From Behavioral and Communication Intervention to Interaction Design: User Perspectives from Clinicians

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ABSTRACT

To improve functional communication and behavioral management, many children with disabilities receive behavioral and communication-related intervention from professionals such as behavioral analysts and speech and language therapists. This paper presents user perspectives from three clinicians who have used and/or designed assistive technology with children with disabilities, and calls for researchers to recognize and leverage clinicians' knowledge to design accessible technology for children with complex sensory and communication needs.

INTRODUCTION

It is estimated that 15% of the global population (approximately 1 billion people) have disabilities, and children constitute approximately 93-150 million of these individuals [1]. In an attempt to positively impact the lives of these children, both researchers and clinical professionals contribute to designing, developing, evaluating, and implementing various forms of information and communication technologies (ICTs) for children with disabilities. In recent years, there have been a few but notably growing number of clinicians who have become designers and researchers of these technologies, in the hope of improving behavior management and communication skills for children with disabilities through technology.

In this paper, we provide a collaborative experience report that unites three clinical professionals, including one board certified behavior analyst from the United States and two licensed speech language therapists (SLTs) from the United Kingdom and the United States. We have worked closely with neurodiverse children with a collective 46 years of clinical practice across multiple settings (e.g., home, school, clinic, and community). This paper is motivated by a desire to address the unfulfilled "promise of technology" [16] and

its high abandonment rate, despite the increased advancement of these technology-mediated clinical tools. Specifically, we share expectations about technology based on our clinical experience working with neurodiverse children using both low-tech and high-tech tools, describe our motivation to pursue doctoral degrees to design these tools, reflect on the tacit knowledge we hold about user experience, and discuss the challenges we encounter as we add HCI research skills to our existing clinical practice. With a critical analysis from our collective clinical perspectives, we reveal the complexity of providing therapy to children with disabilities in areas such as sensory accommodation, behavioral management, and functional communication with different stakeholders, and highlight the importance of looking beyond the mere definition of assistive technology and re-examining conventional design practices with user experience from behavior and communication specialists.

INSIGHTS FROM A U.S.-BASED BEHAVIORAL ANALYST: ALTERNATIVE MODALITIES TO REDUCE SENSORY OVERLOAD FOR NEURO-DIVERSE USERS

I was a behavior analyst for 23 years supporting individuals with autism and other neurodiverse populations (e.g., ADHD, dyslexia). During the last decade, I focused mainly on supporting social skills. Before implementing my social skills curriculum [8] with students or clients, I would build rapport at the start of each session, taking into account their moods, then calibrating the goals for the session. When I became an incoming Ph.D student in Informatics and began my doctoral work, I focused on designs for social skills intervention with the assumption that technology could augment this human mediation to support behavior change. What I did not fully recognize until my dissertation work, was how much mediation I provided as a therapist.

For example, in my prior design projects as an HCI researcher that include sayWAT[7], ProCom [5], and vrSocial [4], I designed with the assumption that I could support behavior change by automating the cueing, prompt, and feedback hierarchies I employed as a therapist. My trained skills as a therapist to accommodate my clients had become invisible and automatic to me. I did not plan for the setting or the rapport-building behaviors I would engage in as a therapist. When I ran an intervention study to measure efficacy of my prototype, it was clear that I had only

programmed for the bare minimum with many interaction pieces missing. As I watched the studies unfold, this degree of mediation was lacking in the systems I designed. I had not acknowledged as much as I did as a therapist in terms of mediating the simple, everyday interactions with my clients (e.g., adjusting my tone of voice and body position to make the child comfortable, or waiting until the child was first looking at me before I began talking).

These issues became even more apparent once I compared results across platforms. I found the more heavily the sensory aspects of the physical environment were mediated (in VR compared to AR), the more comfortable and communicative the participant became. I now realize that technological mediation must support a precursor to behavior change—comfortable and clear communication with the end-user. This requires modifying input from the technological system to accommodate the end user's preferred sensory modality (e.g., visual over auditory).

In reflecting upon my body of work in HCI, the tacit skills of therapists were not captured in my computational systems and may never be programmable, leading me to wonder what the role of assistive technology could be. As HCI researchers, we need to beware of how much of a human-to-human interaction we can support through basic prototypes. How much we can expect machines to augment therapists' work? I have both heard from parents and observed directly in the participants about different degrees of mediation by platform, specifically the mediation of sensory input. The VR systems I built appeared to provide a safety zone for children with autism that resulted in more interaction with a conversation partner than in the AR systems. Information overload appeared to be reduced in the virtual environment. I hypothesize the transformation of sensory information into a virtual form reduced the work for the user, making a social interaction more comfortable. If we could design technology to make users comfortable, we may also be making information more accessible and easily comprehensible for children with disabilities, and have more success in achieving positive clinical outcomes.

With this realization, I am eager to tell the HCI community that technology should do what it is good at—the things humans cannot do, such as automating and transforming information into an accessible form (e.g., real time visualizations of social feedback). This is a task that a therapist cannot do, and is also a different task from the therapists' task of building a therapeutic relationship. Given the complexity in designing such a change from human mediator to technological mediator, the expectation that the technical system can mediate the way a therapist works is currently unrealistic. My projects described above were designed to teach nonverbal communication, but the constraint of a virtual environment provided a prerequisite to learning—a comfort and collateral effect that served as a work-around for sensory sensitivity. I would like to address the fundamental challenge of sensory processing in autism by designing assistive technology that also adapt to the children's learning needs and response to outcomes using ability-based design [18], which prioritizes the need to ensure access to information.

Although the goal of accessible technology (e.g., providing access rather than coaching functional behavior) has been discussed by researchers for at least a decade, many researchers continue to follow the therapist-as-expert and end-user model. While this approach may have its own utility in a therapeutic setting, in the user's everyday life, when a therapist is not available or accessible to mediate, assistive technologies need to target the perceptual strengths of users to ensure that missing clinical information is accessible and is determined by users' strengths. This is not to say that educational technologies and therapeutic technologies should not be cueing and prompting users to learn information, but rather assistance or accessible technology must first succeed at providing the information of interest to users. This shift recognizes the need for assistive technologies to be collaborative, especially in the case where a technology cannot successfully transmit information or provide a comfortable and comprehendible user experience for children with neurodiverse profiles.

INSIGHTS FROM A U.K.-BASED SLT: SIDE STEPPING INTO INTERACTION DESIGN

As a clinician, I regularly draw on a body of tacit knowledge concerning conversational rules and norms in aided conversations that involve children with complex communication profiles and assistive technology. This knowledge is valuable as it enables us to be flexible in adapting how I use tools and methods to involve children in discussions as part of the design process. As part of my clinical background, I have worked with neurodiverse children aged 0 to 19 years, providing speech, language, and communication interventions to children with little or no functional speech, who are often introduced to AAC systems. Whilst it is widely agreed that children who are 'prescribed' assistive technologies are *core* end users, it is crucial to highlight that, particularly for children, therapists, teachers and parents are also key end-user stakeholders owing to the responsibilities they share in supporting children to become proficient communicators. Working alongside teachers and families, therapists frequently immerse ourselves in using these technologies through self-learning, training and practice, in order to draw on these technologies effectively within clinical interventions.

As a therapist, I often experience some of the more nuanced examples of AAC under-use or abandonment. One example of this is the limited uptake of social media through AAC which has also been documented in research [11,13]. Whilst many existing AAC devices have access to social media functions, they are seldom used in therapy and education settings that prioritize traditional language-based work. Connected to this, the introduction of new AAC

technologies can often conflict with broader therapeutic and educational priorities across multi-stakeholders. Whilst the value of working closely with interdisciplinary teams is recommended, logistically, this can be tricky in practice as children's therapy and learning goals can be disjointed or even contradictory. As a clinician, the focus of my interventions is often on supporting children to 'learn new skills' for communicating in 'different ways' in the absence of verbal speech, or supporting them to understand and use language in 'typical ways' if they are 'delayed'. In contrast, my doctoral design-oriented studies move away from interventions that focus on the level of a person's impairment. Whilst this exposes the fundamental medical model that often underpins clinical work, for technology design, this prompts practitioners to be explicit about perspectives that guide their work. This leads us to question: *how might we become more transparent with expressing the theoretical drivers that underpin technology design?*

Communication is complex, multifaceted and constantly being reconstructed. Communication for children with physical impairments and/or neurodiverse profiles can be even more complex, so practitioners should be careful about making value judgements and assumptions about the meanings that children are expressing before they are expressed completely. Therapists who interact with AAC users across settings and over time, can be more familiar with the different ways in which children express their motivations compared with 'outsiders'. Even so, these interpretations needed to be treated with caution. I recall a girl refusing to participate in a group activity for retelling her class group what she did over the weekend. Whilst it would have been logical for someone to associate this with her being reluctant to speak out in class, my clinical training allowed me to further investigate what other realities may be surrounding this behavior. Design practitioners should hold back from making assumptions and instead, collaborate with clinical practitioners to accurately interpret some of the subtle and individualized ways children will communicate for different purposes through their behaviors.

In acknowledging a need for engaging deeply with children's situated communication experiences, we identify that clinicians working in schools, homes and other community settings have access to a wealth of information about the social structures surrounding people, the activities they engage in, and existing tools they use. Rather than drawing on this information by including clinicians as proxies in the design process, we argue that clinicians play an important intermediary role in supporting designers to collaborate with children in ways that remain relevant to children [14]. As an actionable direction, we recommend that it is important to combine creative designerly skills with these rich situated experiences so that children, clinicians, and practitioners can dialogically engaging in developing new possibilities for supporting children's situated, everyday communication experiences. With this in mind, we underscore the importance of joint working and skill sharing.

INSIGHTS FROM A U.S.-BASED SLT: FROM CLINICAL PRACTICE IN THE WILD TO INTERACTION DESIGN

From building rapport to intervention, clinical practice with children with communication impairments is a trial-and-error experience even for many clinicians. Nine years ago, I worked as a life coach in the adult day program, providing behavioral intervention to individuals who have limited or no verbal speech due to developmental and intellectual disabilities. Many of these individuals were unable to follow complex directions and perform activities of daily living (e.g., dressing and toileting), so my primary way of understanding their basic life needs relied on learning their behavioral cues (e.g., whether their crying indicated a personal care routine, or whether their unusual laugh indicated that they are attempting to escape the facility). Years later, I worked as an SLT who programs and teaches AAC systems to children and adults as well as their communication partners (e.g., parents, teachers, other therapists). I witnessed how in one way, AAC technology significantly reduces frustration and aversive behaviors and facilitates functional communication across multiple settings for my clients, in another way, children's communication through AAC with different stakeholders is also being shaped by context-dependent sociocultural practices within and across stakeholders.

For example, clinicians are advised to collaborate with parents through providing parent education and training on how AAC should be implemented and used outside schools or clinics where children receive intervention. However, in reality, when introducing AAC to children with communication impairments, SLTs also face additional tension with key stakeholders, for instance, teachers who are not willing to spare extra time to implement AAC devices, and parents who are concerned that introducing speech generating devices for their children will result in their children never speaking with their own voice. This active use of technology in therapeutic contexts and resistance or abandonment of technology use at home or school brings direct impact on the child's learning progress for AAC. In recent years, researchers in communication science and disorders have coined the term "distributed communication" [15] and argue that "communicative resources and communicative practices…must be examined as (different) facets of sociocultural activity" [12]. This demands clinical practitioners to deliver collaborative services by offering optimal communicative opportunities to support maximal AAC use by children and their communication partners across multiple contexts to ensure success. How can design practitioners support diverse stakeholders who all share the same AAC system with children with communication impairments? We need not only novel designs that accommodate these contexts but also a re-examination of current design guidelines with additional evidence from existing clinical research. This

inspired me to begin my journey towards pursuing doctoral research in HCI.

Two years into my doctoral program, I have realized that researchers across different disciplines have constructed their own vocabulary for children with communication impairments and conducted scientific research using methodologies based on their own ontological understanding and epistemological assumptions. It is important to acknowledge the extensive prior work in AAC by the clinical and technical research communities, but AAC is only one specific genre of assistive technology [17] and was designed to be "assistive" for children with severe communication impairments rather than "instructional" for children and other stakeholders. Learning to use existing AAC systems still rely on clinicians and this reduces the independence that assistive technology should offer. If HCI researchers only design with inputs from prior studies or use a convenient sample group of clinicians as end users, they may neglect the collective knowledge and instructional practices from clinicians who work in other educational or medical contexts.

Driven to capture the contextualized clinical practice from SLTs to inform technology design, I conducted qualitative interviews with SLTs on their user experience with mobile technology in multiple settings, such as home, school, and clinics [9]. My research reveals that clinicians have adopted a variety of native and commercialized mobile apps, and have reconfigured mobile devices (e.g., the iPad) as a versatile tool that offer increased efficiency and efficacy in clinical workflow for themselves and improved motivation for therapy for their clients. Additionally, due to existing gaps in unmet needs from current mobile technologies, many SLTs have created their own therapy apps by collaborating with designers and developers, but they have struggled with a variety of clinical and technical challenges, and encountered sociocultural and ethical issues which demand ongoing interdisciplinary research. How do these clinicians create a new sense of agency with "fun" and "educational" elements for mobile technology, beyond just "assistive"? My ongoing work will continue to unpack this tacit knowledge through analyzing the collaborative technology use between children and their clinicians, designing prototypes using both touch-based and voice-based interaction, and developing frameworks for collaboration with various stakeholders.

DISCUSSION
Using technology to support children with disabilities continues to be a growing research interest among researchers from multiple disciplines, yet many researchers encounter barriers when studying the design and use of digital technology for disabled children, such as bridging interdisciplinary knowledge gaps and integrating contextualized stakeholder needs into design. As different disciplines position children with disabilities at the center of design differently (e.g., "users", "patients", or "learners"),

these divisive labels can be less helpful over perceiving children more holistically, who may instead draw on all of these roles in different contexts. Clinicians who work with these children in diverse contexts also have different roles (e.g., users, educators, informants, and researchers) which shape their level of engagements with technologies. Since these roles are fluid [6], leveraging clinicians' roles as both users and collaborators for design and being explicit about what work the technology will attempt to do is paramount.

One other major barrier is understanding how assistive technologies can successfully be interwoven into the fabric of children's wider daily consumptions of digital media. There is still a need for closer interdisciplinary work to maximize how technology can serve not only children but also their communication partners as a collective group of key stakeholders with distinct needs. For HCI researchers who conduct research with disabled children, understanding how clinically-related knowledge can inform the design process remains to be a challenge. As clinicians, we position ourselves as end users who work alongside others with the goal of serving children and their families. We work on personalizing children's assistive devices, deliver training to teachers and other members of the local team, and most crucially, interpret and advocate for children about their experiences with technology. Therefore, including clinicians in design and evaluation of assistive technology might provide insight into tacit aspects of interaction. Additionally, HCI researchers should also pay attention to other clinical and educational researchers who take a multidimensional approach to investigate technology design and use in various situated learning environments [2,10] for children with disabilities, as this body of research evidence can also inform the design of instructional aspects of AAC systems.

CONCLUSION
In past decades, AAC has been the focus of assistive technology research for children with communication impairments. It is time for HCI researchers to move beyond AAC and examine the holistic utility of digital technology situated in other contexts. Whilst the broader HCI community has acknowledged the importance of designing for people's everyday experiences with technology [3] with a user-centered approach, this can at times neglect the value of clinical and pedagogical considerations in design that special education teachers, therapists, and parents offer. This paper calls for ongoing research to investigate the role of learning, educational, and recreational technology use with collaboration from clinicians. It is our hope that future HCI researchers will continue to address the questions we pose to work together with clinicians to redefine what assistive technology can offer children with disabilities.

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