to lead to improved treatment outcomes [66]. Critically, the personalization of therapeutic interventions includes choosing not only the particular content or intervention, but also the particular ways of delivering that content in order to maintain engagement.

A necessary aspect of therapy's effectiveness is how well it engages children [5]. Studies have shown that success in therapy is directly attributable to therapists' success at engaging clients [64, 69]. Accordingly, therapists may try different approaches to engage different children. Depending on the child, different modalities or approaches to therapy may be more effective. One therapeutic modality that has been shown to be widely effective for children with different needs is *robot-assisted therapy*.

2.3 Robots' appeal to children, especially neurodivergent children

Researchers have studied how robots can be used to support a large variety of child health needs and demonstrated that when used to support such needs, robots consistently lead to beneficial outcomes such as enhanced positive affect [38]. Positive affect is especially important in therapy with children [5]. Research shows that children have a high acceptance of and likability for robots in healthcare contexts [26]. Dialogue-based robots, specifically, can motivate children to interact, and increase children's probability of learning [47]. With autistic children, robots are particularly

[1]The shift from a medical perspective to a social perspective is a core part of the change in language referring to neurodivergent individuals using identity-first language rather than person-first language [13].

well received [52]. A study analyzing fMRI scans of autistic and non-autistic people suggests that autistic people may consider robots as social interacting partners in the same way non-autistic people consider other humans [17]. This is consistent with findings that autistic children lack the bias towards anthropomorphism that is usually present in non-autistic individuals [18].

2.4 Robots' Impact on Children

Researchers have demonstrated that socially assistive robots can successfully help neurodivergent children reach various learning goals, likely as a direct benefit of the increased engagement described in the previous section. In a small study with autistic children learning to program robots, children's collaborative behaviors increased in relation to their engagement with robotic content [67]. Interacting with robots has also been found to be positively correlated with autistic children's verbal expression [23, 34, 40] and eye contact [23, 25], likely due to an increase in engagement. Robots can help children, particularly shy children, engage in social play [36] Additionally, some autistic children show an improvement in emotional response and imitation after interacting with a robot [50].

Longitudinal studies have also shown long-term positive impacts of robots on neurodivergent children. In one 10-week study, pairs of autistic children showed increased eye gaze and positive affect after playing imitation games with a robot [68]. Similarly, in a 12-week study with autistic children learning social skills from an adult, incorporating a NAO robot in some activities lead to an increase in children's frequency and duration of eye contact with the adult and an increase in children's verbalizations [24].

2.5 Socially Assistive Robot Level of Autonomy

There is substantial research showing the impact robots can have on children [29, 55–57]. The bulk of this previous research, however, focuses on child-robot interaction, mostly without emphasis on how these robots are operated. Some research studies are explicit about using autonomous robots [68], or teleoperated/Wizard of Oz style robots [45], but most studies do not specify how the robots they use are operated [17, 23–26, 34, 40, 50, 52, 58, 59, 67], likely since the focus of these studies is to understand the child's response and the impact the robot has on the child. Such research endeavors are valuable because they can provide insight into children's preferences for robot design features, such as robot morphology.

In a review of studies in robots and autism research, Scassellati et al. [57] suggest a need for robot autonomy due to a current lack of sophistication in robot control, which would be needed to handle the "complex, dynamic, and unpredictable situations" that exist in therapy. They also discuss therapists' expertise and the fact that therapists are trained specifically to handle these unpredictable scenarios. We agree that there is room for improvement in robot teleoperation systems and that therapists are the experts in this context. However, we do not conclude that therapists ought to be replaced by autonomous robots. Instead, we argue that improvements should be made to the teleoperation capabilities of robots that allow for effective delivery of therapy *by a therapist*.

To be clear, there are reasonable arguments for the use of autonomous robots in therapy, including on-demand access and the difficulty of teleoperation. However, there are also crucial arguments against the use of autonomous robots in therapy.

2.6 Issues with Autonomous Robots

Autonomous robots result in several key issues when used in therapy. Autonomous robots distance domain experts from their subjects. These robots are often expensive and/or widely inaccessible, resulting in minimal deployment in

practice. When they are able to be deployed, they remove the human in the loop who can bridge the results of therapy from human-robot interactions to human-human interaction.

The process of automation distances domain experts from robot users. This added distance is generally problematic since it increases the difficulty of domain experts to monitor, review and improve these robots. Moreover, this distance makes it more difficult for therapists to monitor, review, and improve therapeutic interventions themselves; a critical component of sustained therapy.

Autonomous robots are typically much more expensive than teleoperated ones, due not only to the cost of developing the robot autonomy, and the cost of integrating domain expertise into that autonomy, but also due to the suite of sensors typically needed to sense participants. Teleoperation reduces costs by removing the need both for this autonomy and by removing the need for the sensors that enable it. The majority of robots that can be used in therapy contexts are not widely accessible specifically because they are expensive. The large cost of robot hardware (typically thousands of dollars) has led to several efforts to create open-source or affordable alternatives such as the Romibo robot [60] or Peerbots [49]. These platforms reduce the cost barrier to widespread adoption of robots in therapy by promoting solutions that rely on teleoperation of comparatively affordable hardware that people may already own, such as smartphones and tablets. Most robots currently used in therapy with children are teleoperated by a therapist or educator, so research intended to benefit current therapeutic practice needs to account for this context of use.

Since human connection is a central component of therapy, having a human-in-the-loop facilitates transferring human-robot interaction outcomes to human-human interaction. Therapy is a sensitive context where children learn how to improve their speech, communication, or motion, all of which are essential behaviors for human connection. Therapists and similar specialists are specifically qualified to help children navigate this experience. While robots may be used to increase interest and engagement in activities, having a human in the loop ensures that therapy remains safe and meaningful for the child.

Above all, teleoperation ensures that a human expert can address the unpredictable, emotionally fraught scenarios that characterize therapy with children. It is imperative that technologists honor therapists' expertise and support their agency in this way. Teleoperation keeps power in the hands of trained professionals who bring empathy, nuanced judgment, and adaptable decision-making to each situation, instead of placing power in the hands of robotics companies and their developers. Recent work [31] supports this idea that socially assistive robots ought to incorporate teleoperation despite current research choosing to prioritize autonomous robots.

2.7 Teleoperated Robots in Practice

While most research has either focused on SAR autonomy [31], in practice, caregivers have been using teleoperated SARs to much success [12, 32, 43]. Teleoperated SARs allow caregivers to incorporate robots into their typical workflow where appropriate. When using teleoperated SARs, caregivers maintain their own agency, autonomy, and control, so that they can override or interfere with any issues that come up.

Importantly, the level of autonomy chosen for robots has an influence on the role that caregivers play. When using teleoperated robots, caregivers control the robot's exact actions. When some autonomy is used, caregivers switch to a more supervising role. When full autonomy is expected, caregivers review the robots' performance. These different roles for caregivers present different teleoperation needs and are therefore crucial to consider when designing teleoperation interfaces [35].

It's well known that robot teleoperators have specific needs that do not arise when robots are fully autonomous. There is a long history of research on teleoperation in the human-robot interaction community [27, 41, 46], which has

revealed key factors that need to be considered when working with teleoperators [1, 21], including the need to consider teleoperators' workload demands and reduced Situation Awareness [1, 21].

Because of the way that teleoperation interfaces need to be carefully developed for specific contexts of use and the particular human factors constraints imposed by those contexts, effective use of robot teleoperation interfaces often requires expertise both in the relevant subject matter area and in robot teleoperation itself [62]. This is true both for teleoperation interfaces used in traditionally high-technology domains like space exploration, as well as socially assistive domains like therapy. In both of these domains, however, the teleoperation interfaces used in practice are not typically designed with consideration for the background technological expertise and skillsets of the workers who will become teleoperators. Recent research on SARs supports this, showing that caregivers considering the use of teleoperated SARs in their practice need to dedicate substantial time to learning teleoperation interfaces [30].

Research on SARs has found robots to be effective at engaging children in therapy, resulting in positive outcomes for children. Most of this research has focused on autonomous robots despite level of autonomy recommendations suggesting a need for teleoperation when supporting critical tasks with high needs for accountability such as therapy [31]. The chosen level of autonomy for SARs heavily influences the design of the robots and their teleoperation interfaces if present. Yet, little is known about therapists' needs when teleoperating a robot in therapy. In this paper, we aim to answer two key research questions:

RQ1. What are therapists' needs in conducting therapy with neurodiverse children?
RQ2. How do these needs change when teleoperating a robot in therapy?

To answer these research questions, we interview individuals with experience teleoperating robots to deliver therapeutic activities for neurodivergent children. We uncover teleoperators' needs by grounding our investigation in the individual experiences of our participants. As a result, we provide guidelines for non-therapists to better understand their experiences.

3 METHODOLOGY

To understand therapists' experience during therapy, we conducted ethics-board-approved semi-structured interviews with 9 participants about their experiences conducting therapy with and without robots. All participants had experience or an accreditation in a therapy practice with children. They all also had experience teleoperating robots during sessions with neurodivergent children. We share more details about our participants' experience in Table 1. Interviews were conducted virtually over a video chat platform and were recorded to allow interviewers to focus on participants and provide a more engaging conversation. Interviews were around one hour long and covered conducting and preparing therapeutic social assistance with and without a robot, and how participants would use a particular robot teleoperation interface shown to them on their screens. Our interviews established a base case of therapy as *therapy without a robot*. We then discussed *therapy with a robot* as an alternative therapy in contrast to that base case. This allowed us to determine the differences and changes that occur when using a robot. In the final portion of our interviews, we asked our participants about how they would use a specific teleoperation interface (Peerbots [49]) to establish a consistent frame of reference across our participants.

3.1 Recruitment

Through a collaborator who has built socially assistive robots for several years, we reached out to 22 individuals who had experience operating socially assistive robots in sessions with neurodivergent children. All approached individuals had experience controlling robot dialogue during these sessions, and some also had experience controlling robot motion.

We sent each participant a description of the research, and a consent and video release form, allowing them to provide their level of consent over data use. Upon signing the consent forms, we scheduled a time for an interview via video chat. Out of 22 potential candidates, 7 did not respond to our initial inquiry, 4 did not respond after research details were shared, 2 declined to participate, and 9 agreed to be interviewed.

3.2 Participants

In this study, we investigated specific individual experiences in order to illuminate broader patterns in the teleoperation of robots in therapy. Details about our participants are described in Table 1. Of our nine participants, six are credentialed therapists, one is an educator, and two are non-therapists who have relevant experience to robot-assisted therapy for children. While the two "non-therapists" do not have the credentials necessary to be licensed as therapists or educators, they have extensive experience using the same robots to perform the same activities with neurodiverse children. Our interviews suggest that they have similar views about and needs from the technology used. All participants had direct experience using robots in delivering therapeutic content to children. Participants had experience with using at least one of the following robot systems commonly used for social assistance: Peerbots [49], Romibo [60], Misty [54], Movia [53]. A majority of our participants (6 of 9) continue to regularly practice delivering therapy.

We used information power [42] as a reference for the quality of our interviewed sample. We chose to use semi-structured interviews in order to facilitate participants' reflections on specific aspects of their experiences in the field. We used these reflections to develop better qualitative understanding of their work [9]. While the population with our desired experience is small, we were able to recruit participants who all had experience operating robots in this context. All our participants were deeply engaged, sharing rich and descriptive stories from their experiences. While each participant had unique elements to their experience, they all shared consistent narratives about their experience in therapy and their robot use.

3.3 Study Procedure

After reading and signing our consent forms and data use policy, participants completed a survey of questions about their background; therapeutic credentials, experience working with children, and experience working with robots. We summarize participants' survey responses in Table 1. After completing the survey, participants scheduled a time for an interview with one of our research team members.

Interviews were conducted over video chat. The interviewer began interviews by asking if participants had any questions about the study procedure, and confirming their consent to participate. The interviewer then reviewed participants' survey responses and provided a summary of the topics they could expect to receive questions about. The interview was broken up into two portions: (1) therapy in general, and (2) therapy with robots. Our interview was semi-structured with guiding questions and prompts for each section shown in Appendix A.

During the portion of the interview in which we discussed therapy with robots, we showed participants a screenshot of Peerbots [49] the example teleoperation interface shown in Figure 1. A larger version of this image is provided in the Appendix in Figure 10. The Peerbots application provides teleoperation capabilities for Misty robots and other

Fig. 1. An example of the Peerbots teleoperation interface that was shown to participants.

ID	Therapeutic Credentials	Experience with robots	Interview (Time, Words)
Alissa (T1)	Registered Behavior Technician with 3-5 years of experience delivering behavioral and art therapy to neurodivergent children in one on one sessions.	Used robots in therapy with children in the past.	00:55, 9,899 words
Blanche (T2)	Dance and movement therapist with 5-10 years of experience working with children who have various disabilities.	Extensive experience with robots and regularly uses robots for group social skills sessions.	01:33, 19,132 words
Caroline (T3)	Therapist with B.S. in Psychology with 5-10 years working with children who have various disabilities.	Used robots in therapy one on one and in groups.	01:04, 8,346 words
Emily (T4)	Occupational therapist for 5-10 years with 3-5 years working with children with various disabilities.	Used robots for some one on one sessions.	00:36, 6,305 words
Fiona (T5)	Licensed marriage and family therapist with over 10 years of experience working with children who have various disabilities.	Regularly uses robots for therapy with children.	00:47, 7,418 words
Greg (T6)	Behavior interventionist with over 10 years of experience working with children who have various disabilities.	Led social skills group sessions for many years then left to found a social robotics company.	01:09, 8,931 words
Holly (E1)	Child development specialist with over 20 years of experience in teaching.	One year of using robots in one on one sessions with children who have various disabilities.	01:04, 8,456 words
Isaac (N1)	No therapeutic credentials. Adapted Aquatics Instructor	Early adopter working with children to delivered social skills content using robots to groups of children for 5-10 years.	00:58 8,133 words
Jaclyn (N2)	No therapeutic credentials.	Organization leader using robots to regularly deliver therapy for groups of children with various disabilities for 5-10 years.	00:58, 10,308 words

Table 1. List of participants and relevant information. Individual codes used start with T for therapists, E for educators, and N for neither.

devices. As a free application available on various operating systems, it provides an example of a teleoperation interface that is relatively widely accessible to participants. As was later verified by our participants, the Peerbots interface was fairly consistent with other teleoperation interfaces our participants had used. The Peerbots interface has (1) buttons to activate robot dialogue, (2) organization capabilities for organizing robot dialogue, (3) edit capabilities to modify robot dialogue content, and (4) features to manage the connection to the robot being teleoperated.

Interviewers used the guiding questions across the interview as starting questions to guide the conversation. Interviewers relied on these questions mostly as fallback questions when they could not build off of participants' responses to previous questions. Importantly, as we conducted more interviews, we became better informed about therapists' experiences and began to ask more targeted questions. As expected, most, if not all, of our interviews shifted from the scripted questions, as can be seen from participants' quotes in Section 5.

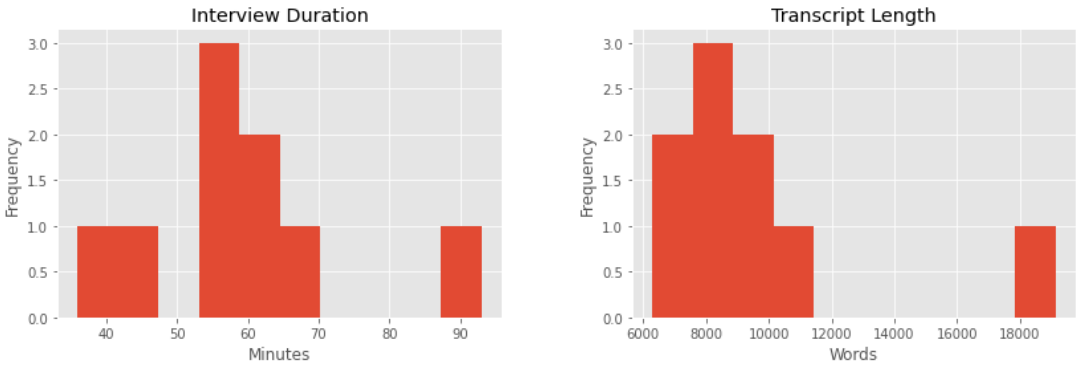
3.4 Analysis

After we conducted the interviews, we used auto-generated transcripts of the recordings as our starting point for text analysis. One member of our team listened to all the recordings and verified and edited these transcripts. Interviews averaged 60 minutes long with outliers at a minimum of 36 and maximum of 93 minutes long. Interview transcripts averaged 9658 words with outliers at a minimum of 6,305 and maximum of 19,132 words. Distributions of these values are shown in Figure 2.

We followed the general principles and heuristic devices of grounded theory [4, 20] to identify and analyze key patterns from our participants' perspectives about therapy. We selected grounded theory since it is effective at working in a largely unknown context to produce an explanation of an underlying process [22]. While therapeutic practices are generally well-defined, the use of robotics in these contexts is comparatively novel, the earliest of which was in 1997 [10]. Our research thus contributes to increasingly important scholarly conversations about robots in therapy [29, 55–57] with a new focus on the teleoperators of these robots.

Our coding approach was conducted as follows. One coder (the first author) began by open coding the finalized transcripts. This coder annotated text with consideration for dominant themes or topics addressed in each passage by the participant. All text was coded, and some portions were coded with multiple codes where the content covered more than one idea. Upon completing the open coding of all the transcripts, this coder read through all the open codes and merged those that presented the same idea but were phrased differently in the code name. The final count of open codes was 528. Two coders (the first and second authors) then conducted multiple iterations of axial coding in which they identified patterns across open codes. By aggregating similar codes, axial codes allow us to find general patterns in the data and come to conclusions about our participants' experience. Our goal was to group the large number of open codes into related concepts with a lens focused on needs and difficulties that our participants have experienced. We arrived at 6 themes with 14 sub-themes that appeared across the open codes. While not all open codes fell in these themes, our goal was to identify patterns specifically relating to therapists' needs. In our analysis, we focus on the themes that were repeated across our participants that seemed salient during interviews and were important to them. The first and second authors discussed different approaches to organize the axial codes and came to an agreement. We present two ways in which these themes relate to each other: (1) hierarchically, when we discuss each theme and subtheme in Section 5, and (2) relationally, when we discuss patterns across themes in Section 6.

We note that our theme formulation originates in the perspectives of technologists, and may differ slightly from strictly therapeutic perspectives. For example, we emphasize the difference between documentation and evaluation,



(a) Distribution of interview duration in minutes.

(b) Distribution of transcript length in words.

Fig. 2. Distributions of interview statistics.

whereas therapists often perform those two activities concurrently. When technology is involved, the processes of documentation and evaluation can be separated, since documentation does not require therapeutic expertise, but evaluation does. We highlight this and other important pieces of our analysis in each theme's description.

By improving our understanding of therapy and how therapists use robots, we can provide guidelines for developing interfaces with their operators' needs in mind. With our identified themes, we are able to describe therapists' experiences conducting therapy in an accessible way to non-experts; specifically those building technological tools for therapists. In Section 4, we define the dual-cycle therapeutic process that stems from our analysis. In turn, this situates readers in the context that our participants experience. By defining this dual-cycle process, we show how therapists' needs are oriented around each cycle and the relationships between these cycles. Following that, in Section 5 we discuss each theme in further detail, providing interface recommendations, and in Section 6 we discuss relationships across these themes.

4 THERAPY AS A DUAL-CYCLE PROCESS

It is essential for developers to recognize that therapy is cyclic and that the cycle of therapy is in fact comprised of two nested and paralleled cycles. Our analysis of participant interviews revealed this as a key pattern in the way therapists discussed their work. Therapy involves examining the client, evaluating their needs, preparing to meet those needs, delivering an intervention, and then repeating that process. This cycle ensures that a client's changing needs are met and their goals are achieved over time. Critically, therapy is defined by two cycles at different levels; on a long timescale of months or years across the clients' sessions (the outer cycle), and a short time scale of minutes or hours within each session (the inner cycle) [2]. We present a visual representation of these cycles in Figure 3.

The outer cycle begins when a new client is identified. They are examined and evaluated by a specialist who can determine their needs in collaboration with parents, schools, and healthcare institutions. Afterwards, therapists collaborate with these other stakeholders to outline the clients' goals and determine the relevant interventions. They then deliver these interventions during a therapy session and examine the child throughout to determine the success

[2]While the inner cycle exists within the outer cycle, when we refer to the outer cycle we generally mean the parts of the outer cycle that are distinct from the inner cycle —this distinction will become important in future sections.

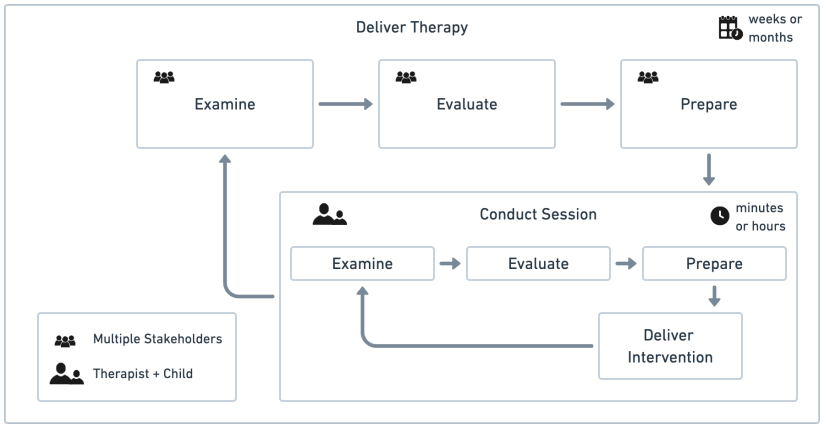


Fig. 3. The cyclical process that therapists undergo in therapy with a client. The outer cycle involves a variety of stakeholders whereas the inner cycle within a particular session is focused on the therapist and their client.

of each intervention. These observations are collaboratively reviewed, goals are reconsidered, and the outer cycle of therapy continues.

Within each individual session (the inner cycle), therapists undergo a similar cycle of (1) examining and evaluating their client, (2) preparing interventions, and (3) delivering interventions. In this context, therapists are not in direct collaboration with other stakeholders. The inner cycle involves only the therapist and child working together.

In summary, while both cycles follow a parallel process of examining, evaluating, preparing, then delivering an intervention, key differences exist in terms of time-scale and whether other stakeholders are involved.

Therapy is often approached with a focus on either the outer cycle of macro-interactions between stakeholders [7, 61] or the inner cycle of therapeutic interventions [23, 23, 25, 40]. However, these single-cycle perspectives miss a key piece of the story. By understanding how the outer and inner cycles interact from therapists' perspectives, we identify valuable considerations that can improve robotic technology used in therapy. We described earlier in Section 2.5 that most research focuses on the robot-child interaction. It may in fact be more precise to say that it focuses on the inner cycle of therapy, often without acknowledging outer-cycle activities like preparation. In contrast, our research takes a broader view that places enhanced emphasis on the outer cycle of therapy. Moreover, and distinct from the bulk of prior literature, our research focuses on the therapists who seem to often be ignored as the real users of these systems. Participants seemed generally appreciative of our interviews. Emily (T4) concluded their interview with, "*I'm just happy that you all, are taking into account therapists' opinions, so I really appreciate that.*"

The six themes that emerged from our interview analysis are directly connected to the way that therapists examine, evaluate, and prepare in the inner and outer cycles of therapy. In the remainder of this paper, we will explore the details of each theme, outline recommendations for developers building tools used in this context, and describe how these themes relate to each other. We ground our recommendations in the experiences of the therapists who are the real-world users of these products. Based on our analysis, we develop recommendations that are directly connected to our participants' stories and experiences. Additionally, to facilitate the discussion with developers, we present the following high level guidelines:

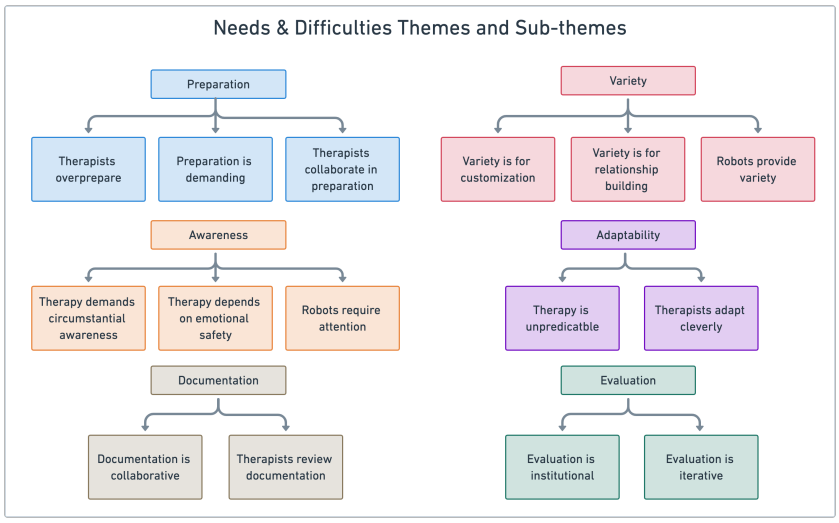


Fig. 4. The themes and sub-themes derived from our analysis of interviews about delivering services using robots to neurodivergent children.

(1) When possible, tools should directly meet an identified need of therapists in the moment it occurs—within the inner or outer cycle.
(2) Tools should account for the interdependent relationships between and the consequences of actions that occur in the inner and outer cycles of therapy.
(3) Since therapists have more time during the outer cycle, tools should move demanding or time-consuming activities to the outer cycle when possible.

5 THEMES

We identified six themes that consistently emerged across our interviews (as visualized in Figure 4):

(1) **Preparation:** therapists need to create or organize the resources they need for therapy.
(2) **Variety:** therapists rely on a variety of content to deliver effective therapy.
(3) **Awareness:** therapists maintain a high level of awareness in therapy to respond to their client and surroundings.
(4) **Adaptability:** therapists adapt within each session to clients' needs in the moment.
(5) **Documentation:** therapists rely on thorough documentation.
(6) **Evaluation:** therapists continuously evaluate their clients to determine progress and upcoming interventions.

5.1 Preparation

Effective preparation is necessary for effective therapy. Yet preparation is often omitted or disregarded in work focusing solely on the inner cycle of therapy sessions with children. In contrast, framing therapists as robot users naturally centers their preparation process. Our participants explained how demanding preparation can be, how the uncertainty of therapy leads them to over-prepare, and how introducing robots complicates their preparation process. In tension

with these feelings, therapists also reported that they only feel prepared when they're over-prepared. When they use a robot, this need for over-preparation becomes even more salient, since preparation with a robot is more time consuming.

5.1.1 Preparation is demanding. Preparation is a fundamental part of therapy. To prepare, therapists read documentation about their clients' goals and previous sessions (see Section 5.5.1) to create or organize the appropriate interventions. When we discussed preparation with Holly (E1) , they explained that "*you're preparing your lesson. ahead of time, based on what the goals would be for that session*". Blanche (T2) , a music and dance therapist, describing their preparation for sessions without a robot, says "*the first thing I do is set up my playlist*"[3] Blanche (T2) says that when selecting music, "*the music really has to support the goals of the clients as well, so it is a big deal. I spend, a ridiculous amount of time nerding out about music*". For Blanche (T2) , it's clear that the preparation process is time-consuming and demanding. Blanche (T2) explains that "*For this week, maybe I know we want to work on self regulation ... so I'm going to, I know I'm planning to play a freeze dance game*". Blanche (T2) shows us that preparation isn't just a one-time occurrence but instead changes every week or session. Holly (E1) , a teacher with over 20 years of experience, mentioned that "*there's always preparation, no matter how experienced you are.*" Preparing for therapy is clearly time-consuming even without the incorporation of a robot.

When a robot is introduced, it can exacerbate this time burden. Holly (E1) explained: "*You know, I wasn't born and raised with technology like kids today. So, the technology end of it for me kind of felt like a lot of my focus in preparation*". Therapists are therapy experts, but not necessarily experts in operating robots or other technologies. As Blanche (T2) puts it, "*I'm a therapist, like, I'm not like, like, I don't know tons of tech stuff, like, I am passable at best... I can troubleshoot small things, but when something massive is happening with an app that I know nothing about, I'm bewildered.*" Holly (E1) mentions that "*it does require skill on the therapist*". Even Isaac (N1) , who suggested being technologically savvy (" *we're nerds here, and we like to do nerdy things*"), mentions that "*I took some practice because it was, it was a tedious process in the beginning.*" Caroline (T3) shares that "*planning for that session (with a robot) for me was harder, really hard in the beginning*", and that was because "*I did have to learn how to use the software.*" Greg (T6) elaborates on the precise and time-consuming ways that the introduction of a robot exacerbates existing preparation challenges: "*you have to have your content, and your interface pretty well mastered ahead of time to be able to respond as quickly as you need to respond in a therapy session.*"

Preparing robot content requires far more detail when compared to not using a robot. Caroline (T3) , a therapist with over 5 years of experience, described how when using a robot, " *I actually have to plan even more.*" They clarify: "*If it's just me talking I have control about myself. If I have to put things in the robot prior then he can only follow whatever I put there—my preparation needs to be well-polished.*" Three of our participants (T1, T3, E1) explicitly described how planning details is a big part of preparing with a robot. Alissa (T1) mentions that with robots they had to "*pre-plan everything really extensively to be successful in those sessions.*" When asked about what was involved in preparation with robots their initial response was just "*A lot. A lot.*"

Recommendation: We recommend that developers building robot teleoperation tools present functionality for authoring content and operating robots in separate interfaces. Separating these modes of use acknowledges that authoring (preparing) and operating occur at different times and require different kinds of mental effort. Authoring generally occurs in the outer cycle when therapists have more time to be thorough. Teleoperation occurs during the more time-sensitive inner cycle of therapy sessions. Authoring interfaces ought to support planning for a high level of detail that simplifies teleoperation while incurring minimal inconvenience for the content author.

[3]In music and dance therapy, music selection is analogous to content and activity selection in other forms of therapy.

5.1.2 Therapists over-prepare. For therapists, being well-prepared means being over-prepared. When Holly (E1) described their preparation process with a robot, they emphasized: "*I typically over-prepare—I mean have many activities in the bag…in case you pull out an activity and the child is not interested in the activity, you might try another.*" Preparing a large variety of activities helps therapists connect with their clients (see Section 5.2.2). An important part of understanding therapists' needs around over-preparation is understanding *how much* they over-prepare. Blanche (T2) explained that "*if the session is going to be 45 minutes or an hour I'm going to have probably 85 minutes worth of music…I always over-prep everything. I'd rather be over-prepared than under-prepared.*". That's close to double the amount of content used in-session. They add that over-preparedness is necessary because therapy is unpredictable (see Section 5.4.1): "*it might not happen, but I'm planning (for it)*". Isaac (N1) affirms this when they say "*We always had a backup*". Greg (T6) mentioned bringing a "*Mary Poppins bag of tricks*", explaining that "*we bring our big, you know, big suitcase full of toys and, and reinforcers and figure out what works for (the client)*". Although therapists' over-preparation is time-consuming, it nevertheless provides them with the tools necessary to form a strong relationship with their clients (see Section 5.2.2) in order to create an emotionally safe environment (see Section 5.3.2).

While having more content can help therapists feel prepared, it makes it more difficult to organize and access content easily in sessions. Blanche (T2) revealed that "*I would write so much (session content) But then, sometimes in the moment it's hard to scroll through screens to find what it is that you want.*" Blanche mitigated this issue by opting for a highly modular system: "*So for me, I always like to work with separate palettes for opening and closing and maybe sometimes separate palettes for transitions. If I know I'm transitioning from this activity to the next one, this is a palette I can come back to all the time.*" Our analysis uncovers a clear need for easy content organization but also shows that therapists use diverse approaches to content organization. Robot teleoperation interfaces typically allow therapists to group content to be verbalized by the robot into collections. Some teleoperators, such as Jaclyn (N2) , organized all content chronologically, in a single collection. Some, as Blanche (T2) mentioned, created activity-based collections that were modular. Others chose to create modular collections according to content theme, such as content for feedback, redirection, or relationship-building, instead of specific activities, such as a game or book.

Recommendation: We recommend that tools for robot content authoring and teleoperation support intuitive, adaptable content organization strategies that allow therapists to plan activities easily and stay organized to minimize demands on teleoperators' attention during sessions. We note that by over-preparing, therapists are moving a difficult process (creating an intervention) from the inner cycle, where they have a short amount of time, to the outer cycle, where they have more time. This approach inspired some of our recommendations and is one of our high-level guidelines outlined in section 4.

5.1.3 Preparation is collaborative. Our analysis shows that collaborative preparation is vital to therapy and occurs during the outer cycle. Our participants described preparation as a matter of iterative input from many stakeholders. Goal setting, which is a primary component of preparation, for a client or for a session can rely on parents, teachers, insurance companies, and others.

Information about clients is often consolidated for easy access to a child's information. For example, US children's special education teachers organize their goals into Individual Education Plans (IEPs). Holly (E1) described how they begin with "*knowing what (the client's) IEP might say, having anecdotes from teachers—that's preparation.*" Therapists often rely on this crucial documentation from others (see Section 5.5.2). Fiona (T5) similarly recounted that "*preparation may include reviewing what kinds of goals are in the IEP, like anger management…to see what's been going in class in terms of behavior and everything we keep track of.*"

Parents often provide substantial input into their children's therapy. Greg (T6) told us how "*the first step of any therapy is figuring out a preference assessment, A lot of times you get that ahead of time from the parents (who) can tell you what worked for them already.*". Because parents' input is given such weight, they can sometimes play a crucial role in therapy. In the early stage when "*the adult/the parent will typically establish these goals with the therapist*", Emily (T4) mentions that they would follow up with parents to elaborate on ways they can achieve these goals or other goals that might be important. Several participants shared challenges of working with parents. Alissa (T1) when describing out-of-session guidelines that parents should follow, "*And they don't want to follow it, and then they wonder why their child is still (discouraged activity)*". Overall, parents play a vital role in therapy through their input and expectations of therapy.

While parents and therapists have direct interactions with children over the course of therapy, other indirect, yet significant stakeholders are also involved such as health insurance companies. In the USA, where all of our participants practice, insurance approval is often required for children to receive therapy. Participants described coordinating with insurance companies to approve a robot as a therapy tool or to incorporate it into a treatment plan. Greg (T6) connected the approval process back to goal-setting: "*Most therapy is paid for by insurance or by the state and so it's fairly structured. You have to be working towards very specific goals and those goals have to be agreed upon by the team*". Goals and children's regular evaluations are used to determine whether a client receives funding for their therapy. These regular evaluations are often handled by the therapists' employer (see Section 5.6.1) so that a child's records are easily passed down if therapists change.

Recommendation: We recommend that developers of robot tools incorporate collaborative communication tools for various stakeholders to share information about children's goals and preferences. These tools should account for the role that insurance companies or other health institutions play in the use of socially assistive robots. Specifically, it is important for developers to understand that their interface design choices can impact, support or hinder, insurance (or similar) approval.

5.2 Variety

When therapists prepared, they focused on getting a variety of activities ready for clients. All of our participants stressed that having a variety of activities and interventions for a session helps therapy proceed smoothly and work effectively. Therapists emphasize that variety is critical in order to customize sessions and build relationships with their clients. Robots provide access to a variety of content which makes the robots appeal to therapists for use in therapy.

5.2.1 Variety is for customization. Therapists choose different interventions for different children based on factors such as children's age, the challenges they face, their therapy goals, and the features of their IEP or insurance plan. Emily (T4) reflected that the challenges a child faces "*present in so many different ways; and then what's important to one child might not be important to another While " there are some standard goals, like improving school performance or improving social interaction, that looks different to different people.*"" All interviewed therapists (6 of 6) emphasized that there is no single criterion by which to categorize children and determine whether they would benefit from specific types of activities.

Participants were reluctant to make generalizations based on children's age or disability; some even challenged interview questions that implied such generalizations. Greg (T6) pointed out that "*with autism, there's such variety. You can have a ten-year-old working on the same skills as a five-year-old, it's really dependent on the child.*" Alissa (T1) shares that "*it's important to not force kids into a box, that we want them to fit in. Like I think it's important to let a kid be*

who they are, and to meet them where they're at in any type of therapy that they get. " Technologists ought to be careful when deciding to structure (or market) products according to disability or age. Therapists themselves rarely rely on such generalizations, which are, on their own, often unhelpful or inaccurate for individual children. Our centering on therapists' perspectives presents the highly individualized process of therapy and shows that tools must work for all children.

Recommendation: We recommend tools easily accommodate a large variety of content that can be used in a variety of activities to better engage with clients. As we have outlined earlier, engagement is a crucial part of therapy's efficacy [5].

Recommendation: We recommend that tools for robot-assisted therapy allow therapists to easily tailor session content to a child's specific interests. For teleoperation interfaces, this could include features that allow operators to populate content with information specific to a given child—favorite colors, sibling's names, sports teams, and so forth. By incorporating children's preferences in teleoperation interfaces, tools can ease therapists' delivery of potentially stressful therapy sessions.

5.2.2 Variety is for relationship-building. Content and activity variety provides the structure to build a strong child-therapist bond. Caroline (T3) described the role that variety plays in the initial formation of relationships with a client: "*Independent of age or developmental issues—I might bring board games, or just painting or drawing or singing or drama. It could be infinite possibilities to play with this child until I feel I have some rapport created. They need to trust in me.*" Building a relationship between a therapist and a child is necessary to create a safe space for therapy (see Section 5.3.2). Greg (T6) brought up similar points about the relationship between variety and trust: "*in between all the structured exercises, you want to maintain the relationship with the child, so you have to find ways to make it fun and build that trust relationship. So having a lot of variety is always good* " Greg (T6) added that children often have specific interests and specific media that they're already partial to: "*Trains are really common; a lot of kids get interested in trains. There are lots of little categories.*"

Variety not only supports the varied interests of clients but allows therapists to identify these interests. Our participants describe therapy as an experimental process where therapists try new activities and see what engages their client. Holly (E1) mentions that when a child is not engaged, "*it could take two or three attempts to figure out why they're not engaged*". As Greg (T6) puts it, therapists are "*just constantly trying new things until you figure out what works and what turns (clients') mind on*". Offering variety fosters trust and promotes a positive client-therapist relationship. However, having to consider this vast number of tools and activities for preparation likely contributes to therapists' over-preparation (see Section 5.1.2).

Recommendation: We recommend that tools support or provide a variety of activities in a way that is easy to organize and move between. The goal behind supporting a large variety of activities is to provide therapists with the tools they need during the inner cycle of conducting a therapy session. However, when tools provide support for a larger variety of activities, the need to consider different content organization approaches becomes even more crucial.

5.2.3 Robots provide variety. Robots' ability to offer a large variety of activities contributes to their appeal for use in therapy. Our participants reported that they use robots to facilitate games, read books with children, listen to children read books, start conversations, and conduct many other activities. Fiona (T5) mentions that "*there's a lot of different options with this robot and software; everything from academics, to social skills, to vocational skills, self, daily living skills, stories*". Isaac (N1) talks about having content for "*a basic conversation. And some go-tos like either like Simon Says, I Spy.*"

Therapists typically rely on a variety of content to administer therapy, whether or not they use a robot. However, with robots, each individual activity is rigid in terms of customization. Emily (T4) describes without a robot, customization is simpler "*since I'm the one verbalizing everything I can customize it because I'm verbalizing*". Holly (E1) describes their difficulty trying to customize activities for children using robots by explaining that "*with responses of the robot you only have one or two keys, you can press*". These difficulties can slow down therapy as therapists try to figure out how to use the available tools. Robots add an extra step for the therapists when conducting therapy (see Section 5.3.3) especially with the difficulty of customizing content.

Instead of customizing specific activities, some therapists choose to provide variety by transitioning between different activities. Holly (E1) mentioned that "*I don't think there was a lot of wiggle room for customizing the activity itself, but you could customize which activity you chose... the selection of activities were diverse enough that if the child didn't feel comfortable reading a book with me, I could do a coloring book, for example.*" Alissa (T1) described how they could prepare two books and " *let (the client) choose between these two books but I already have both of these books typed into the robot so (the client) can choose between these two.*" However, if the child asks "*can you read me my own book?*" Alissa (T1) would respond with "*you know what (robot name) is tired today we're gonna have to wait till next week to read this book.*". Alissa (T1) later explained that they may then ask to borrow that book and use it to prepare for an upcoming session.

Recommendation: We recommend that tools allow for easily customizable and modifiable content. One way to do so would be by allowing the authoring of content with placeholders. This would reduce the workload on therapists within the inner cycle to customize content and move much of the effort for customization to the outer cycle when they are authoring content.

5.3 Awareness

Within the inner cycle, therapists say they are highly alert to everything going on. During a session, therapists must monitor their client's feelings, keep track of the features of the teleoperation interface, and resolve any technical difficulties. Therapists need to maintain the pace of conversation and avoid missing the important moments in a session.

5.3.1 Therapy demands circumstantial awareness. Our participants described different environments in which they conduct their sessions, often homes or school classrooms. Each of these variations comes with different needs. That, coupled with the vast assortment of goals that therapists work on with different clients, requires a high level of attention from therapists. When we asked Alissa (T1) about what they need to be aware of in sessions they said "*Everything. Everything at the same time*". They went on to add that "*you have to be aware of of everything, because we work on potty training, we work on how to hold utensils when you eat, we work on ...*". They went on to describe an in-home session where the parent was stressed and home renovations were happening at the same time during therapy. This example illustrates that, in addition to being unpredictable in terms of what a child might need (see Section 5.4.1), therapy can be unpredictable in terms of environmental factors. Alissa (T1) said "*I'm trying to, really, you know, do my work, but then all of those factors definitely, definitely play a factor in, in... You know, what I'm doing*". Therapy demands a great deal from therapists, as Blanche (T2) explains "*it is definitely a hard job and some days you go in there, like oh I'm already so tired how am I going to do this*".

Therapists need high awareness to detect factors that may be impacting their clients. When we asked Greg (T6) about the sorts of things they are aware of during a session, they told us "*Everything! You have to be aware of everything in the environment at all times. You can be missing 90% of the picture if you're not tuned in.*" Greg (T6) describes how something as simple as "*some flickering thing in the corner or some loud sound outside or some buzzing*" could be "

absorbing (the client's) awareness at the moment". Greg (T6) added that they also learned to be aware of contextual factors in a child's life ("*what their day has been like, what their diet has been like, have they eaten at all today, do they need to go the bathroom, did they just have a fight with their brother, sister...*") Alissa (T1) shared a story of one instance where a child hadn't "*pooped in four days*" and how that affected the therapy session. "*So you haven't pooped and you don't sleep and now I'm sitting here asking you to to identify this item that you don't care about so I'm gonna throw some behavior I'm going to scratch or I'm going to do whatever because... It's dumb!*" Prior to sharing that story Alissa (T1) mentioned that "*I talk about bowel movements. A lot. So, I, forgive me, but... We talk about poop constantly.*" alluding to the fact that the shared story is not a one-off occurrence. This story illustrates therapists' need to be aware of not only what's going on within a session but also much of what else is going on in their clients' lives. One way therapists do that is through "*anecdotal remarks from other staff, like So-and-so just got moved into a new foster home this week'*" says Holly (E1) . All these factors inevitably add to the cognitive load that therapists experience in the inner cycle of therapy.

Recommendation: We recommend that developers avoid introducing any artifacts that create substantial complexity for therapists. Tools should be as minimal and easy to use as possible so that therapists can continue to focus on what's important in therapy—the children.

5.3.2 Therapy depends on emotional safety. A fundamental component of therapy is the client's feeling of emotional safety. Fiona (T5) described how most of their awareness goes towards "reading" their clients, "*So, you always want to read them ... because you want to build rapport. If you don't, if the child doesn't feel comfortable, then everything else you're trying is not going to be effective.*" This form of awareness builds the foundation for therapy. Without it, clients cannot work toward any of their goals. 4 of 6 therapists described how their relationship with clients makes therapy both possible and meaningful. Caroline (T3) explained that: "*The most important thing for (clients) is not to understand 'oh, I have to change.' The most important thing for them is 'I could be here sitting with this lady once a week because I do feel safe here and I did create a nice relationship.'*" Other participants emphasized this same sentiment. Blanche (T2) affirmed how "*the most important aspect of therapy for anybody is that experience of being seen, being witnessed—being allowed to be your whole self.*" Emotional safety precedes all other activities in therapy. Therapists use their awareness during a session to cultivate a safe space for their clients.

Children may feel emotionally safer with robots than with humans. Caroline (T3) describes the general pressures that play a role in clients' expression, " *as any human, we do have some type of social expectations. And some children really struggled in responding to those social expectations, even if I tried my best.*" Caroline (T3) went on to discuss how despite the tools available to them as therapists to help children regulate, since therapists are still human, therapists present a "*demand*" on their clients. Caroline (T3) says that "*The way the robot presents itself doesn't come with like this, many years of social representations you know. It feels safer for some clients.*" When robots are used in therapy, they change the client-therapist relationship. Caroline (T3) describes that robots "*create some like closeness and distance between us and the client. In a way that can feel safe*". Emily (T4) describes the change as a "*perceived power shift. So, the robot kind of creates this new dynamic that we would never be able to achieve in the session, because I'm bigger, and I'm older and they know that, so it helps. The robot is less intimidating, not constantly watching every move the child makes, and so that helps*". Blanche (T2) mentions that "*The safety that (clients) feel with a non- human entity, you know, they there's a level of automatic trust that I saw a lot of our kids have, that was safe for them*". This perspective that robots help in creating a safe space for children is shared by *all* of our participants. When asked about how a robot changes the child's experience of therapy, Alissa (T1) says "*it's definitely a safer environment*". Children react to the robot in ways that they normally wouldn't with a human. To the point where parents say things like "*Oh wow, my kid doesn't even,*

like, look at how they're talking to that robot, like, they don't, they don't even talk". Jaclyn (N2) explains robots' impact saying, "*the robot was able to open them up; reduce their inhibition and motivate them to verbalize*". This is consistent with the research [57] and is a large factor in why therapists use robots. When asked why they use robots, Jaclyn (N2) says "*because they work, because they absolutely hands down are the best tool we ever have come up with*".

Recommendation: Technologists should carefully ensure that their tools do not compromise therapists' Situational Awareness so that therapists can successfully deliver their planned interventions. Any technological tools which are too distracting or frustrating run the risk of impairing the carefully-built sense of emotional safety that grounds therapy.

5.3.3 Robots require attention. When teleoperated robots are used in sessions, they place further demands on a therapist's attention during an already stressful inner cycle. Emily (T4) mentions that "*the robot is just kind of like an added step, so I actually think it adds to what I need to be aware of*", then later says "*but I don't think that's a hindrance*". This sentiment that robots are difficult to use but are worth it comes up frequently. Robots may be considered worth it because of how they change power dynamics with children, or due to the increase in variety that robots provide therapists (see Section 5.2.3) to connect with clients.

Robots can introduce additional logistical concerns for therapists. Isaac (N1) , Alissa (T1) , and Holly (E1) told us how tracking robots' battery life complicated their sessions. Isaac (N1) mentioned that "*Being aware of how well it was charged, you know. In the beginning those charges held really well, but towards the end, I mean, it was getting used and abused. Those products have a shelf life.* "

Since therapists aim to have robots match the client's pace of conversation, teleoperation interfaces themselves inherently demand attention. Emily (T4) told us about this challenge: "*That to me is the biggest struggle as a therapist—to kind of maintain that that timeliness of response in the conversation when you're trying to like type out a new button.*" Greg (T6) had similar reflections about their use of robots; "*There's a definitely a tempo that you have to keep to keep engagement going... If you're fumbling with the interface and you can't figure out how to say the thing that you want to say, but there's a moment that's happening right in front of you, and you want to address it and you want to make it teachable.*". In these moments, the technology should be getting out of the way but instead " *it's still a lot of scanning and searching to find the visual button that you need at the moment. You're maintaining a tempo and you're trying not to miss opportunities.*"

Recommendation: We recommend developers build tools that minimize the attention required to teleoperate robots in sessions, and that are easy to learn how to use. By making tools easier to learn, teleoperators can develop habits using the teleoperation interfaces that make it easier to keep up with the pace of conversation in sessions.

5.4 Adaptability

As therapists maintain Situational Awareness of their environment in therapy, they must respond to what occurs within their environment. Therapists describe therapy as an unpredictable, dynamic interaction in which maintaining a positive relationship is key. As the client's needs change within a session, therapists have to adapt and respond in the moment. With robots specifically, therapists have developed clever, narrative strategies to make up for technical difficulties and lags in child-robot conversation.

5.4.1 Therapy is unpredictable. In a session, a therapist's success at delivering therapy heavily relies on how they respond in the moment. Three participants explicitly mention that therapy rarely goes according to plan. Blanche (T2) said that "*it's cute to sit there and, like, for me, before session to type in all these different possible responses and I do. But then when I get there in the moment that doesn't mean that I'm going to have the right response.*" Blanche (T2) later

explains that "*it is super hard to predict what kids are gonna say*". Children may also test the therapist's knowledge and preparation as Isaac (N1) illustrates, "*I learned the hard way that the kids will test the robot and see if it does actually know everything*". Overall this just leads to more preparation (see Section 5.1.2). Alissa (T1) describes how, in order to run a game involving colors with a robot, they "*had to type in random colors in case somebody said that they wanted... so I had to pre-plan a lot with the robots.*"

Regardless of over-preparation, Isaac (N1) also mentions the importance of being flexible within a session "*I would kind of go in with more of an open mind . . . and go, you know, this is our goal. We might not reach it*". Jaclyn (N2) seems to agree when they say that "*we kind of have to be flexible and deal with whatever we get but, but we do try to take everything into account that we possibly can to make things appropriate.*" Therapists have to respond to whatever is happening in the session as illustrated by the inner cycle (examine, evaluate, then respond). Fiona (T5) mentions that "*maybe something else comes up in the conversation, and maybe I want to go to a different program that I didn't pre plan*". When asked if this is stressful, Fiona (T5) said that "*it's not really stressful it's just as long as they're patient maybe they'll give me a second, I want to do something that's really fun, . . . so it's not stressful.*" Fiona (T5) then alludes to a need for easier-to-use tools: "*I don't know, maybe there's a quicker way to even find it here I'm not sure.*" Holly (E1) mentions that "*most kids are pretty forgiving so I don't think you have to be perfect at it*". This likely explains why current tools continue to be used despite their imperfections. The benefits of children interacting with robots can outweigh the issues that therapists have to deal with; but for this positive impact to scale, technologists should simplify their products so they are more accessible to non-experts in robotics.

Recommendation: We recommend tools simplify in-session authorship and provide simple organization techniques. While we generally advocate for minimizing the use of autonomous tools in SARs, if they are to be used, we recommend autonomous tools be used to support therapists in authoring content. An example is through providing therapists with hypothetical responses that children might have. Therapists would then author content to respond to the hypothetical interaction and prepare appropriate content in case that arises in a session.

5.4.2 Therapists adapt cleverly. Therapists adapt their activities according to what they notice in the moment. Holly (E1) described how adaptation keeps children engaged, "*I always focus on getting them back engaged by adapting, you know, just walking over to them and talking to them about what they're doing and get getting them back on track.*" Blanche (T2) mentions that "*You go in there with like a general goal, maybe for the student, but you have to be spontaneous and you have to be ready to respond to what's there*". Emily (T4) describes a similar experience where therapy with new clients may start off in a similar way, but over time "*you find out what the child prefers and what works and what doesn't that's when the sessions, get a little, they diverge a little bit there, because you're going in different directions at that point.*"

Therapists are constantly having to respond to children in therapy. Blanche (T2) highlights that in contrast to simply delivering a lesson plan, "*as a therapist my training is . . . not this is my list of things I'm going to accomplish, no matter what else happens. That's not how I operate.*" In practice, therapists are able to adapt in the moment during therapy thanks to the variety of information they prepared for all the custom needs of their clients (see Section 5.2.1).

The use of robots introduces another facet of therapy that therapists have to adapt to, especially when technical difficulties arise. Our participants talked about how they manage technical difficulties, low batteries, or teleoperation delays. Emily (T4) described how: " *if the robot is thinking of a response and or is glitching then I'll obviously step in.*" Emily (T4) 's experience shows the worst case scenario; when therapists are unable to resolve the issue using the technology. Holly (E1) also described that when problems occur they "*certainly can impair the whole process if you're if there's a glitch in the technology*".

With certain technical complications, therapists are able to continue to use the technology to explain away the problems seamlessly through a narrative. Alissa (T1) says: "*I use the power nap one a lot. Like right before I knew (the robot's) eyes would die, because I could see like the 10% in the corner, I would have a button that says "oh I'm getting so sleepy! I need to take a quick nap!" and I would press that button right before it died.*" Emily (T4) mentioned utterances they authored specifically to compensate for delays: "*I did have some buttons that said, like "Hmmmm... let me think about that", like after the child asks a question. I was doing a lot of free typing in and adding buttons on the fly kind of which definitely got a little stressful.*" When therapists teleoperate robots, pacing is critical to providing a natural-feeling, positive experience for the child.

Recommendation: We strongly recommend that technologists ensure that therapists have full control over robots used in therapy. Specifically, therapists should have the ability to override any robot functionality to regain control of the situation.

5.5 Documentation

Therapists document their observations since documentation is a crucial component of the planning process and is often used to justify therapy's merit or validity to health insurance. Therapists assigned to a particular child may change over time. Good documentation allows a new therapist to easily pick up where the last therapist left off. When therapists document sessions, they often automatically include an expertise-based evaluation of the child. As developers, we emphasize the difference between documentation (writing down what happened) and evaluation (assigning a valence of that outcome). When technology is used in therapy, tools may support therapist-authored documentation which includes evaluations but we emphasize that any evaluation should be shaped and performed by the therapist themselves.

5.5.1 Therapists review documentation before sessions. As part of preparation, therapists review documentation. Therapists explicitly mentioned this review process as a way of getting ready for a session. Blanche (T2) shared that "*I usually review my progress notes from the session before just so I can catch myself up, because details might escape you a week between sessions*". This review is to " *help me assess baseline levels for the top of the session* " Caroline (T3) had a similar experience saying that "*before the session I usually kind of like review what happen last time ... I'm going to remind myself: this is where we were last week*" Holly (E1) described a similar scenario for reviewing documentation, "*when I was in the hospital with children, I mean every morning, we would go over their documentation*".

Greg (T6) pointed out that documentation happens both before and after each session, "*For two hour sessions, usually hour and a half doing direct therapy and 30 minutes documentation. 15 at the beginning 15 at the end.*" Alissa (T1) mentioned that they "*run trials on different activities and things of that nature and I collect data on that*" implying that this data collection occurs during the session. It's clear that therapists have notes and collect data, because they're reviewing those at the beginning of the session, but isn't clear from our interviews if there are explicit standard ways in which they do so. Our participants mentioned documenting their interactions at the beginning, during sessions and / or at the end of sessions. Regardless of the format in which they collect this information, we know that it is crucial for them to review documentation, which plays a role in preparation being demanding (see Section 5.1.1).

Recommendation: We recommend technologists develop tools that ease therapists' review of documentation and make documentation content easily accessible and editable throughout sessions. This is especially important in the US where therapists are often paid by session hours, not work hours overall [70]. A tool that eases the review process is more likely to be accepted by therapists who want to use their out-of-session time wisely.

5.5.2 Documentation is collaborative. Our participants described several different ways that their teams collaborated to document therapy. Jaclyn (N2) described how "*we have a Google form that all of the staff complete after any kind of session they provide, whether it's an art class or art therapy or anything. We call it an activity notes form. So, they fill that out that gets compiled into a computer program.*" Alissa (T1) described how "*I collect data on pretty much every move that a child will make on a specific goal. There's usually multiple goals*" Other therapists similarly reconciled notes from different stakeholders. Holly (E1) described how educators are an important source of documentation:"*If you're the head teacher or a teacher's aide or you're in the classroom every day with that child then your homework would be that there's documentation. Okay, and everyone should be aware of the documentation, whether the child is you know, has atypical or typical learning*" Holly (E1) also describes how there is informal collaborative documentation: "*It could also be that going by the ... anecdotal remarks from other staff.*" Fiona (T5) has a similar experience asking others about their client, "*I'll also talk to teachers, how is so and so doing in this behavior ... how they are in the class, as well as from administrators, because we all have different relationships with them, and we see different sides of them*". The documentation process serves to synthesize knowledge and observations from multiple therapists, educators, parents, and other stakeholders in each child's life. As Fiona (T5) describes, this collaborative aspect of documentation is essential to see all the different sides of the child.

Recommendation: We recommend that tools are designed to ensure that therapists have easy ways of collaborating to create and modify documentation from other stakeholders. Since it is important to understand a child's needs from different perspectives, we recommend that documentation tools be designed to highlight the individuals contributing the documentation and their role in the child's life. Understanding the context of a child's needs can help therapists determine the right action to take during therapy.

5.6 Evaluation

Evaluation is a collaborative and iterative process that ties together therapists' responsibilities within and between each session. Institutions provide support with evaluation by creating standard procedures to ease therapists' evaluation and maintain consistent records about clients. With iterative evaluation, therapists are able to monitor their clients' progress, and report to other relevant stakeholders.

5.6.1 Evaluation is Institutional. Institutions can provide a lot of support for therapists and maintain a consistent experience for children over the course of their therapy. As we mentioned earlier, Jaclyn (N2) describes a "*Google form that all of the staff complete after any kind of session*". Institutions can provide a standard format for evaluating clients to ease the burden on therapists. Jaclyn (N2) continues to describe " *summary forms —Those are evaluation forms and those we have for individuals and we have for groups, and we have those for any kind of robot engagement that we do*". While these per-session evaluation forms are important, being able to analyze the success of therapy over a long period of time is also crucial. Jaclyn (N2) describes " *evaluations after each program*" where programs are six, eight, or ten weeks. As the director of an institution, Jaclyn (N2) mentions running "*a pilot for our multi-sensory session, that was a six-month pilot but we broke it into like two three-months summers for that*" An essential part of these pilots is the evaluation of the therapy delivered. If the evaluation shows a successful delivery of the therapy, then these programs are then deployed. Through deployment, the organization creates all the content necessary to deliver the program and establishes the necessary metrics for a program's evaluation. Using this structure, new therapists can deliver these repeatable programs with ease.

Institutions provide continuity when working with the client and other stakeholders. When discussing preparation for a new client, Greg (T6) mentioned that *you're usually reading the notes from a therapist that worked with the child last. So you know if they picked up on something definitely want to try to build off of that.* The continuity across therapeutic evaluations is helpful especially when we consider the experimental nature of therapy in identifying what children respond effectively to. When describing the experimental process to connect with a child, Greg (T6) even mentions a last resort option to "*swap out therapists*" for the child. While ideally, children would work with the same therapist over time, institutions provide an ability for them to work with other therapists as well.

When incorporating robots in therapy through an institution, clients may develop a relationship with the robot and not the therapist. That means that if the therapist changes, therapy for the children is not significantly hindered. Alissa (T1) describes their experience entering an organization that had been working with robots: "*I kind of came in. Maybe in the middle of when they had started, but there were some schools that had already seen (the robot) for like a year and a half or two years before I started. So when I came in, they already kind of had this like established relationship with this robot.*" Kids would respond to the robot by telling other kids things like "*hey man, like, look at this, like, I knew him before*" or "*oh yeah, I remember him*". This experience was despite them having never met Alissa (T1) before.

Recommendation: We recommend that tools be designed to ensure that it is easy to share and retain information within an institution. Since documentation about therapy is private client information, this may create added privacy concerns for tools and require extra caution in the development of such tools.

5.6.2 Evaluation is Iterative. Therapists report that it is crucial to continuously evaluate clients to monitor their improvement and ensure that they are receiving appropriate interventions. Greg (T6) mentions that a child's overall "*goals are determined periodically throughout the year*" and that they are"*very specific to the children*" resulting in "*a lot of variety*" of goals. Not only do therapists have different goals related to different children, but their goals for an individual child usually change over time. Caroline (T3) describes that "*through the sessions, we realize, you know, that goal could shift a little bit more to this or to that*". Caroline (T3) later describes that even though these goals may change, "*we have to have goals. We have to know where we want to get. So, based on that. You need a(n) assessment.*" Caroline (T3) shows us that evaluation is a central part of therapy.

Therapists describe two key ways in which the results of their assessments are used; insurance and preparation. Alissa (T1) explains that "*insurance requires an updated treatment plan every like four to six months*". Alissa (T1) shares that an update to a child's treatment plan will be made up of "*a whole new set of goals that are put into the treatment plan that he needs to work on, because he made progress, in these, these are all done, we don't need to work on these anymore, so now we're going to move to this other stuff that we need to work on.*" Insurance needs these updates to ensure that the funding they are distributing to the child is worthwhile and the therapy is effective. Therapists also want to make sure they are delivering effective therapy and use assessments to determine upcoming interventions. Fiona (T5) mentions that "*We can measure how much of a goal has been accomplished, and if it's less than maybe 70 to 80% I may want to continue with that*", showing that evaluation directly feeds into session preparation.

Recommendation: We recommend that tools display reports of the client's progress on various activities, as determined by a therapist. To repeat a critical point: while technology should be used to support therapists, we advocate for therapeutic evaluation to be entirely performed by therapists and not incorporate any automated tools. Developers should also consider how their tool's approach to evaluation may help therapists with insurance approval.

6 PATTERNS ACROSS THEMES

As we've shown through our analysis, many therapists' needs and difficulties with robots are interconnected. In this section, we highlight some important high-level relationships across our themes that provide an alternative presentation for technologists and help re-enforce the needs of therapists. For each of these relationships, we present the relevant sub-themes while highlighting the cycle of therapy to which they generally belong.

6.1 Therapists manage uncertainty to ensure emotional safety

During the time-sensitive inner cycle, therapists maintain awareness of a multitude of factors (Section 5.3.1), especially their client's emotional safety (Section 5.3.2). The lack of predictability in therapy (Section 5.4.1) requires therapists to adapt in the moment to meet their clients' needs. To do so, therapists use the available time during the outer cycle to over-prepare by authoring a large amount of interventions (Section 5.1.2) that they rely on to more easily adapt in the moment. This over-preparation often involves creating a large variety of content that is specific to their client and eases connecting with the client to build a relationship (Section 5.2.2). Equipped with the large variety of interventions that therapists over-prepare, they can more easily create an emotionally safe and engaging space for children to receive the therapy they need. We present a visual representation of this pattern in Figure 5.

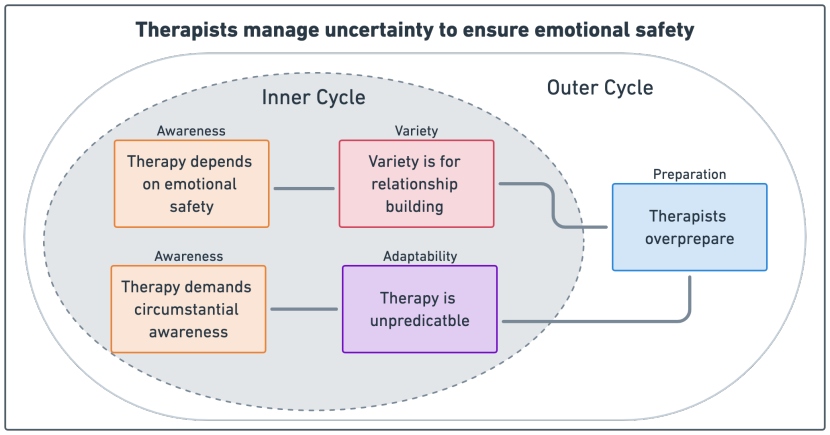


Fig. 5. During the inner cycle of therapy, therapists manage the various factors producing uncertainty in order to ensure emotional safety for their clients. Importantly, they rely on their over-preparation in the outer cycle to deliver effective therapy.

6.2 Therapists adapt to customize therapy

During the inner cycle, therapists have to adapt cleverly to their environment, client's needs, and any technical issues that arise from the interventions they deliver (Section 5.4.2). To adapt, therapists rely on a variety of content that they've customized to meet these particular needs (Section 5.2.1). The variety of interventions available to therapists is what allows them to customize and adapt. Customization ensures that clients are engaged, which is crucial in delivering effective therapy. We present a visualization of this relationship that considers the dual cycle model of therapy in Figure 6.

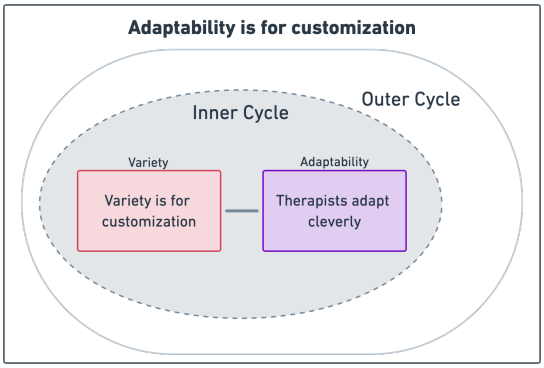


Fig. 6. During the inner cycle, therapists rely on the variety of interventions available in order to adapt in the moment by customizing interventions to the client's in-the-moment needs.

6.3 Robots create a Variety-Attention trade-off

Robots' ability to introduce and support a large variety of interventions is a key reason for therapists' interest in using them for support in therapy (Section 5.2.3). However, therapists also explain that robots increase the demands on their attention during therapy (Section 5.3.3). Therapists describe a trade-off (see Figure 7) between the value a robot brings in terms of an engaging variety of activities and the cost of having to learn to use a potentially complex system in an already stressful time. It is therefore crucial for technologists to minimize the attention required to use teleoperating interfaces in this context.

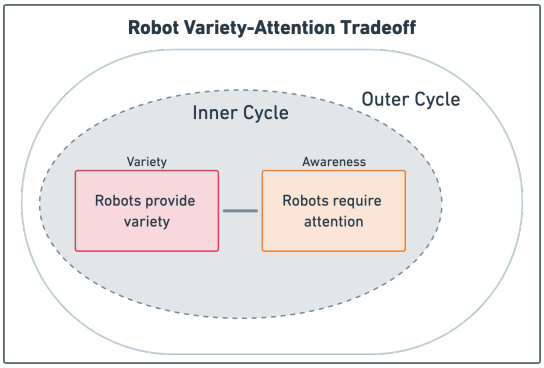


Fig. 7. Robots create a tradeoff between the variety they can provide and the attention they require during a session.

6.4 Therapy constantly changes

As part of preparation for therapy, therapists have to review documentation from previous sessions or other collaborators (Section 5.5.1). This review increases the demanding nature of preparation (Section 5.1.1) since the client's evaluation throughout therapy is iterative (Section 5.6.2). As therapists deliver therapeutic interventions for their clients, their

clients achieve the established therapeutic goals. After achieving these goals, the clients' therapeutic needs begin to change. Through preparation in the outer cycle, therapists adapt sessions to their client's changing long-term needs. Preparation is a crucial step that can minimize the effort required and stress endured when delivering therapy. We present a visualization of this relationship in Figure 8.

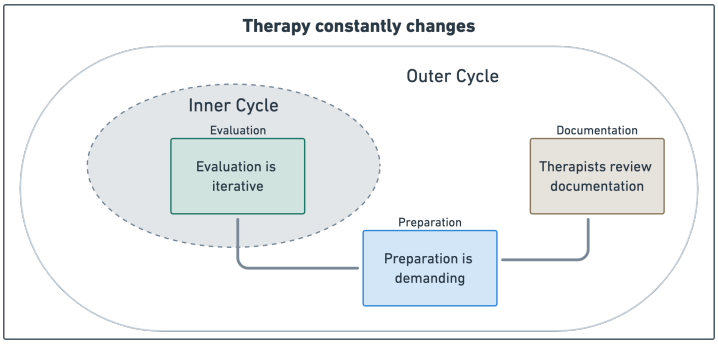


Fig. 8. The iterative nature of evaluating a client results in demanding preparation for therapists who review the constantly changing documentation of the child's progress.

6.5 Collaboration exists throughout therapy

Therapy is collaborative during preparation (Section 5.1.3), documentation (Section 5.5.2), and evaluation (Section 5.6.1). Collaboration involves a diverse set of stakeholders including parents or guardians, teachers, therapy institutions, and insurance companies, each with different perspectives about the child. As we have described before, these stakeholders are mostly involved in the outer cycle. We show how collaboration crosses several themes and is mostly present in the outer cycle in Figure 9.

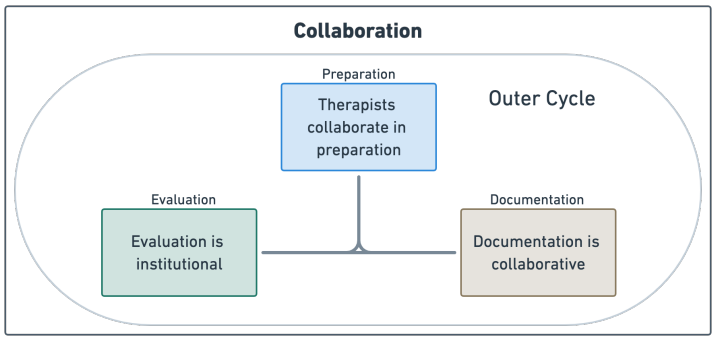


Fig. 9. Therapy is collaborative across preparation, documentation, and evaluation.

7 DISCUSSION

7.1 Recommendations Summary

By better understanding the needs of our participants, we are able to provide both high level and detailed recommendations. We begin with our overarching recommendation to technologists: focus on the *teleoperators* of robots as the *end-user* of teleoperation interfaces. To meet teleoperators' needs, we group our recommendations under three high-level guidelines: (1) meet therapists' needs in the moment, (2) account for the inner and outer cycle and their relationships, and (3) move actions to the outer cycle when possible. We present a summary of all recommendations in Table 2 with references to the particular problems they address in the relevant sections above.

Recommendation	Section	Target
(1) Meet therapists' needs in the moment:		
Support both modular and chronological content organization.	5.1.2	General
Support a large variety of content.	5.2.1	General
Support a variety of content accounting for child-specific preferences.	5.2.2	General
Take into consideration and design for the likely non-technical audience of tools.	5.3.3	General
Add minimal distraction in the inner cycle.	5.3.1	Operating
Consider the sensitive context of therapy that requires emotional safety for the child.	5.3.2	Operating
Design for pace of conversation.	5.3.3	Operating
Incorporate easy on-the-fly authoring during the inner cycle.	5.4.1	Operating
Ensure that teleoperators have as much control as possible including overriding any automations introduced.	5.4.2	Operating
(2) Account for inner and outer cycle and their relationships:		
Incorporate collaborative documentation that identifies documentation author.	5.5.2	General
Allow institutional content organization and sharing.	5.6.1	General
Support collaborative goal-setting and preparation.	5.1.3	Authoring
Allow access to edit and view documentation in the inner cycle.	5.5.1	Operating
Present previous sessions' evaluations in the inner cycle.	5.6.2	Operating
(3) Move actions to the outer cycle when possible:		
Separate authoring and operating modes in robot-assisted therapy interfaces.	5.1.1	General
Incorporate dynamic placeholders for information that can be gathered in the inner cycle.	5.2.3	General
Incorporate hypothetical responses during authoring to help therapists imagine how therapy could go.	5.4.1	Authoring

Table 2. Summary of considerations for technologies supporting robot-assisted therapy.

7.1.1 Meet therapists' needs in the moment. Robot-assisted technologies need to meet therapists' needs in the moment. We recommend that technology for robot-assisted therapy support a large variety of content, that accounts for child-specific preferences and is easy to organize in several ways based on therapists' preferences. Technology for robot-assisted therapy should account for the technical expertise of the therapist operator across tasks like setup, authoring, and teleoperation. Currently, systems often assume more technological expertise and debugging capabilities than teleoperators possess. During a session, technology needs to ensure minimal distraction to teleoperators considering the sensitive context of therapy. Robot-assisted therapy tools ought to ensure it is easy for therapists to incorporate

in-session authoring and maintain the pace of conversation. While some tools may already offer a form of on-the-fly authoring, the capabilities are often limited to a simple textbox to type in. Our participants highly valued the ability to author content in the moment and we recommend further improvements. Robot-assisted therapy technologies should ensure that teleoperators maintain as much control as possible in order to best leverage their expertise. Current systems often introduce automation or autonomy to support therapists, but instead, we recommend that these robot-assisted therapy solutions rely on the expertise of therapists who are trained to handle precisely the scenarios that arise during therapy and ensure therapists have full control to override any automation.

7.1.2 Account for the inner and outer cycle and how they relate. When technologists consider tools for robot-assisted therapy, they often focus on the inner cycle of sessions without consideration for the outer cycle and how it influences therapists. We recommend that technologists account for both the inner and outer cycles and how they relate; specifically the collaboration that occurs across these cycles with multiple stakeholders. Robot-assisted therapy technology should support collaborative documentation that identifies the documentation author. Current systems may allow for simple content importing and exporting but should consider improved sharing capabilities to support the institutional and collaborative nature of therapy. Importantly, teleoperators should be able to easily access documentation and evaluation reports within sessions and edit them with updated information in real time.

7.1.3 Move tasks to the outer cycle when possible. Considering the outer cycle's influence on the inner cycle is clearly important, but technologists should not stop there. We noticed that therapists' approach to preparation in the outer cycle is intended to move actions from the inner cycle to the outer cycle. Technologists should follow this approach that therapists are already taking. For example, we recommend content incorporate dynamic placeholders for information that can be gathered about individual clients during sessions. Currently, therapists have to duplicate content and make many small edits to customize content. Incorporating dynamic placeholders would allow therapists to easily duplicate and customize content to their clients.

It is also critical to consider how the inner and outer cycles differ. While teleoperation tools offer some authoring capabilities, these capabilities are not sufficient for therapists' authoring needs in the outer cycle. We recommend technologists develop separate authoring and operating modes and tailor these modes to therapists' different needs in the outer and inner cycles. While authoring content, therapists often imagine how their clients will respond to chosen content and develop additional content to accommodate those responses. Therapists may also use content over many sessions and update content based on unexpected responses during those sessions. We recommend robot-assisted technology for authoring content to provide hypothetical client responses to therapists that may minimize the time it takes to prepare content.

7.2 Limitations & Future Work

In this section, we share two key limitations of our study, and provide suggestions for future work. First, although our sample of participants is sufficient to infer many important patterns about robot-assisted therapy for neurodivergent children, the raw number of participants is quite small. Second, the way we recruited participants could be responsible for some similarity of perspectives within our sample.

Our sample was small because the population we were investigating was itself quite small and comprised of individuals with a very specific and narrow area of expertise. To recruit individuals with the specific set of expertise and experience needed, we needed to leverage our collaborator's professional network. In turn, this means that there were likely some network effects within our sample, due to similar experiences shared across our participants. Nevertheless, even within

our sample, participants show a diverse range of therapeutic expertise, backgrounds, and experience, as shown in Table 1. As robot-assisted therapy gains further adoption, we expect it to be easier to recruit participants for similar studies. As systems improve following our recommendations presented in this paper, we also expect therapists' needs to change to match the limitations of the systems present at the time.

In the future, it may thus become both more necessary and more feasible for researchers to recruit larger samples, and to engage in longitudinal work to investigate therapists' needs as they change over time. Future work should also evaluate implementations of our recommendations based on therapist feedback, as motivated by our overarching recommendation: listen to therapists.

7.3 Vision

In this section, we share a vision of robot-assisted therapy that encompasses the principles behind our recommendations. We use this vision as an example of how to apply our recommendations to robot-assisted therapy in particular, and as an exemplar for teleoperated socially assistive robot systems in general. We describe the experience of a fictional therapist, Dana, who uses a fictional "Ideal Robot-Assisted Therapy" (IRAT) solution in their practice.

Dana is taking on a new client in their practice, Chloe. In Dana's first meeting with Chloe, they document the client's needs and goals in the IRAT system. Dana can also see information provided by the children's parents and teachers in the IRAT system ahead of time with an easy way to follow up with them to ask questions. After the first evaluation, Danafinds intervention suggestions in the IRAT system that other trusted therapists had labeled for clients with similar goals to Chloe. Dana pins some of those for easy access in the future. Dana also notices that some of Chloe's goals are similar to another client they are already working with, Moe.

A week later, Dana is preparing for their first session with Chloe just 10 minutes before the session, they open the IRAT system to check their notes from the initial evaluation, and any additional comments from teachers and parents. They find no comments from teachers or parents. Dana starts preparing for a session based on the main goal that they prioritized for Chloe; Dana selects three of the pinned activities as a reference to use for the session. Dana then sets up the robot and IRAT teleoperation interface in just under a minute. When Chloe comes to the session with their teacher, the teacher mentions that Chloe had a difficult time today with a friend. Dana quickly notes that information from the teacher in the IRAT system and finds content to support relationship building and communication. Dana begins the session focusing on what Chloe needed in the moment. After the first twenty minutes of the session, Dana is able to switch to Chloe's originally prioritized goals and make some progress towards them by using the originally pinned activities. As Chloe's engagement increases, they begin asking many questions and the conversation veers off into a topic that Dana does not have content for. Dana uses the IRAT teleoperation interface to easily respond with on-the-fly answers to Chloe's questions. At the end of the session, the IRAT system displays a summary of the session for Dana to review. Dana adds some notes in the evaluation section to note how Chloe is doing. Dana packs up the robot and teleoperation device, which are still at over 90% battery, and goes to the next session.

Dana arrives late to their next session with Moe. They quickly glance over the IRAT system summary from last session, and select an activity they did that session. Dana gets the robot set up in just under a minute and Moe is very excited to interact with it. Dana easily selects some relationship-building content to engage with Moe as they look through content they want to use to best match Moe's goals. Dana starts the activity that they did last time with Moe but Moe seems uninterested. Dana needs to choose another topic instead and finds that the activity they just did with Chloe would be a good fit. They select the activity and the IRAT system automatically customizes the activity based on Moe's profile of interests that Dana has updated over many previous sessions. Moe is engaged with the robot

as Dana selects content easily and is able to calmly relax after being late to the session. They start reading through Moe's documentation and find that Moe's parents had mentioned some tasks that they want Moe to work on. While the parent's suggestion is useful, Dana relies on their expertise to pick an activity that matches the underlying goal to address. Dana finds an activity from the vast collection of content in the IRAT system and pins it to work on next.

As Moe engages with the robot, Dana determines that Moe has progressed in reaching their main goal. Dana notes that in the IRAT system. They then switch to the new activity and work on that. The session continues smoothly and Dana reviews the summary at the end, adds additional notes, and updates their evaluation further. As Dana packs up and is ready to leave, Moe's parent cheerily comes to pick up Moe and is appreciative of Dana's work; Moe's parent had seen the updated evaluation in the IRAT system from earlier in the session and are very happy with the therapy their child is receiving. Moe's family has been very happy with the progress Moe has made and have purchased an affordable robot to use at home. Dana suggests some activities for them to use at home to follow up on therapy. These activities were originally designed by Dana's colleague who ensured that they would be easy for parents to follow and Dana has made some changes to accommodate Moe's particular goals.

After leaving, Dana recalls that their manager had asked them to develop some content to support other colleagues. Through their experience, Dana has become an expert at supporting children in dealing with conflict. At home, Dana selects some session activities from the IRAT authoring system and begins to update and customize activities based on their experience. The IRAT system offers suggestions for what children may say in response and creates an engaging authoring experience that makes authoring enjoyable and more effective. The IRAT system's suggestions remind Dana of previous sessions and they're able to look them up for reference. After completing authoring the activity, Dana shares them with their colleagues and manager who are very grateful for the effort they put in.

8 CONCLUSION

As robots are adopted in therapy for neurodivergent children, it is crucial to understand how these technological tools are being used by therapists and educators, and the ways that these tools are changing and mediating the practice of therapy and education. We interviewed nine participants who had all used robots to differing extents in the context of therapy for neurodivergent children. In each interview, we discussed with participants how they prepare and conduct therapy with neurodivergent children in their usual practice, how they do so when using a robot, and we asked them to walk us through an example robot teleoperation interface. We conducted a grounded theory analysis of our interview transcripts to determine key themes around therapists' experience in therapy. We guided our analysis with the intention to summarize and explain a therapist's experience to non-therapists who are developing tools that support therapists in delivering therapy.

Our analysis results in several key contributions: (1) a new understanding of the cyclical processes within therapy that may generalize to all longitudinal social assistance, (2) a taxonomy of six themes that help elucidate the unique needs and difficulties of therapists using robots with neurodivergent children, (3) guidelines and detailed recommendations for technologists to address therapists' needs in particular and social assistance experts' needs in general when operating robots in their practice, and (4) a vision of the ideal robot-assisted therapy tool informed by therapists' needs and our recommendations. Our results demonstrate that therapy can be best understood as a process consisting of two cycles: the outer and inner cycle shown in Figure 3. The outer cycle occurs between sessions on a time scale of days or weeks, during which therapists and stakeholders collaboratively examine and evaluate children to prepare and conduct therapy sessions. The inner cycle occurs within each individual session and exists on a time scale of minutes or hours, during which therapists re-examine and re-evaluate their clients in the moment in order to adapt, and/or deliver therapeutic

content. Understanding how tools relate to each of these cycles is crucial to delivering the most effective support for therapists.

Our analysis produced six themes of needs and difficulties that arise during therapy; preparation, awareness, variety, adaptability, documentation, and evaluation. We described each of these themes, how they relate, and recommendations to address these needs in robot-assisted therapy technologies. We present a concise collection of our recommendations as a reference in Table 2. Finally, we outlined a vision of an ideal robot-assisted therapy system describing how a therapist would use these systems to engage with new clients, existing clients, and colleagues.

Our study, analysis, and approach reflect and encourage an overarching belief that developers should approach the design of therapeutic tools by examining how therapists use current tools, and using such examination to determine what therapists most need to deliver effective therapy for their clients. This approach may avoid the stumbling blocks that currently arise from the over-emphasis on the automation of therapeutic activities.

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A INTERVIEW PROCEDURE

As we described in Section 3.3, our interviews were broken up into two portions. The first portion discussed participants' experience with therapy in general, when applicable. The second portion discussed participants' experience working with robot-assisted therapy technologies. In this section we describe the procedure we followed for each portion of the interview.

A.1 Questions about therapy in general

In the first half of the interview, the interviewer began by stating that they would ask questions about therapy sessions in general, and that this portion of the interview was explicitly intended to discuss sessions where participants are **not** using a robot. The interviewer then suggested that participants think of two children with whom they had recently conducted therapy. Our guiding questions were as follows:

- Could you describe how you conduct a therapy session?
  - How does this differ for different disabilities that children may have?
  - What do you have to maintain awareness of during a therapy session?
  - What is most important to you when conducting a therapy session?
  - What do you find is the most difficult in conducting therapy with children?
  - What do you sense is most important to the child receiving therapy during the session?
- Could you describe what you do to prepare for a therapy session?
  - How does your preparation differ for different disabilities that children may have?
  - How much customization do you typically do for a particular child receiving therapy?
  - How do you establish goals for a child? What kind of goals are there?
  - How do you go about preparing materials for the therapy session?

A.2 Questions about robot-assisted therapy

In the second half of the interview, the interviewer asked participants about their experience preparing and conducting for sessions with a robot. Similar to the first half, the interviewer asked participants to think of the most recent time they had used robots in a session. Our guiding questions were as follows:

- Could you describe what you do to prepare for a therapy session using a socially assistive robot?
  - How does it differ from preparing for sessions without using a robot?
  - How much customization for each child are you able to do when using a robot?
  - How does using a robot change the child's experience and response during therapy?
  - Are children's responses to the robot consistent across different disabilities and conditions?
  - How much do you talk compared to the robot? Do you ever have a conversation with the robot?

Following those questions, the interviewer shared their screen and showed participants the example teleoperation interface shown in Figure 10 of the Peerbots application [49]. We used this example interface to center the conversation around teleoperation to understand how participants would use an interface, what they expect from interfaces, and their likes and dislikes with interfaces. We asked participants some questions about that interface following the listed questions below as a guide:

Fig. 10. An example of the Peerbots teleoperation interface that was shown to participants.

- Do you recognize the interface shown in this image? Have you used it before?
- Can you talk me through how you've used it in the past [or how you would use it]?
- Is there anything in the interface that you've never used before?
- What do you like about the interface?
- What do you dislike about the interface?
- What do you wish was easier to do using the interface?
- Is there anything within the interface that you find useless?
- How would you rate the interface on a scale of 1 to 10 where 1 is very difficult to use and 10 is very easy to use?
- Do you see any opportunities for using robots in therapy in the future?
- Is there anything else you would like to tell us about using robots in therapy with children?