Understanding the Technological Practices and Needs of Music Therapists

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Music therapists provide critical, evidence-based care to a diverse range of clients. However, despite their active role in empowering individuals affected by disability, stigma, grief, and trauma, music therapists remain understudied by the HCI community. We present the results of a mixed methods study of 10 interviewees and 20 survey respondents in the U.S., all of whom are practicing music therapists. Our results show that music therapists engage in technology-aided practices such as making personalized connections with clients, assisting in identity formation, encouraging musicking (music-making), and preserving legacies. Results also show that music therapists face key challenges such as environmental, societal, and financial constraints, including high workload, lack of awareness of the value of music therapy among the general community, and limited access to secure technologies for remote client care. In light of these challenges, we present a set of design implications for creating future technologies for music therapists. This work diverges from previous studies on music therapy technologies, which focus largely on interventions with music therapy clients, by highlighting the often-neglected perspectives from music therapists.

CCS Concepts: • **Applied computing** → **Sound and music computing**; • **Human-centered computing** → **User studies**; **Computer supported cooperative work**; *Accessibility technologies*; *Accessibility systems and tools*; *Accessibility design and evaluation methods*; • **Social and professional topics** → *People with disabilities*; *Gender*; *Sexual orientation*; *Cultural characteristics.*

Additional Key Words and Phrases: Music therapy; Music therapist; Music technology; Assistive technology; Personalized technology

ACM Reference Format:
Anna N. Baglione, Michael Paul Clemens, Juan F. Maestre, Aehong Min, Luke Dahl, and Patrick C. Shih. 2021. Understanding the Technological Practices and Needs of Music Therapists. *Proc. ACM Hum.-Comput. Interact.* 5, CSCW1, Article 33 (April 2021), 25 pages. https://doi.org/10.1145/3449107

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2573-0142/2021/4-ART33 $15.00
https://doi.org/10.1145/3449107

1 INTRODUCTION

Music profoundly affects both body and mind. Neuroimaging studies have found that music perception engages multiple areas of the brain, including those related to attention, memory, sensorimotor systems, reasoning, and creativity [8, 14, 33, 50, 77, 79–81]. Recent work has also demonstrated the ability of music training to shape and enhance cognitive and motor functions, even in fully developed brains [12, 38, 97]. Further, many case studies have demonstrated music's capability for cognitive rehabilitation of patients suffering from neurodegenerative diseases such as Parkinson's and dementia [73, 97]. Given the wide-ranging effects of music on the human body and brain, many individuals have turned to music therapy over the years to find hope and healing [3].

Music therapy in the United States is "the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship" [1]. According to the American Music Therapy Association, nearly 1 million people in the US received music therapy services in 2010 alone [3]. Unlike other therapy professions, which tend to focus on one dimension of health at a time, music therapy takes a holistic approach to address needs across multiple health domains; these domains may include motor, communication, cognitive, or emotional needs. Therapists and clients form strong relationships and address domain-specific goals through *musicking*, the act of taking part in a musical performance [84]. Clinical studies have provided evidence for music therapy's efficacy in multiple populations, showing it may help mitigate mental and behavioral symptoms of schizophrenia [89], dementia [94], and autism [45]. The field is also well-known for its service to marginalized populations, including individuals with disabilities, older adults with cognitive impairments, and individuals with mental health issues.

HCI has historically supported therapists across the clinical spectrum, including physical therapists [40], occupational therapists [39, 83], and art therapists [20]. However, HCI research with music therapists remains limited, especially within the CSCW community. Further, existing HCI works in music therapy nearly always focus on the needs of the client, rather than the needs of the therapist [15, 18, 19, 35]. As a result, HCI practitioners have a poor grasp of how and why music therapists use technology in their practice, and music therapists thus remain largely understudied by the HCI community. In this work, we present an interview and survey study with practicing music therapists in the United States. The contribution of this research is twofold: We (1) contribute to the understanding of music therapists' technological practices, challenges, and needs, and (2) provide recommendations for designers seeking to create more useful technological tools for both music therapists and their clients.

2 BACKGROUND

In order to understand the technological needs of music therapists, it is important for designers to familiarize themselves with music therapy as a field. Here, we provide an overview of the phases of music therapy as well as the types of music therapy commonly used today. We include this content with the goal of encouraging designers to identify critical points in the music therapy process in which technologies for therapists can be better utilized, and to identify potential differences in technological need according to the type of therapy being used.

2.1 The Phases of Music Therapy

Different schools of thought have conceptualized the division of the music therapy treatment process into distinct phases. Here, we briefly highlight phases defined by Davis, Gfeller, and Thaut: *Referral*, *Assessment*, *Treatment planning*, *Documentation of progress*, and *Evaluation and termination of treatment* [25]. In this work, we focus mainly on Assessment, Treatment Planning,

[1] https://www.musictherapy.org

Documentation, and Evaluation; the Referral and Termination stages rely on tools that are generally used by therapists (broadly) and healthcare providers, and aren't specific to music-therapy.

Referral comprises how the client is introduced to music therapy. Referrals typically come from another professional such as a teacher or psychologist, who suggests music therapy to a client for a specific clinical issue (i.e., having difficulty with fine motor control, trouble swallowing, etc.). Clients can also self-refer.

Assessment is undertaken by music therapists after the referral stage is complete. This stage is meant to address the client's needs by understanding their strengths and weaknesses and determining what, if any, music therapeutic technique will be beneficial for the client. Assessment guidelines have been created to provide therapists a way of systematically observing and gauging the client's responses to various musical stimuli [5]. Less formal approaches may also be conducted, such as an interview with the client, speaking with family members or friends, or reviewing medical and educational records.

Treatment planning follows assessment. In this phase, the goals and objectives of the various therapeutic interventions are outlined. This phase is often conducted with an interdisciplinary team of professionals who design a comprehensive treatment plan for the client. Treatment can involve a number of intervention methods, but the main focus of this stage is to clearly define the goals for the client and how the client can achieve those goals in a reasonable time frame. Treatment planning naturally leads to interventions (which, we note, is not conceptualized as a separate phase). Treatments comprise three primary rehabilitation domains: motor, communication and language, and cognitive.

Documentation during treatment planning and interventions is important, as it provides a clear summary of results for not only clients but also for insurance companies, which rely on these qualitative data to support music therapists in their efforts to better address clients' needs. These data are then used to perform *evaluations*, which determine the client's progress or how effective the therapeutic intervention was for the client after a period of time. Both Documentation and Evaluation are ongoing throughout the client's rehabilitation efforts and are necessary to better adapt the therapeutic methods towards the client's needs.

Termination is the final step in music therapy and may occur because the client has met the specified goals, has found another therapeutic technique that is more effective for them, or has shown no substantial progress in their rehabilitation.

2.2 Types of Music Therapy

Music therapy's roots date back to at least the early 1900s. One of the earlier approaches is the *Orff-Schulwerk* method, developed by Gertrud Orff at the Kinderzentrum München in Munich, Germany [71]. This approach focuses on using human psychology and music as a means of improving patient-client communication in the therapy session. Another early approach is *Dalcroze Eurhythmics*, the philosophy and approach of music education and comprehension credited to Émile-Henri Jaques-Dalcroze. This method consists of three components: solfege (ear training), improvisation, and eurhythmics [29] and has been used in therapy for developing a sense of physical awareness. Individuals with motor disabilities benefit most from this type of intervention. An emphasis on physical function was also encouraged in the *Kodaly* approach, created by Zoltan Kodaly. This approach to both music education and therapy incorporates all facets of music (rhythm, notation, movement, etc) to help facilitate rehabilitation, and is regarded as the theoretical foundation of Community Music Therapy [76, 93].

Paul Nordoff and Clive Robbins helped usher in an era of research-grounded methods with their *Nordoff-Robbins* technique. This method, developed through 17 years of research in both individual and group therapy with children with conditions such as autism spectrum disorder and mental

disorders, emphasizes that inborn musicality resides in every human being and can be used to enact personal growth and development [46]. Later, Dr. Helen Bonny developed *The Bonny Method of Guided Imagery and Music (GIM)* [31] after observing that curated playlists of classical music evoked extreme emotions and symbolic images in clients. GIM today uses mental imagery as the main therapeutic driver, allowing the client to use these images to aid in coping with physiological and psychological issues. Most recently, Michael Thaut introduced *Neurologic Music Therapy (NMT)* as a research-based system of standardized clinical techniques based on individualized diagnostics and functional goals. NMT uses music as a medium for training and rehabilitation in the sensorimotor, cognitive, language, and speech domains [91].

3 RELATED WORKS

3.1 Music Therapy in HCI Research

Research in HCI on music and musical tools has spanned a number of domains, including accessibility, education, and collaboration. These recent works have utilized ubiquitous mobile sensors to provide audio, visual, and tactile feedback, and to augment traditional musical instruments for a variety of users. Project Torino, introduced in 2019, is one such work targeted toward accessibility [96]. This tactile programming language for children uses interlocking pods with their own circuit boards and microcontrollers to enable the creation of music and audio, regardless of the user's visual ability. Klamka et al. also contributed to the development of tactile tools by creating the ScaleDial tangible user interface for enhancing the teaching of musical scales [48]. In a similar vein, Tao et al. created the DrumGenius system, which relies on a mobile accelerometer, Arduino, and a wireless transmitter to encourage musical learning through physical activity [90]. Further, Arterbury et al. created the MoveMIDI instrument for gesture-based control of musical data [2]. Tools that use vibration-based feedback have proven beneficial in teaching contexts, in particular, especially for those affected by disability. Petry et al. showed that the MuSS-Bits++ system, which provides both visual and vibrotactile feedback, increased confidence levels in deaf children taking music classes [72]. Further, Li et al. created the Tactile Teacher fingerless gloves which synchronize movement vibrations between the hand of a piano teacher and that of a student [57].

Despite the plethora of musical tools featured in the HCI literature, HCI research focused specifically on music therapy is sparse and has mainly comprised intervention studies with specialized populations. Corrêa et al. demonstrated the use of an augmented reality system for music therapy for children with cerebral palsy [21]. The authors evaluated this system, which prioritizes activities such as music creation and recording, in a case study with a music therapist-client pair. Results indicated the system could be of use for targeting both musical and non-musical (e.g., cognitive and sensory) goals in future therapeutic interventions. Kosugi et al. took a systems-level approach to address latency in remote music therapy sessions, introducing a prototype for seamless communication between music therapists and older adults with dementia [51]. Their prototype, comprised of a secure network that relies on Yamaha's custom NETDUETTO program for remote music-playing, was tested with two music therapists across several music therapy activities (e.g., singing and music-guided exercise.). The system demonstrated low latency, and therapists found the system to be promising. Most recently, Lobo et al. addressed issues related to communication, engagement, and assessment in children with neurodevelopmental disorders [58]. Their network-connected CHIMELIGHT system attaches to existing musical instruments (handchimes) and provides visual feedback during musicking based on accelerometer, gyroscope, and magnetometer readings. CHIMELIGHT was shown to support

evidence-based practice by enabling therapists to monitor "target behaviors" in real time. Further, CHIMELIGHT was shown to increase client engagement.

3.2 Technology Use in Music Therapy

In this paper, we define "technology" as any hardware and or software that the therapist uses while working with a client. With the scope of the music therapy process being so broad, examples of technology-aided music therapy interventions range from automating business processes to assisting clients in the musicking process. This related works section showcases some of the uses for technology in the music therapy process and, in doing so, hopefully inspires designers to see the potential HCI has for designing tools for therapists' consumption.

Music therapists have been using computer-based technology since the 1980s to streamline data retrieval and better analyze behavioral interactions during therapeutic interventions [23, 37, 86]. In the late 80s and early 90s, the use of technology for music therapists shifted towards using notation software to transcribe music therapy improvisations and to then analyze musical elements of the interactions between the client and therapist. CAMTAS, a computer-aided music therapy analysis system, was created to help organize data collected from audio and video recording of music developed during a session [95]. These data were then used to track the physical activity of clients over a selected time interval, thus giving the therapist a quantitative measure to compare between sessions. Throughout the next decade, the number of data analysis tools for music therapy grew exponentially. These include: The Individual Music Therapy Assessment Profile (IMTAP), used to collect and manage data from music therapy assessments with infants and adolescents [5]; the Music Therapy Toolbox, used to analyze MIDI recordings in music therapy[27]; the MAWii music therapy system, used to analyze data collected from virtual instruments through Wiimotes [6, 7]; the Music-therapy Analyzing Partitura (MAP), used to describe music therapy events qualitatively [30], and the Music Therapy Logbook, used to collect and store data from music recordings of both acoustic and MIDI instruments for qualitative and quantitative data retrieval [86].

Technology has also been pivotal for improving the administration of therapy and the achievement of goals. Music therapy utilizes the *SMART* goals paradigm; a SMART goal is specific, measurable, achievable, realistic or relevant, and time-specific. In rehabilatory or therapeutic settings (such as music therapy), these goals are used to measure the efficacy of the therapist's chosen intervention for the client [11]. SMART goals in music therapy can range from: *Client A will improve cognition skills by demonstrating sustained attention from playing the piano for 2 consecutive minutes without stopping in 3 out of 4 trials with minimal prompting by January 2021* to *Client B will improve gait symmetry by walking on the beat to a song played at 120 BPM during a 45-minute music therapy session without stopping 5 out of 6 5-min trials by March 2021.* SMART goals can vary widely based on the type of music therapy employed; therefore, therapists require flexibility in administering therapeutic techniques that are best suited for the client's needs. Previous work has shown a high rate of technology use within music therapy practice [34], in part due to the flexibility technology provides during goal-formative stages. For example, using electronic music creation tools gives clients autonomy in a therapy session [66]).

Aside from facilitating SMART goal achievement, integrating technology into music therapy has empowered clients to explore their unique identity through new musical ideas and experiences. Kirk, et al. explored how new and emerging technologies within the therapeutic intervention can be used to provide a "blank sheet of paper" for the construction of musical experiences through the means of sonic interaction [47]. More precisely, these technologies decouple the performance gesture for a musical instrument from the instrument's sound-generating process, creating new opportunities for creativity that were not possible with conventional acoustic instruments [47]. Further, Nagler et al. have argued that digital technologies may provide greater autonomy in

constructing musical experiences than traditional acoustic instruments afford [68]. Technology has also lowered the barrier to entry for potential clients, especially those with disabilities [64]. The unique challenges these clients face have spurred the development of new digital instruments and tools designed with accessibility in mind. Soundbeam, created in 2002, is perhaps the most well-known tool within accessible musical instrument literature [88]. This instrument allows the user to control and shape sound effects through even the most minute of movements, providing users with limited mobility range a more intuitive way of modulating sounds. MIDIGrid affords users the ability to trigger musical events in real-time using a mouse, joystick, or another input device that is better suited for the user [41]. The Magic Flute is an electronic wind instrument designed for users with motor impairments. The instrument can be fully controlled by breath and small movements of the head, allowing the user to manipulate sounds with little assistance.[2] Skoog is an external MIDI controller that connects to any iOS device.[3] This device is centered around the user being able to express themselves freely without the need for any previous musical skills or abilities. Beamz is a device that consists of laser beams and non-tactile instrument triggers, allowing the user different types of interactions depending on their ability level.[4]

These examples are presented in order to convey the diversity that appears within accessible music technology literature. Although all of these technologies can, when used appropriately, directly address issues within domains such as motor, communication, cognitive, and socio-emotional functioning, their limitations must be identified when necessary to ensure successful access to musicking is being conducted [65].

Interestingly, few papers in the music therapy and HCI literature have explored use of technologies by music therapists, and creation of technologies for their unique needs. Moreover, few HCI studies have sought to understand the deeper reasons behind therapists' use of technology in therapy. One exception to this gap in the literature is the work of Baltaxe-Admony et al., who examined existing technologies in use within music therapy, established a set of design considerations when designing specifically for therapists, and developed prototypes based on these considerations [4]. Despite Baltaxe-Admony et al's progress, HCI as a field still suffers from a lack of understanding of what technologies music therapists use and why. This leaves designers ill-equipped to design for music therapists and the clients they serve. In the remainder of this paper, we present a study on the use of technology by music therapists and seek to close this notable gap in the literature. We describe our data collection process of gathering 10 interviews and 20 survey responses from practicing music therapists. We then report their technology usage and challenges that they faced. Finally, we discuss design implications that could better support the work of music therapists.

4 METHODS

This study was approved by the Institutional Review Boards at our universities.

4.1 Interview

We conducted semi-structured interviews with 10 music therapists, whom we recruited through convenience sampling via email and cold calls. The first author (A1) contacted local music therapists as well as those planning to attend a national music therapy conference. A1 then conducted interviews locally, at the (remote) conference venue, and via video conferencing. Interviews lasted between 30 minutes and 1 hour and were audio-recorded and transcribed verbatim for later analysis.

[2]https://touchthefuture.us/product/magic-flute/
[3]https://skoogmusic.com
[4]https://thebeamz.com/therapy-rehab/

Table 1. Interview Participants

Participant	Years Practicing	Clients	Individuals or Groups?	Session Duration / Frequency	Technologies Used
I-1	14	Older adults, individuals with developmental disabilities	Individuals and groups	Unspecified	GarageBand and Spotify
I-2	12	Teenagers with developmental disabilities	Individual	1 hour, 1-2x / week	iPad
I-3	9	Older adults, individuals with autism, individuals with developmental disabilities, children in CPS care	Individuals and groups	1x / week (Length unspecified)	iPad with GarageBand, Apple Music, and iLyrics
I-4	6+	Children and teenagers	Unspecified	Unspecified	YouTube
I-5	19	Adults with disabilities, psychiatric facility clients, hospice patients, grieving individuals, LGBTQ+ individuals	Individuals and groups	45 min - 1 hour, 1x/week	Digital piano keyboard
I-6	10	psychiatric facility clients, hospice patients and grieving families	Individuals and groups	Unspecified	YouTube, GarageBand, DropBox
I-7	Unspecified	psychiatric facility clients, correctional facility clients, individuals with chemical dependency, transgender children and teens	Groups	1.5 hours, 1x / week	GarageBand, Google Hangouts
I-8	5	Palliative care patients, psychiatric facility clients, individuals with chemical dependency	Individuals and groups	1x / week (Length unspecified)	Tuning app, Bluetooth speaker, Spotify, YouTube, Triller (app), Loopy (app)
I-9	8	Hematology and oncology patients, burn patients, individuals with cystic fibrosis, grieving children	Individuals and groups	1-2x / week (Length unspecified)	YouTube, GarageBand, iPad, recording apps
I-10	6	Individuals with developmental disabilities	Individuals	1-2x / week (Length unspecified)	YouTube, tablet computers

A1 asked interview participants about how a typical music therapy session flows, what technologies are used during the session, and what barriers therapists face in their practice. The interviewee population were white ($N = 10$), primarily female (8 females, 2 males), and clustered in the eastern United States. All participants were actively practicing music therapists, with years of practice varying between 2 and 17 years. Table 1 provides an overview of participant demographics; we adapted Baltaxe-Admony et al.'s reporting format, which provides detailed insight into participants' therapy practice (e.g., which clients they serve and how long sessions last) [4]. In the remainder of this paper, we denote interview participants with an "I-" preceeding the participant ID number.

We coded the transcripts using thematic analysis [85] and affinity diagrams [36, 43]. A1 conducted and transcribed all interviews and constructed the first round of diagrams. All authors then worked together to extract additional codes and refine all emerging themes, and performed iterations until they had reached agreement. The authors then repeated this process for the survey, extending relevant themes from interviews to the survey data.

Table 2. Modified MTPS with Technology-Centric Questions Included

	Question
1	To design individualised music therapy treatment
2	**To use playlist creation tools (such as Spotify or iTunes) in sessions and in preparation for sessions**
3	**To use music streaming platforms (such as Spotify or YouTube) in sessions and in preparation for sessions**
4	**To use physical technologies (such as MIDI keyboards) to create music with the client(s)**
5	**To use smart devices (such as tablet computers / iPads) to create music with the client(s)**
6	To conduct music therapy sessions
7	**To use video chat platforms (such as Skype, Google Hangouts, or Zoom) to conduct individual sessions**
8	To communicate with staff
9	To communicate with trainees, colleagues, supervisors
10	To perform administrative duties
11	**To use instant messaging applications (such as Slack) to communicate with staff, trainees, colleagues, and supervisors**
12	**To use task management applications (such as Trello, Asana, and Wunderlist) to keep track of responsibilities among staff, trainees, colleagues, and supervisors**
13	To adhere to the ethics of the music therapist
14	**To protect clients' privacy if they generate new digital content during sessions (e.g. Don't upload clients' creations to public YouTube or SoundCloud channels, or instead use private social media channels for sharing content)**

4.2 Survey

We designed a survey in which we modified Biasutti's Music Therapy Practice Scale (MTPS) [9]. The MTPS is a 15-item scale that assesses music therapists' knowledge of good practice, such as the ability to "diagnose client needs" and to "design the evaluation of a music therapy treatment". Respondents answer each item using the phrase "I know how" on a scale of 1 ("Strongly disagree") to 5 ("Strongly agree"). Unlike Biasutti, we were less interested in participants' level of general professional competency. Rather, we wanted to gauge (1) participants' willingness and ability to use music therapy-relevant technologies within their practice, and (2) how this willingness and ability differs between different types of technology. We therefore adapted the original scale to include technology-specific items (e.g., use of music streaming and playlist creation tools). Moreover, as level of competency is irrelevant to the focus of this work, we elected to use a 3-item categorical response scale rather than the original 5-point likert scale. Response options included the following: *I do NOT want to learn how*, *I want to learn how*, and *I know how*. We present the modified MTPS in Table 2, with new or modified questions highlighted in bold.

In addition to the modified MTPS, we included questions about specific categories of technology (e.g., streaming services, MIDI) that therapists use, and how often. We also included several free response questions regarding desired technologies, selection of music for clients, and organization of materials. Questions were informed by the second and fifth authors' expert knowledge of music technology and by the results of the interviews.

We recruited participants through snowball sampling and posting to social media sites such as Twitter and Facebook. We then administered our survey via Qualtrics, garnering 20 responses

in total. The majority of survey respondents were white (85%) and female (80%). Respondents were generally young: 85% were under 35 years of age. A small percentage were self-employed (10%), while most others worked for an employer (80%). As with the interviewee population, the gender and ethnicity splits for the survey population closely align with statistics from AMTA's 2018 Member Survey and Workforce Analysis report [3]; however, the survey attracted a larger percentage of young therapists than is representative of the field.

As the total number of survey responses was too low to conduct statistical tests, we instead generated summary statistics for the augmented MTPS and technology-specific questions. We also conducted iterative, inductive analysis on free response questions. Survey particpants are denoted throughout this paper with an "S-" preceeding the participant ID number.

5 RESULTS

Table 3. Technology Use Frequency

Technology	Never	Once A Month	Once A Week	Mult. Times / Week	Every Day
iPad / tablet computer	2 (10%)	1 (5%)	0 (0%)	3 (15%)	14 (70%)
Smartphone	4 (20%)	0 (0%)	0 (0%)	3 (15%)	13 (65%)
Music streaming services (e.g. Apple Music, Spotify, Pandora, SoundCloud, LastFM)	4 (20%)	1 (5%)	5 (25%)	6 (30%)	4 (20%)
Digital music instruments (e.g. keyboard)	4 (20%)	4 (20%)	4 (20%)	4 (20%)	4 (20%)
Video Streaming Services (e.g. YouTube)	5 (25%)	4 (20%)	6 (30%)	4 (20%)	1 (5%)
Digital Audio Workstation (e.g. GarageBand, Reaper)	3 (15%)	7 (35%)	5 (25%)	4 (20%)	1 (5%)
Music identification services (e.g. Shazam, SoundHound, Genius)	13 (65%)	5 (25%)	2 (10%)	0 (0%)	0 (0%)
Music management platform (e.g. iTunes, Google Play Music)	8 (40%)	5 (25%)	3 (15%)	3 (15%)	1

Results showed widespread use of a range of technologies among music therapists, with smart devices emerging as the most frequently used. Table 3 shows a breakdown of the frequency of use for different technologies by respondents. Tablet computers (especially iPads[5]) were used the most frequently, followed by smartphones and music streaming services. Meanwhile, music identification services and music management platforms were the least used. The use of video streaming services such as YouTube and Digital Audio Workstations such as Garageband was relatively evenly distributed.[6]

Results also showed that therapists are largely willing and able to employ many different therapy-relevant technologies in their practice: Participants selected "I know how" 85% of the time on the modified MTPS. A small percentage did express that they did not want to learn to use instant messaging (10%) or task management applications (15%), indicating a possible preference for asynchronous forms of communication (e.g., email) and non-technical means of organization (e.g., paper calendars or binders).

[5]https://www.apple.com/ipad/

[6]https://www.apple.com/ios/garageband/

After analyzing interview transcripts and open-ended survey responses, we identified four primary themes which motivate the use of technology in music therapy: (1) *Efficiency*, (2) *Communication & Musicking*, (3) *Personalized Connection*, (4) *Identity Formation*, and (5) *Legacy Preservation*. Further, we identified five key barriers to effective music therapy practice: *Environmental and Societal Challenges*, *Workload*, *Education*, *Privacy and Connectivity*, and *Finances*.

5.1 Why Music Therapists Use Technology

5.1.1 Efficiency. The standard of just one to two hour-long therapy sessions per week represents a highly condensed time period in which to make meaningful therapeutic progress. It is therefore of critical importance that therapists come to each session ready to meet the client's needs from the very start. Participants expressed gratitude for technologies which increased their efficiency, both prior to and within a session. For instance, many described how free and ubiquitous platforms like YouTube have greatly reduced the time therapists spend on the tedious tasks of constructing custom playlists for clients or finding materials (e.g., chord progressions) requested by the client in real time:

> *"When I first started...I would spend hours and hours putting together a song list. Now all I have to do is search [online]". So I can sit down in 3 hours - it used to take days."* - I-1

> *"YouTube is this amazing gift... Voila! There's there's the song and there are the chords."* - I-6

> *"[B]eing able to go on YouTube and look up any song that a person requests is amazing. I remember when I was in school, our professors would be like 'Don't just ask for any song, because you won't be able to just find it.' Now you totally can."* I-10

Participants also found technology increased their efficiency in organizing their materials. For example, survey respondents frequently mentioned two distinct apps they liked to use: *OnSong*,[7] which brands itself as a paperless upgrade from traditional binders that can be used to organize sheet music and other content, and *Ultimate Guitar*,[8] which focuses more on chord and guitar tab notation organization. Survey respondents also mentioned the use of cloud storage websites such as Google Drive[9] and Dropbox.[10] It is important to note, however, that technology-grounded solutions for increased efficiency did not always eclipse physical organizational solutions:

> *"I have a large dining room table with added organizers on top of the table and other organizers and shelves around the room to hold all my materials and equipment. I also have a stage for my clients to use with instruments and a place for recording equipment if needed."* - S-14

Within therapy sessions, physical objects such as digital piano keyboards were valued for their portability and compact, tactile nature:

> *"As much as I love a real piano, the keyboard has been helpful because it's portable, and I can put it in people's lap, and they can play it [more easily]."* - I-5

I-9 described how such tools can give therapists an increased sense of control, help the session run more smoothly, and afford clients the freedom to create music without fear of negative feedback:

> *"On the iPad, GarageBand gives the kids more control. They can record instruments with their fingers, I can set the key...before the session...I can pre-program [keys and chord*

[7] https://onsongapp.com/
[8] https://www.ultimate-guitar.com/
[9] drive.google.com
[10] www.dropbox.com

progressions]...and then they can go in and be creative and not play any wrong notes." - I-9

5.1.2 Communication & Musicking. Communication and musicking often go hand in hand, according to our participants. Strong communication between therapists and their clients is a necessity for productive musicking and progress within therapy as a whole. Tools such as tablet computers are often a necessity for communicating with clients with developmental disabilities [44, 53, 54], who may have limited mobility range or verbal skills. These touchable, tappable tools grant these clients a degree of independence and facilitate socialization:

"[F]or my clients who are nonverbal...or [who] are difficult to understand, being able to use a communication device to request activities, ask to use the bathroom, having a conversation with someone [another client] in the lobby - that happens a lot...so tech is really helpful with that." - I-10

Tablets are especially valued for their customizable nature. Software such as GarageBand was often used in tandem with other apps on smart devices as tools for expression and unpacking of unresolved grief and trauma in certain populations, such as children with disabilities. When clients use these tools to communicate what has happened to them, therapists are better able to assist the clients in the therapeutic healing process:

"It was oftentimes recognized after working with them and getting them to open communication through technology, through iPad work...there was significant trauma that they had experienced, and being nonverbal they [were not able] to express themselves openly...That's a result of significant loss - loss of communication, loss of meaningful childhood..." - I-2

However, not all participants fully embrace newer technologies such as tablets. For instance, S-10 described concern over the difficulty for clients of tapping on a flat, hard screen while musicking:

"iPad apps are great for creating/improvising music, but the flat, smooth glass is often not tactically engaging for non-verbal clients and I haven't had much success using them."- S-10.

Communication between participants and their clients often transcends physical boundaries. For participants with clients in rural or remote areas, telehealth solutions offer an alternative to long, dangerous commutes to clients' homes. I-9 even envisioned a future in which telehealth enables a broader range of clients and loved ones to experience therapy together, across a distance:

"It would be great to have patients and families [from all over the state] bounce into a music group via technology somehow. They [would] have existing technology in their house, and it would be safe and secure and [sessions] would be in real time, which I think would be really difficult. I don't think we're quite there yet." - I-9

S-20 also echoed the importance of communication via telehealth in the all-digital era of COVID-19:

"Due to the COVID-19 pandemic, music therapists are using technology a lot more because they have to, so I think the landscape of tech in music therapy is going to change." - S-20

5.1.3 Personalized Connection. Interviews painted a portrait of music therapy as a dynamic and individualized process rooted in evidence-based practice. Participants received extensive educational training spanning multiple disciplines, including clinical practice and the physiology of music perception. This well-rounded educational path led them to source their assessments from other fields, such as psychology or physical therapy, in order to establish an appropriate set of goals tailored to the unique needs of the client. In fact, I-1 likened sessions to "prescribing" music oriented

towards specific goals, much like a physician might prescribe medication to treat a particular condition.

According to participants, goal-establishment relies on a strong client-therapist foundation of trust and *personalized connection* that grows stronger across sessions. The early phases of treatment are critical for laying this foundation:

> *"We're always going to be coming in and immediately beginning to build rapport with that patient or client...For a little kid, building might be letting them hit a drum for the first 10 minutes. That's building the trust with you. With an adult, it might be talking about the weather that day or letting them choose a song to listen to. So it...looks completely different for every person, and we will totally adapt what we are doing."* - I-8

Therapists value technologies that facilitate strong, personalized client-therapist connections during this trust-building process. For example, therapists appreciate the comprehensive and readily-accessible nature of streaming services such as Spotify and YouTube:

> *"I use [the] Spotify app, and I can look up any songs that the patient requests, and that's a really good way to build rapport with them. They may request a song that I don't know how to play, and I can just instantly pull it up on Spotify or Youtube and it's there...if it's not on spotify, I'll pull it up on YouTube."* - I-8

Indeed, music accessed through a computer (as opposed to music the therapist plays on a live instrument) often helps free the therapist of the constraints of music-making and helps them to more fully engage with the client's preferences and emotions:

> *"I often start with things I know they won't like, just to get them to respond, and sort of go from there. And so I do a lot of playing music on the computer for those first sessions."* - I-7

This technology-aided freedom is especially useful when therapists need to deviate from their original session plan in order to better meet the client's emotional or physical needs. Participants spoke of tailoring sessions in the moment in order to best "meet the client where they are" (I3):

> *"You execute your plan, but when you feel like oh, my plan is not going to work for this particular day or this particular emotional state that the client is in, then you have to become totally flexible and just be at the moment with the client."* - I-4

> *"We're constantly changing stuff. I never want it to look stagnant. So if we never met that goal, maybe we set it too high. Maybe it's an unfair expectation. Let's lower it, or we get better or higher if they have met it. So I'm constantly trying to think of how those objectives fit."* - I-3

Participants brainstormed several creative ideas for new technological tools for individualized treatment. For instance, S-04 expressed their desire to create a customized app for their practice. S-13, meanwhile, envisioned a playlist-deployment system for hospitalized clients that optimizes the timing of music delivery based on the client's schedule in the hospital:

> *"I want to make it possible for my hospital patients to access music from a personalized playlist to play in their rooms. This would have to be built-in in a way that would ensure the actual devices would remain in the room when the patient was discharged. I would also like to have music playing in the dayroom during certain hours of the day, a generalized 'standards' playlist that comes on and turns off automatically."* - S-13

5.1.4 Client Identity Formation. Helping the client to discover their place in the world, including their identity as a unique person, was also seen as a key facet of connecting with the client. "Identity" for clients spans many domains and may include religious, cultural, sexual, or gender identity. Prior to beginning identity-focused work, the music therapist works to cultivate a respect for (and deeper

understanding of) the client's background. One salient way of doing so is to approach the use of freeware services such as Spotify and YouTube in a new way. For therapists, this means shifting from the typical consumer approach of using these services in-the-moment for leisure towards using them as professional resources for session preparation:

> *"[I use YouTube] to better prepare myself...To connect better with my clients I have to be culturally sensitive, and that includes music too...[I familiarize] myself with what they listen to....That's one way I use technology. It's very basic, minimal."*- I-4

Recorded music from streaming services and other sources is also important during the identity formation process itself. I-10 described how recordings (as opposed to live music-making, or *musicking*) are simple yet effective tools for engagement. Further, I-7, explained how recordings can be used to assist clients with marginalized identities (e.g., LGBTQ+ youth) in exploring the parts of their identities which they struggle to reconcile with their backgrounds:

> *"Really, what we're doing is attachment work...so many of [my clients] have been removed from households, have difficulty reconciling identity with religious backgrounds and cultural backgrounds...they have interrupted attachments...So, really within those first sessions, what it looks like is me being calm and using a lot of recorded music to try to find the child's musical identity."* - I-7

Participants also described the usefulness of customizable software in the identity formation journey. For instance, I-7 often relies on plugins for GarageBand, which offer more customized sounds:

> *"I buy a lot of [GarageBand plugins] according to the child's cultural identity as well...and often times what I end up doing is helping kids to write tracks that have instrumentation from their cultural background."*- I-7

Across participants, the concept of "making space" for the client emerged as a powerful motivator for identity-focused work. Participants described the importance of acting not as the sole determiner of the client's treatment path, but rather as collaborators in a client-determined journey:

> *"Music therapists are uniquely situated to engage clients in these dynamic music experiences that are individualized to them. So at the end of the day, it's not about my music. It's about their music. I'm just a facilitator."* - I-6

Moreover, irrespective of the technology used for identity formation, clients emphasized that the ultimate goal of music therapy is a profoundly non-musical goal: to have clients emerge as stronger and more empowered individuals. As I-2 expressed, "[T]he idea is to get to the point where I'm not needed."

5.1.5 Legacy Preservation. Music therapy is a powerful tool at the end of a client's life. Participants who work in hospitals and hospice care facilities often engage in *legacy preservation* to help their clients cope with death and grief. Legacy preservation entails creating a recording with a client and saving it for the client or loved ones to keep as a memento. Within this process, the acts of music discovery, musicking, and recording are often used as a pre-bereavement ritual. For instance, I-5 described how recording the singing voices of dying individuals became a ritualistic way of supporting grieving families. As I-6 noted, "families want that artifact [after the loved one has passed away]".

During legacy preservation, multiple technologies are used in tandem. Participants placed heavy emphasis on the importance of using high-quality technologies worthy of the memories they help to create:

> *"I use GarageBand to record when the patients write a song. It's really important for them to record it and have a really nice quality product. So I will use a really nice, semi-nice microphone...and then either use my iPad or my laptop using GarageBand to help them make that recording. I've [also] used iMovie before to help teach us to make videos, to make legacy projects. I've used this one app that makes music videos..."* - I-8

Unfortunately, financial and resource constraints can make creating legacy recordings a challenge:

> *"I would like to use heartbeat recordings more often to create legacy projects. We have access to specialized stethoscopes and apps but sharing amongst 8-10 MTs is difficult. I would prefer to buy my own but can't afford it right now."* - S-15

5.2 Barriers to Effective Music Therapy Practice

5.2.1 Environmental and Societal Challenges. Barriers related to the client's environment, as well as societal barriers imposed on the client, were the most frequently mentioned barrier. These barriers extend to therapists by preventing them from fully engaging with clients in challenging circumstances. For instance, I-6 mentioned feeling like "a guest" whenever they visited a client in hospice, who was surrounded by family. As a result, I-6 felt unable to support the family going through pre-bereavement.

Environmental barriers also frequently arise for clients with marginalized identities, such as gay or transgender youth. The stigma associated with these clients' identities [59–63, 92] leads not only to ongoing trauma, but also a lack of material resources. LGBTQ clients, in particular, are often unwelcome in their former home environments and seek independence with little monetary or social support to back them up. For instance, I-7 described how immediate needs for shelter and sustenance can override emotional needs, for clients with marginalized identities:

> *"The kids in the trans groups are primarily homeless. So they largely have put those traumas in a little bit of a metaphorical box. They have bigger issues to worry about today, which are: Where am I going to live? How am I going to get to school? How am I going to eat? Are the people that I'm trusting around me going to hurt me? So they are often in a space where...they are just not going to touch that trauma yet."* - I-7

Other participants described systemic issues preventing a strong client-therapist connection, such as the societal expectation that clients with developmental disabilities learn to overcome obstacles on their own or with limited support resources. Such comments highlighted the tension participants experience between client autonomy and need for support:

> *"There are a lot of very large ditches that are constructed by other people for people with developmental disabilities to inhabit, and [society expects them to] climb out of the ditches, [rather than expecting] therapists, or teachers, or other support people to give ladders."* - I-2

Still others mentioned the risk that unstable environments can be triggering and thus hinder therapeutic progress. For instance, I-6 discussed how psychiatric facility patients would get into arguments with other patients following a music therapy session, effectively "wash[ing] away" the positive impact of the therapy. Further, I-5 described how grieving individuals face emotional challenges tied to instrumentation:

> *"It complicated their relationship to music, because the person who died was their biggest fan. So playing the piano was really really painful. So they would avoid that, at times."* - I-5

These excerpts highlight how a client's unmet basic needs often overshadow the need for long-term healing and growth that can result from the therapy process. Consequentially, music

therapists (especially those working with marginalized populations) may feel limited in their ability to effect meaningful change in clients' lives if they cannot first help clients overcome immediate environmental challenges.

Environmental barriers include participants' own work environments, as well. Music therapists experience great strains on their time and talents brought on by heavy caseloads and restrictive contracts. For instance, I-6 noted that caseloads in medical settings are generally large, making it "impossible to have any sort of consistent relationship development with [clients]" due to the infrequency of seeing clients and the sheer number of clients therapists have to serve. Further, I-7 explained that their contract only allowed for two short group sessions per week, totaling approximately 4 hours in total. All of these factors prevented therapists from fully connecting with clients as they would have preferred.

5.2.2 Education. Educational barriers include challenges with both therapists' educational backgrounds and the need to educate community members about the importance of music therapy. With regard to therapists' backgrounds, several participants mentioned a lack of standardization across degree-granting music therapy programs:

> *"The therapists who work [with me], we're all from different states, and we all have different education experiences, and they're all pretty different. And I feel like they probably shouldn't be that way...we all have to take the same board examinations, so I guess that's a way that the profession has ensured there's a there's a baseline, but it just baffles me."* - I-10

With regard to education of the community, I-4 expressed discouragement over the amount of time music therapists must dedicate to convincing the public that their services are worthwhile:

> *"It's challenging to go out into the community and talk about music [therapy]. It's very time-consuming...There's actually an overflow of private practices. But it doesn't mean that people have a good understanding of what music therapy is. So, the education portion becomes very important."* - I-4

Further, I-6 expressed frustration over public perception that music therapists are no different from recordings or mere music-making machines:

> *"Music therapists are often relegated to being entertainment...and that's not why we're there. Oftentimes we'll get referrals like 'oh, well the client likes music'. And I'll say to the nurse, 'Well, if they like 7th Heaven, the TV show, does that mean they're eligible for a chaplain referral too?'...Just because somebody likes music doesn't mean they're appropriate for music therapy. We're not there just to play for people. We're not entertainment. We're here to help people meet clinical needs."* - I-6

Both I-4's and I-6's sentiments highlight how the prevalence of a service doesn't necessarily correlate with public knowledge of its utility or support for the service itself. Just as independent local businesses may have to convince consumers of the value of purchasing goods from them rather than from a big box store, music therapists often have to justify how and why their services are preferable to cheaper but lower-quality alternatives (like simply listening to music on one's own, without therapeutic intervention).

5.2.3 Privacy and Connectivity. The software or hardware used as part of a therapist's practice present several issues surrounding privacy and connectivity. While few therapists identified specific technological barriers, those who did described issues related to access to care. For instance, I-7 described the challenge of using video calling platforms with clients in rural communities. Like other therapists who rely on technologies for remote communication with their clients, I-7 is faced

with the tradeoff of opting for more secure platforms (which tend to cost money) or spending hours of valuable time on paperwork in order to use less secure (but free) platforms:

> *"I have to do a looooot of paperwork around that because it is *not* an encrypted form of communication and I *can't* guarantee absolute confidentiality...Skype has better options but I have continuous difficulty with Skype - calls being dropped in the middle, and it just totally disrupts the whole process."* - I-7

I-7's situation stems from the issue of adherence (or lack thereof) to *HIPAA* in consumer-grade video conferencing technologies such as Google Hangouts and Skype. HIPAA, the Health Insurance Portability and Accountability Act, was established in order to protect the privacy of patients' medical data in the United States [13]. Today, HIPAA governs many aspects of US healthcare practice, and "covered entities" such as music therapy practices are required to comply with HIPAA regulations. HIPAA places limitations on how, where, and why health data can be transferred; these limitations extend to tools such as video calling software, which may not be HIPAA-compliant. As a result, therapists must shoulder the burden of completing additional paperwork prior to using popular video calling platforms, as in I-7's case.

I-9 and S-3 touched on additional challenges in the area of privacy and connectivity. In particular, S-3 noted that freely-available platforms (e.g. Skype or Google Hangouts) experience frequent issues with latency, which can disrupt shared singing sessions (S-03). S12 wished for better telehealth options (i.e. those with reduced lag and increased privacy) that could enable "completely remote" sessions.

5.2.4 Finances. Financial barriers are often enacted by state governments, which determine what kinds of specialized services (e.g., music therapy) receive funding. P7 described how insurance may only cover music therapy if the client has a specific diagnosis. Further, P5 described the irony of working in a hospice setting where bereavement services such as music therapy were "mandated, but not funded." Participants also frequently mentioned how funding was tied to whether or not music therapy was seen as a worthwhile service to state agencies:

> *"[With] Child Protective Services, [it] is so hard to try to get them to pay for music therapy...one of the things that we're looking at is getting title protection...so that we're really completely...seen as a legitimate service [by the State]."*- I-3

6 DISCUSSION AND IMPLICATIONS FOR DESIGN

Our results reveal that music therapists are both technologically fluent and highly skilled in engaging and empowering clients of diverse backgrounds. Therapists sttendedtend to use a combination of freely-available and paid technologies. Free services (e.g., streaming services) functioned more passively, serving as inspirational resources for kickstarting the therapy journey. Meanwhile, paid technologies (e.g., mobile applications and extensions, tablet computers) functioned as dynamic tools for communication and expression. Together, tablet computers, mobile applications, streaming services, and other technologies comprise a readily-accessible ecosystem of resources that provide much needed control and customization for both the client and the music therapist throughout the therapeutic journey.

Results also showed that despite the immense benefits clients receive, the music therapy process is fraught with unique challenges that hinder clients' ability to grow and progress through therapy as well as therapists' ability to assist clients. Music therapists are tasked with the enormous challenge of helping clients wade through a sea of disempowerment, grief, and trauma, functioning as both counselor and therapist. At the same time, therapists must balance demands on their time and finances while fighting to be seen as worthwhile in the eyes of the community and funding agencies. Though technology has eased some of these burdens, many challenges still remain. Here, we present

three main implications for design, directed towards designers seeking to build future technologies with and for music therapists and their clients.

6.1 Create Personalized Technologies that Foster Client-Therapist Relationships from the Ground Up

Personalized connection was a prominent theme in our results, and was strongly tied to identity formation. Participants described how technologies which encourage clients to connect to their own unique sense of identity (e.g., apps like GarageBand which contain culturally-relevant plugins) help, in turn, to foster strong client-therapist relationships. Several participants also expressed a desire for apps with more customization options tailored to their own clients' needs. Personalizing mobile apps for in-the-wild intervention remains a challenge given the sheer amount of information that must be gathered to determine user preferences, thoughts, and feelings regarding treatment. However, in recent years, researchers have sought to rectify the challenge of personalization by capturing indicators of user behavior *in-situ* using tools such as *ecological momentary assessment (EMA)* [82]. EMA has been widely used in mHealth studies to capture momentary indicators of mental and physical health (including music use) [10, 26, 74, 78] and has been explored as a supplement to therapy, in certain contexts [52, 67]. In the context of music therapy, EMA could be integrated within a mobile application to periodically assess a client's physical or emotional state in the days leading up to a music therapy session. For instance, the mobile application could send the client a daily notification to fill out a short 2-item self-assessment of mood and a 4-item self-assessment of pain. In turn, these in-the-moment self-reports could be used by therapists to tailor an upcoming therapy session's goals to the client's most salient needs (e.g., calming anxiety or fine-tuning motor skills) and to set smaller goals for the client to work towards outside of therapy (e.g., finding songs that speak to their cultural identity).

Participants alerted us to the challenge of fostering personalized connections with clients when clients have immediate, unmet physical or emotional needs. Technologies that encourage personalized connection should thus be equipped to facilitate shared coping and resilience-building activities. In this sense, the concept of *self-transcendence* is relevant to the domain of personalized connection within music therapy. Self-transcendence is defined as the innate human desire "to reach out beyond the boundaries of the self to achieve broader perspectives and behaviors that help one discover or make meaning" of human life [28, 56]. Frankl [28] posits that individuals can foster self-transcendence during difficult or stressful times by engaging in collaborative and creative activities. Furthermore, self-transcendence can bring meaning and purpose into one's life through connections with the self and others [22]. Existing applications used in music therapy appear ill-equipped to foster self-transcendence among clients from particularly challenging circumstances (e.g., LGBTQ+ youth and clients with disabilities). These applications focus on the music-making aspect of therapy but *not* on the importance of the client-therapist connection. We therefore encourage designers to create tools that specifically support the client-therapist connection via self-transcendence activities. For instance, a mobile application could be designed as a *sonified scrapbook* that allows both therapists and their clients to arrange sound snippets (gathered from other applications such as Spotify or Garageband) into a story format that relates to the needs and current stage of the client's journey. Further, clients could use this audio scrapbook to record sounds that inspire them "in the moment", even outside of treatment. Such an app effectively would leverage the benefits of the quantified-self movement [87] by encouraging introspection and personal growth beyond the structure of guided therapy sessions.

6.2 Increase Opportunities for Client-Driven Identity Exploration

Identity exploration and formation were also frequently mentioned as important aspects of the music therapy journey. In particular, therapists described the use of preferred music and sounds (e.g., within music creation software such as GarageBand) as powerful tools in this journey. Preferred music is a highly emotional and salient stimulus that has been shown to improve positive affect. For instance, one study found that participants rated higher on self-reports of positive state affect and cognitive performance, highlighting the relevance that preferred music has on emotion and cognition [55]. Unfortunately, technologies for preferred music currently exist almost exclusively in the consumer sector. *Recommender systems*, which are designed to make appropriate recommendations to a user based on their interests [75], are a potentially useful tool for curating preferred music during a music therapy session. We note, however, that such systems would need to be expanded to best serve the needs of music therapists and their clients. For instance, clients may prefer to find songs whose lyrics echo their own personal experiences (as in the case of lyric analysis [49], a popular music therapy technique). However, recommender systems which consider content such as lyrics are rare [32, 69]. Moreover, a recommender system based on lyrics would still lack important information about the client's identity, such as cultural background, gender, and mental health status. We posit that a successful recommender system for music therapy would take both lyrics and identity-related factors as input and use the information to identify relevant songs for the client's unique situation. In turn, the therapist could provide feedback to the system about which songs are most appropriate, and the system would learn from these preferences over time as the client progresses through therapy. Such a system would be akin to a more emotionally-attuned Spotify or Pandora[11] that is more easily controlled and customized within the therapist-client partnership. We encourage designers to broaden the landscape of content-based recommender systems for music therapy, creating systems that leverage both content and user background information [1].

Participants expressed a strong desire to see their clients grow in resilience. A music therapy-oriented recommender system could help identify songs with lyrics focused on coping with a chronic illness or difficult situation, and could help clients to progress in building resilience and in re-framing challenging situations with a more positive perspective. Such a recommender system could be particularly helpful for clients with marginalized identities (e.g., members of the LGBTQ+ community) or conditions (e.g., mental health illness) by helping them more easily find music that validates their journey. We note that such a system would need to be designed with specific safeguards in place, given the tenuous nature of identity exploration within therapy. For instance, therapists often described the importance of avoiding a client's triggers (e.g., songs that might upset them). A well-designed recommender system for music therapy should be included as part of a broader system that allows therapists to easily identify and avoid triggering songs, which contain lyrics that further exacerbate the negative emotional impact of a particular condition for the client. For instance, a comprehensive system for lyric analysis could apply customized "flags" to potentially-triggering songs, similar to how "explicit" labels are applied to music containing curses or sexual content.

6.3 Prioritize the Development of Customized Telehealth Solutions for Music Therapy

In the wake of the COVID-19 global pandemic, telehealth has become the new linchpin of healthcare infrastructure. Novel telehealth solutions (e.g., video call platforms) are becoming increasingly valued in clinical and therapeutic practice for the ability to provide remote access to care to a variety of patients, including those homebound due to illness or susceptibility to infection and those in rural communities. Moreover, freely-available video conferencing platforms developed for

[11] https://www.pandora.com/

non-telehealth audiences (e.g., Skype) have already been assessed for delivery of therapy remotely and have shown promising results. For instance, Choi et al. conducted research to assess the delivery of problem-solving therapy over Skype for low-income homebound older adults experiencing depression [17]. Results from this study showed that participants felt comfortable and had a positive attitude towards the therapy delivered in this modality. Furthermore, participants registered lower scores of depression after receiving telehealth therapy at 12 and 24-week follow-ups. Additionally, recent work comparing patients' perceptions during in-person and telemedicine consults found that there was no difference in patients' perceived empathy of physicians [16], pointing to the utility of remote telemedicine in high-empathy environments such as music therapy.

Several participants indicated a desire for more reliable telehealth and remote communication tools for their music therapy practice. However, our findings also revealed inadequacies in existing telehealth technologies that uniquely impact music therapists, including (1) lag and (2) the tradeoff between privacy and financial cost. Here, we address each of these inadequacies briefly:

6.3.1 Lag. Lag (latency) in telehealth applications can occur for several reasons. Low-income clients might not be able to afford high-bandwidth internet speeds needed for typical remote sessions, and those living in rural or impoverished areas may lack the infrastructure needed to support adequate video streaming speeds. The music perception community has made great strides in understanding lag and related issues (e.g., lag tolerance and systems adaptation to live human performance) in music-making settings [24, 42]. Additionally, as mentioned in Section 3.1 , systems such as NETDUETTO have shown promise in music therapy settings [51]. Despite this collective progress toward lag mitigation, testing of lag tolerance in telehealth environments for music therapy, specifically, remains an under-explored research problem. We encourage designers to work closely with software developers, computer scientists, and audio engineers to (1) prioritize lag mitigation research with open-source telehealth platforms[12,13] [70], and (2) create variants of these platforms geared towards music therapists.

6.3.2 Tradeoffs Between Privacy and Financial Cost: As highlighted in our findings, HIPAA regulations place stringent limits on the sharing of patient data [13], and thus impose significant time and resource burdens on therapists who rely on freely-available video calling platforms to facilitate remote sessions. We urge designers to create tools that make the HIPAA compliance process easier for music therapists, either by connecting them with free, HIPAA-compliant video calling services or walking them through the paperwork needed for non-HIPAA-compliant platforms. Ideally, these tools would be able to curate both freeware recommendations and paperwork walkthroughs based on the therapist's geographic location, taking factors such as internet infrastructure and state-specific HIPAA guidelines into account. We also urge designers to work with government entities to establish new guidelines for HIPAA compliance for telehealth in the COVID-19 era.

7 LIMITATIONS

While we received valuable insights from both the interviews and survey, we were limited by our small sample size and largely heterogenous survey sample of young, white, female participants. The small sample size further prevented us from using techniques such as Principal Component Analysis (PCA) to draw deeper inferences about the validity of the modified MTPS. Further, the heterogeneous sample of survey respondents points to a risk of bias in our proposed implications for design, as these implications may not fully address challenges faced by therapists in other demographic

[12]https://www.intelehealth.org/
[13]https://doxy.me/

groups. We encourage designers who draw upon this work to consider these limitations and to include music therapists of diverse backgrounds in activities such as participatory design when possible. Finally, participants rarely discussed the use of technology at the very beginning or very end of treatment (i.e., in the *Referral* and *Termination* phases). We hope that future works will gather additional data about technologies used in these phases. In turn, we hope such works will propose more advanced technological solutions to facilitating strong client-therapist matches in the Referral phase, and helping clients transition out of therapy in the Termination phase.

8 CONCLUSION

In this work, we evaluated the technological practices, challenges, and needs of music therapists through an HCI lens. Our results show that music therapists are highly fluent in a wide array of technologies, including streaming services and smart devices. Further, results showed that music therapists use these technologies for the distinct purposes of staying efficient, engaging in communication and musicking activities, fostering connection and personalization, encouraging identity formation, and preserving legacy content. This work touches on the unique challenges music therapists face, including relationship and communication barriers and strains on resources such as time and finances, and highlights a need for designers to further engage with music therapists in the technology creation process. We encourage designers in this space to create new technologies for music therapists that encourage personalization, identity formation, and telehealth.

ACKNOWLEDGMENTS

We thank our participants for their time and rich insights.

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Received June 2020; revised October 2020; accepted December 2020