Exploring the Creation of Useful Interfaces for Music Therapists

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ABSTRACT

Music therapy is utilized worldwide to connect communities, strengthen mental and physiological wellbeing, and provide new means of communication for individuals with phonological, social, language, and other communication disorders. The incorporation of technology into music therapy has many potential benefits. Existing research has been done in creating user-friendly devices for music therapy clients, but these technologies have not been utilized due to complications in use by the music therapists themselves. This paper reports the iterative prototype design of a compact and intuitive device designed in close collaboration with music therapists across the globe to promote the usefulness and usability of prototypes. The device features interchangeable interfaces for work with diverse populations. It is portable and hand-held. A device which incorporates these features does not yet exist. The outlined design specifications for this device were found using human centered design techniques and may be of significant use in designing other technologies in this field. Specifications were created throughout two design iterations and evaluations of the device. In an evaluation of the second iteration of this device it was found that 5/8 therapists wanted to incorporate it into their practices.

CCS CONCEPTS

• **Human-centered computing → Sound-based input / output**; User interface toolkits;

KEYWORDS

Music Therapy, Human Centered Design

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1 INTRODUCTION

Music therapy practice promotes health using "music experiences and the relationships that develop" through those experiences [1]. Most music therapy sessions involve a client's participation in the creation of music. There are as many applications of music therapy as there are methods. Technology in music therapy has great potential, allowing therapists to catalog their client's actions in real time and cater to clients with limited mobility. The use of electronic music technologies and resources in music therapy practice has been of increasing interest over the last two decades. Music technologies useful for clinical settings include computer-based applications such as software devices using musical instrument digital interface (MIDI) and assistive devices to trigger musical applications [6].

New and interesting musical interfaces may be used to keep clients with Autistic Spectrum Disorder focused [13], and let clients without a musical background create complex music [12]. The applications of such technologies seem endless, but we have found that very few music therapists utilize a significant amount of technology in their practice. Because it is such a wide-spanning practice, creating a fit-all device is nearly impossible. However, by involving a group of music therapists from different geographical locations and backgrounds in the design process, we found that we are closer to creating a piece of technology that meets their shared needs.

This paper describes the prototype design process of a modular and customizable device for use by music therapists. The paper is structured in the following way: Section 2 introduces existing technologies in the field. Section 3 discusses the methods used to gather requirements from the target population. Section 4 discusses the design considerations and prototyping of a device which meets the needs of the population as closely as possible. Section 5 discusses the final prototype's alignment with the requirements.

2 EXISTING TECHNOLOGIES

Many devices exist specifically for use in music therapy settings. Relatively few of them have been made commercially available to music therapists. Although the devices which exist are relevant to the needs of the field, average music therapists have been reluctant to adopt them [7], possibly due to a lack of confidence using technologies that are too technical or confusing for them [10] as validated by our interviews. Several of these devices are described below. Featured similarities of these devices are shown in Table 1.

Table 1: Several common traits of the technologies described in Section 2 and the number of technologies that feature them.

Trait	Number of Technologies (of 8)
Visual feedback	4
Physical movement	4
Buttons and switches	3
Desktop	3

2.1 BendableSound

BendableSound is a tactile interface for children with Autistic Spectrum Disorder (ASD). Visuals are projected onto a canvas screen at the height of the child. Audio plays as the child interacts with the surface. A computer is used to control the music and take motion input from a Xbox Kinect. The sounds are projected from speakers behind the canvas screen. This device is highly novel and has been proven to keep the attention of children with ASD [3]. However, it requires an array of specialized and large equipment and has not been made available on the market.

2.2 Soundbeam

Soundbeam translates body movement into sound. Ultrasonic sensors pick up body movement such as waving gestures and proximity to the sensor. This is the most commonly used New Interface for Musical Expression (NIME) in music therapy[7] as of 2006, but it is fairly expensive and only available in the UK. Soundbeam is great at making complex compositions a possibility to those without any musical background [12]. However, there are limited options for those with mobility issues who cannot wave at the system to create sound.

2.3 Music Care (https://www.music-care.com)

Music Care is a web-based application that provides a self-assessment tool for individuals and music fit to relieve pain, to help with sleep, or to help stay awake. Data is kept on a user's account based on music listening sessions. Music therapy has been shown to be a useful tool for improvement of sleep quality, reduction of anxiety [4] and pain management [8]. This tool is helpful for finding appropriate music for these ailments and tracking a users self-reported statistics, but is used at-home. It is not a tool for creating music.

2.4 MIDI-Based devices

The following devices for music therapy are built using the Musical Instrument Digital Interface (MIDI) standard.
CAMTAS, Shell Instrument, MidiGrid and MidiCreator were developed by researchers from the University of York [5]. A Computer-Aided Music Therapy Analysis System **"CAMTAS"** was developed in the mid-90s. It is a MIDI-capturing tool that can be used to capture music therapy sessions for later playback. CAMTAS also includes some data visualization based on the recording. This was the first analyses tool of its kind, but was only a prototype [11].
The **Shell Instrument** is a tactile instrument which translates vibration on its surface into sound. This exploration into tactile instruments showed the benefit of giving a NIME "character" for the performer to relate to [5] but also did not make it past the prototyping phase.
MidiGrid is a computer software developed in the 90's. It allows the user to play their keyboard as a musical instrument by changing settings on screen. It is an inexpensive software, but needs to be run on a full computer, which a travelling music therapist may not always have access to.
MidiCreator utilizes an array of dedicated switches and converts their signals into MIDI notes and chords for use with MidiGrid. Of these, MidiGrid and MidiCreator are the only commercially available systems.

2.5 VESBALL

VESBALL is a ball-shaped instrument for group music therapy. The ball features a touch sensor and an accelerometer which trigger sounds when caught and thrown [9]. This system requires very little technical knowledge to set up. However, VESBALL only offers two methods of interaction for two sound modes. Users may become tired of the same sounds and interactions quickly. It has not been released passed the prototyping phase.

3 REQUIREMENTS GATHERING

It is clear that musical devices have been and continue to be developed for therapy settings. They offer a wide range of benefits when included in therapy sessions. Why then are those devices not being utilized in the industry? We hypothesize it is because the device must be designed with the music therapists as the primary users of the product. Keeping the therapist involved at all design stages could help a technology fit within the field and encourage its adoption. Working with therapists at the forefront of the project also insures that we do not overstep our bounds as designers. The therapists have extensive experience working with their populations that gives them a better understanding of the nuances of working with their clients than we can project. To better understand the needs and technological proficiency of music therapists, we conducted a series of interviews with six music therapists around the world. All of the interviews were performed either in person, on the phone, or through VoIP media such as Skype or Google Hangouts depending on the therapists' location. We decided to involve music therapists from more than one geographical location with the hope that the system we propose will have broader applicability for global music therapy practices.

3.1 Interviews

Two sets of interviews were conducted. Both sets of interviews were held via Skype and phone. Interviews were recorded and transcribed for analysis. The first round of interviews were non-directed (unstructured) sessions [2]. Non-directed interviews were

Table 2: Data collected from interviews with select participating Music Therapists

	Interviewee 1	Interviewee 2	Interviewee 3	Interviewee 4	Interviewee 5	Interviewee 6
Years as a practicing music therapist	14	30	28	27	37	11
Location	Japan	USA	Australia	Canada	USA	USA
Main client populations	Neuropsychiatric, Children, Physical impairments	Neurological, Psychodynamic, Children, Elderly, Communication	Adult mental health, Brain injury rehabilitation	Children and adults with severe behavioral issues	Children with developmental disorders	Memory, Brain injury, Mental health, Team building
Individuals or groups	Primarily groups of 3-8, Some individuals	Primarily individuals, Some groups of 6-10	Groups	Individuals and groups	Individuals	Individuals and groups
Session Duration	1 Hour	$\frac{1}{4}$ - 1 Hour	2 - 3 Hours	1 Hour	$\frac{1}{2}$ Hour	$\frac{1}{2}$ - 1 Hour
Where sessions take place	Client homes, Community centers, Care facilities	On site	Community center	Client homes, Care facilities	On site	Client homes, Community centers, Schools
Instruments used	Piano, Vocal, Bells	Listening, Vocal	Improvisational percussion	Vocal, Percussion, Improvisational piano, Vibrations	Piano	Piano, Guitar, Percussion, Vocal
Technology already used	None	BioDex Music care	None	None (tried and stopped use)	iPad for looking up lyrics	Musical iPhone app
Data collection	Video, Counting expected behaviors	Music care	Video Voice recording of reflections on session	Quality and length of playing, Behavioral data	None	Behavioral data
Specified design needs	Single tone instrument for groups, Ease of use for clients with limited mobility	Data acquisition for insurance	Tempo analysis for multiple improvisers	Small form-factor for ease of transport, Ease of use for clients with limited mobility	Holds children's interest	Breath and heart rate recording No tangled wires

chosen for this first round to foster a space where ideas and reservations could be openly discussed without the perceived pressure of a structured interview or questionnaire. The non-directed interviews consisted of five phases. The phases were:

- **Introduction:** Background on individual and their intentions in therapy
- **Warm Up:** Walkthrough of a therapy session, specific emphasis on methods and tools used
- **General Issues:** Discussion of technology's status in their practice and as perceived throughout the industry
- **Deep Focus:** Introduction of a technology that could assist them in their work with discussion of applications and downfalls
- **Retrospective Wrap-Up:** Reflection on the discussion and additional comments

From this process, we were able to uncover the backgrounds of the interviewees, their current practices, their receptivity towards technology, and their thoughts on incorporating technology into the field. This information is used in order to understand the applications of technology in their everyday work.

The second round of interviews was structured and was focused only on device specifications. To create a grounded approach, this structured series of interviews also involved questioning the interviewees about the interview itself. After each interview, the questions were altered according to their responses in order to maintain only the most appropriate questions and add questions we may have originally overlooked. Information on music therapy practices and device specifications obtained from these interviews can be seen in Table 2.

As a whole, we found that the main similarity between therapists is that they incorporate a wide range of methods for a wide range of clients. Additionally, there are some common design features that transcend geographical boundaries in terms of the music therapists' location. They are listed in the next section under "Primary Design Considerations."

4 DESIGN

This paper reports the first two iterations of the music therapy supporting device. The most important contribution of our work is that the two iterative prototyping exercises of the devices had been completed in accordance with the needs of the target population as found through interviews described in Section 3.

In the following section, we summarize the primary design considerations and the features of both prototypes. The phrases that are italicized and between double quotes are direct citations from the music therapists themselves. The following themes emerged from the interviews.

4.1 Primary Design Considerations

The most important common needs of the therapists for a device as determined by the interviews are as follows. The italicized quotes within these design considerations are direct quotes from the interviewees.

- **Versatility** - All of interviewees catered to multiple client populations. According to one interviewee, a device must work with many groups of people to be worth using because he *"love(s) working with a really large diverse pool of patients"*
- **Form factor** - More than half of the Interviewees traveled to different locations to perform music therapy, and all interviewees had done this at some point in their careers. It was particularly important to one Interviewee 4 that the device be something she could *"throw in {her} purse and easily carry"* from client to client *"because most [music therapists] are moving around a lot"*.
- **Ease of Use for Therapist** - The interviewees described troubles with existing technologies. They are *"difficult to operate and take too much time"* for the therapist to figure out and set up. Because of this, one interviewee says she has stopped using tech in her practice 2. Another interviewee specifies that he does not want any wires that he would have to untangle just to use the device. Furthermore, *"wires would inhibit the patient experience."*
- **Standalone** Many existing technologies require a computer, television screen, etc. in the space where therapy is being conducted. However, because therapists go to many different places, theses amenities are not always available. One interviewee stopped using a device because *"it really needed a huge monitor to really make it work well."* A standalone device or a device that can be used with peripherals when present is necessary to continued use for a majority of therapists.
- **Data collection** - Most interviewees interacted with insurance companies or hospitals in some capacity. Because of this, data collection was important to them. A few stated that if a device could gather quantitative data for them, it would be helpful for reporting to hospitals and insurance agencies. Any therapist who *"Working in a facility"*, has clients *"convered by insurance"* or practices *"neurological music therapy would always want data."* However, one therapist specifically stated that she does not and would not like to collect any data on her clients, making her practice as close to a music lesson as possible because *"Parents don't want [evaluations and data], all they want is a musical experience for their kids."*

4.2 Prototype One

The first iteration of this design is a desktop interface. This decision was made based on the existing technologies in Section 2. We decided on a modular input due to the highly diverse nature of music therapists today. Modularity allows the user to decide on the best interface to be used for any given client in any given surrounding. The therapist is free to decide based on their experience what sensors and audio/visual output is appropriate.

As shown in Figure 1, the first prototype can be used with a proximity sensor, buttons, and computer peripherals such as a keyboard, monitor, and mouse. The system is powered with a wall charger and can be used with external speakers or headphones. This system does not have an enclosure. Table 1 shows that movement is a useful trait for devices in music therapy. To fulfill that trait, we chose the proximity sensor. We chose buttons because of their ease of use and presence in other musical devices. Each sensor shield can be plugged and unplugged seamlessly without restarting the system. The platform used is the Raspberry Pi 3b. It was chosen

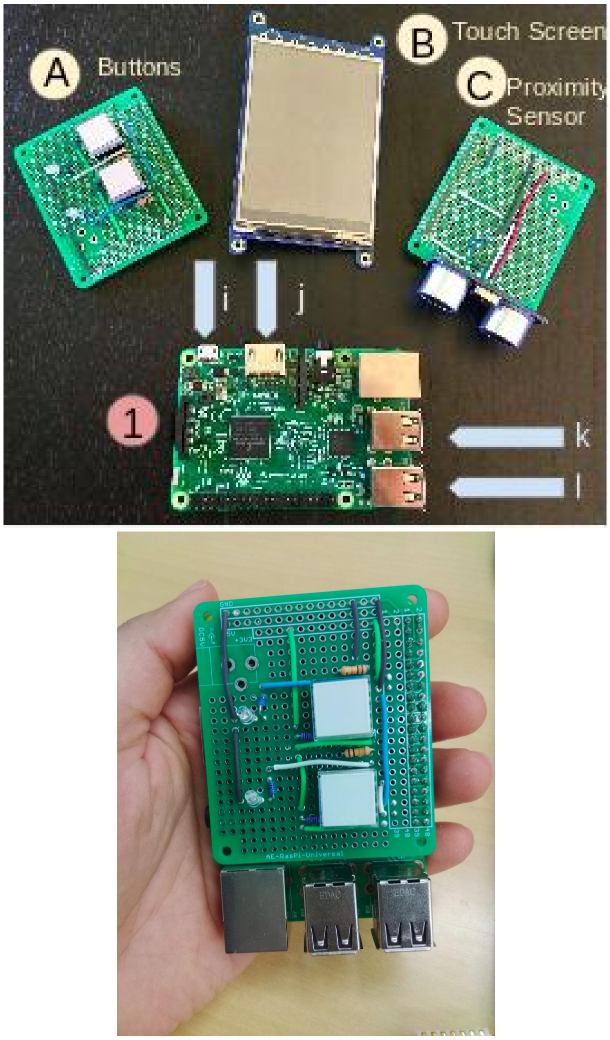

Figure 1: Prototype 1 of the device for music therapy. The raw device features multiple shields (A,B,C above) which can be swapped on and off the main device (1 above) for ease of use. Peripherals such as a keyboard and mouse can be attached to ports i-l above. The device assembled with one shield is pictured below.

because it is a small but powerful computer that allows for growth in future data analysis for the project and it is available worldwide. A block diagram of both prototypes can be seen in Figure 2.

4.3 Prototype Two

The second prototype is a 13cm, standalone device that can be recharged between uses. From interviews and the questionnaire in Section 5, it was shown that therapists would benefit from a system that could be used without the constraint of having a desktop computer or being in a specific space for every session. The second prototype includes a touch screen for visualization as well as another input. When a sensor is not plugged in, the system defaults to touch screen mode, taking input from on-screen colored keys like a piano. For both the button shield and the touchscreen when a key is pressed, sound is emitted from the system. For the proximity shield, sound is emitted based on the distance between the device and any other object. This sensor could be used by waving your hand, walking closer to the device, or pointing the device in different directions.

As shown in Figure 2 Prototype 2 incorporates a second microprocessor for the sensors. Having two micros allows us to dedicate GPIO pins on the Pi to touch screen use for portability. It also keeps the sensor input separate from the functionality of the device. Future sensor shields can be developed and used with the system with no change to the system running on the Pi. We can create new sensors while the current sensors are tested with music therapists. If a new sensor is requested, we can provide it after the basic device principles have been learned by the user.

4.4 Description of Interaction

The button shield features seven buttons, corresponding to seven notes in the C Major scale. The touchscreen is lit up with eight different "keys" (sections of the screen) which correspond to 8 tones in the C Major scale. For both the button shield and the touchscreen when a key is pressed or tapped, sound is emitted from the system. For the proximity shield, sound is emitted based on the distance between the device and any other object. 8 tones corresponding to the C major scale are played based on the distance from the device. This sensor could be used by waving your hand, walking closer to the device, or pointing the device in different directions.

All sensors display a color that relates to the note being played. Colors are consistent among sensors. When a button is pressed, a square of color grows for the duration of the press. When a tone is triggered from the proximity sensor, the screen changes colors corresponding to the tone being played. Each color key on the touchscreen corresponds to a different tone that is played when the screen is tapped.

5 RESULTS AND ANALYSIS

The second prototype conforms to the following established design considerations from Section 4:

- **Versatility:** Various sensor shields have been integrated as seen in Figure 2. These sensors cater to different abilities and populations and can be used in various clinical settings. With the hope of catering to various abilities of movement, the device can be used with gentle taps or harder presses, large gestures or small movements. In the future, more interaction shields should be developed to encompass a greater span of user abilities.
- **Form factor:** The device is 13cm wide and can fit in a handbag or backpack, as specified by Interviewee 4. It is rechargeable with a standard micro-USB (android) cable
- **Ease of Use for Therapist:** Sensor shields which pop on and off when needed and don't require any other setup make the device straightforward to use. A therapist simply has to turn the device on for it to begin working. Further testing remains to be done with the design population to monitor their usage success.

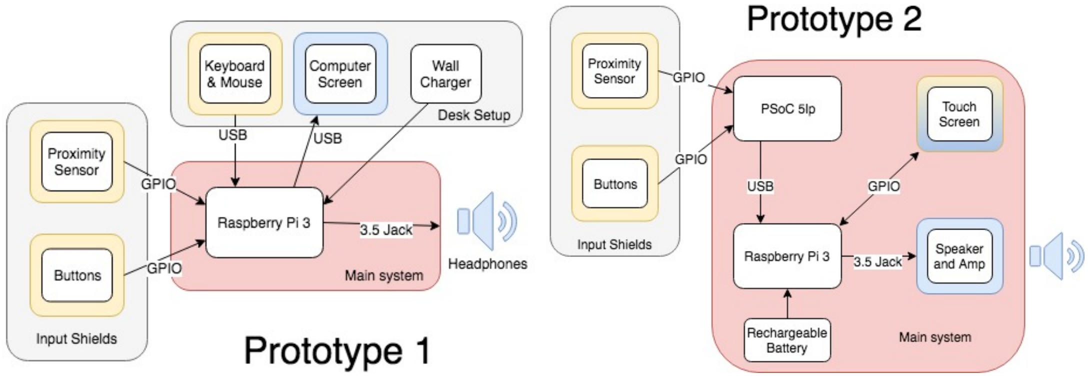

Figure 2: Block Diagram for Music Therapy Device prototypes 1 (left) and 2 (right). Blue indicates output, yellow input.

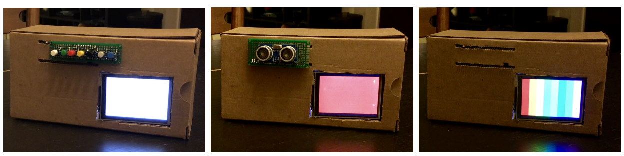

Figure 3: Prototype 2, pictured in three different modes. Button, Proximity, and Touch (from left to right)

- **Standalone:** The use of this device is independent of location and does not require additional peripherals. It can be used on its own (touch screen) or with the various provided sensors. The battery life of this prototype is about six hours continuously running, twice the length of the longest therapy session duration found in the interviews. This is important for use in locations with limited facilities.
- **Data collection:** Data on the length of use of the system and activity are taken, but further studies with music therapists need to be held for the usefulness of this type of data. More meaningful physiological sensory data could be implemented in the future for a more well rounded understanding of use.

5.1 Evaluation of System by Therapists

The system was evaluated by a group of 8 music therapists. A video recording of both iterations of the device in use was sent to these participants and they recorded their thoughts in a questionnaire. Participants indicated interest in this device's further development and 5/8 indicated that they would like to incorporate this device into their music therapy sessions. From these questionnaires, we found that therapists found it "easy to use." In the future they would like to see a more aesthetically pleasing prototype. As it stands, the the device is fairly bare-boned and might not feel friendly in a therapeutic environment. One therapist noted that "children would be very intrigued" by the use of this device in clinical practice, and another suggested "larger interfaces" for elderly populations.

6 CONCLUSION

Music therapy can connect communities, strengthen mental and physiological wellbeing, and provide new means of communication for individuals with phonological, social, language and other communication disorders, and various musical technological advances can help in automatic, recording, and analyzing music therapies. However, very few music therapists utilize a significant amount of technology in their practice, partially due to lack of familiarity of technology and partially due to the complex technology that discourages music therapists from using it.

In this paper, we have discussed the needs of the music therapists and developed several prototytpes of a device to fit them. By keeping music therapists involved in the design process we believe we were able to create a prototype that closely met the needs of therapists from various countries, music therapy practices and backgrounds. The takeaway that resulted from our interactions with music therapists is that while the design features of a useful music therapy supporting device vary wildly, there are some commonalities that contribute to the usefulness of the device, and those are:

- Versatility: The device must be useful for a variety of users with varying cognitive and motor abilities.
- Form factor: The device must be portable and small enough that it won't require a specialized transportation and carrying arrangement.
- Ease of use: The device must be usable with very minimal training for music therapists with diverse technological exposure levels.
- Standalone: The device must not require additional devices (e.g. a laptop) to run.
- Data collection: The device must be able to collect data that the therapists consider useful.

It will be worthwhile, in the near future, to continue exploring these preliminary findings and to conduct a more rigorous study on the usefulness of such a device. Testing the device "in the wild" with therapists in their day to day practices will be necessary in validating these early findings.

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