Active Listening: Encouraging Sound Awareness Through Tangible Sonic Toys

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ABSTRACT

This paper explores how sound-based tangible toys can encourage children to engage with sounds in their environment through active listening and collaboration with their peers. Twenty-eight children, aged 3 to 4.5 years old, explored sound in their environment through three toy prototypes. One toy focused on hearing sounds in relation to their environment; such as traffic and children playing. Another toy explored the recording and playback of their own sounds, being "caught" in a racket and blown out. The third toy explored a combination of shaking in sounds, stirring them to manipulate them, and pouring the mix out. This project uses a mixed-methods approach and is presented as a step towards further studies comparing toys with different approaches to sound.

CCS CONCEPTS

• **Human-centered computing, Human computer interaction (HCI), Interaction devices, Sound-based input / output**;

KEYWORDS

Tangibles: Sound: Children: Active Listening

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1 INTRODUCTION

Sound is an important design feature in toys. We often see toys that include background music, button triggered sounds, or are designed as instruments [16]. Yet, we rarely see toys that are specifically designed to encourage a child to actively listen to environmental sounds in different ways, outside of musical training. This paper explores children's experience of sound through the lens of active listening. We use the term active listening to mean 'listening with attention' to details within the sound, or in how sounds in the environment relate and contribute to the overall sound [15]. Children are naturally active listeners. Such ability directly aligns with their perception of the affordances of sounds as information within their world. R. Murray Schafer, while promoting the term "acoustic ecology", passionately discussed the deterioration of listening skills in children. We align ourselves with Schafer's belief of the importance of listening as inspiration to design sound-based toys [19]. We have designed three prototypes to observe how toys may support the child's process of exploring/learning the relationship between sounds and their personal agency, their experience of their environment, and their relationships to people around them. Our current work frames this interest by asking two questions: 1) Can we encourage young children's awareness of sounds in their environment? 2) Can we encourage the sharing of their experience with peers and teachers? We explore this project as a step towards further studies comparing toys with different approaches to sound. This paper presents our design process and a mixed-methods evaluation of 3 toy prototypes.

2 THEORETICAL BACKGROUND

When looking at playful and social experiences with sound, music is often used as the platform for the experience. By learning to hear different instruments in a piece of music, a child can develop an understanding of sound structures and how the child can contribute to the structure through their voice or instrument [18]. Listening skills include the ability to separate as well as combine sounds, developing skills of locating sound spatially as well as associating sounds with environmental or physical attributes such as distance, weight, material, and size [7]. Children learn cultural associations such as HAPPY IS UP, SAD IS DOWN and will apply these in their exploratory play with new toys and environments [2]. Lakoff and Johnson refer to these associations as orientational metaphors [11]. For example, BASS MUSIC is HEAVY, or LOUD SOUNDS GET IN THE WAY [3]. In these ways, children learn language metaphors which support and guide their understanding and experiences with sound.

One aspect of a child‘s interaction with sound through toys is the impact (or agency) the sound affords them in their environment [8][12] and in earlier studies we have categorized three levels of sonic affordance [6]. First, a simple button or trigger such as can be found on the side of a truck suggests being pushed to trigger a motor or siren sound [10]. A second level is what the making of the sound affords. The noisy toy can afford the child new agency in their environment such as the gaining of attention by repeated triggering or nuanced playing. The third level of affordance focuses on the sound as information or feedback. Gibson discusses the notion of active and passive touch. For Gibson, this is the difference between touching an object as a way to feel it and gain information or too touch as a byproduct of holding [8]. We may infer a sonic equivalent in the experience of actively attending/ listening to a sound vs. passively letting sounds fade into the background [9].

Projects that focus on active listening and social engagement through sound includes Our Little Orchestra by Browall and Linquist. This work explores how children collaborate with sound in technology in ways that would not be screen, panel, or mouse-based [5]. Blipblox Audio Exploration Module is a kid‘s synthesizer for encouraging play with electronic music [1]. MusicPets designs plush toys for children to store audio in a DJ-like scenario [17]. Projects that explore sound play in toy and tangible design include TouchSound, a bracelet that generates sounds when the wearer touches other objects and can control the pitch, volume, and tempo [13]. BuildaSound is comprised of 25 large foam blocks with images on them that can be configured, smashed, thrown and played within any way and will compose sounds through computer vision of the block organization [14]. The Moving Sounds project explored tangible prototype design concerning how children understood metaphors of sound relating to pitch, volume, and tempo [4].

3 TOY DESIGN PROCESS

We developed three prototypes of sound-based toys based on our observations of 2.5-4 year old children playing with traditional toys in prior work [6]. Our prototypes focused on encouraging children to consider sounds around them as a tangible object to explore and share with their peers. We designed toys using as iterative process to be interactive, to have a leveraged engagement from other commonly existing toys, and required motor engagement beyond pushing a button. The build of each toy used Bluetooth speakers with microphones embedded into the toy to center the emitting and collecting of the sound at the toy. Each toy was networked to a laptop running Max/MSP patch, designed to provide the interactions for including playing, recording, and manipulating sounds.

The Sonascope is a short, straight tube inspired by a telescope, which incorporates the metaphor of isolating a sound and bringing it 'closer'. The interaction of pointing in different directions is analogous to a parabolic microphone; however, our 'wizard-of-oz' design avoids the limitations and inherent noise of an actual mic while affording us new abilities such as being able to point at objects through windows or beyond the child's sight while still in their environmental awareness (eg. a playground at the end of the street). The Sonascope played pre-recorded sounds related to area of the daycare facility, for example sounds of babies were North, street sounds were Northwest, playground sounds were South.

The Butterfly Racket leverages the activity of playing with butterfly nets and bubble wands. The base interactions included waving the racket to “catch” a sound, and then blowing on it to “release” the sound. We chose these actions to support a novel way that a young child might try to catch and remove something very light from a net. When the child waves the racket, the microphone records the nearest sounds. When the child blows on the racket, the recorded sound played back through the speaker.

The Mixing Pitcher is made from a typical mixing pitcher for holding liquids, and is used by speaking into the pitcher (recording sound) or "shaking in" sounds. The shakers produced a shaking acoustic sound while triggering a sound from the files in the software. Once a sound is "added" in the pitcher it may be stirred to change the tempo (fast or slow). Even after pouring out sound, more sounds can be added or the pitcher dumped and the process can start again.

Figure 1: Racket, Pitcher, and Sonascope Toy Design

4 STUDY DESIGN

Protocol

The first session had 12 participants (8 male, 4 female) aged 3-4 years. The second session had 16 participants (7 male, 9 female) aged 4-5 years. In total we had 28 participants, 54% male, 46% female. The authors performed the study as an open play session at a daycare facility. Sessions started and ended by talking about what kinds of sounds could be heard. The protocol of the study was consistent in each session; the Sonoscope was first to encourage an engagement with the sonic environment, the Racket was second to encourage agency, and the Pitcher was third to explore layering. This study focuses on the possibility of sound-based toys enhancing awareness of environmental sound before comparing these designs to traditional sound toys, and extends prior work observing children with traditional toys [6]. We acknowledge the challenges of studying interactions in a group setting, and decided that focusing on solely the new toy prototypes would give deeper feedback at this time. Video recording was not allowed by the daycare facility. The children's responses were collected and qualitatively analyzed through open coding.

Findings: Quantitative Results

The recorded time duration for the interactions provided data for the child's the length of focus with each toy (see Table 1). We also timed the duration the class as a whole remained interested in each toy (see Table 2). We found that on average, the length of interaction time was dependent on the size of group that was engaging.

Table 1: Total Time of Engaged Play with Sound Toys

Toy	Total Time in Session 1	Total Time in Session 2
Sonascope	20 min	18 min
Racket	17 min	21 min
Pitcher	23 min	18 min

Table 2: Average Time Instances of Engaged Interactions with Sound Toys

Toy	Solo	Small Group	Large Group
Sonascope	1.5-2 min	3-5 sec	3-5 sec
Avg Instances	1-2	20+	20+
Racket	1.5-2 min	3-5 sec	2-4 sec
Avg Instances	1-2	20+	20+
Pitcher	30 sec-1.5 min	3-4 min	4-6 min
Avg Instances	5+	5+	5+

Children tended to interact in three different ways: solo with the toy, in small groups (2-4 children), or in large groups (8+ children). In large group interactions (see Table 2), many children had very short, direct interactions with the toy but passed it around or shared their sound with others. This process resulted in the average time each child spent with the toy as 2-3 seconds to listen to or speak into the toy, listen to its playback, and share it with another. The sharing repeatedly around the group meant the interactions could go on for up to 10 minutes of constant, short, interactions with 8+ children simultaneously.

Small-group interactions happened between 2-4 children, where the interactions (of the one child) were about the same length of time as the large group (2-3 seconds) as the children repeatedly shared the toy. Individual children would join and leave the group while the overall number stayed the same. A small group would exist for 2-4 min. Children explored more alternative and creative ways to engage with the toys, and did not repeat gestures as much. Solo interactions happened when a single child got the toy, and had a longer time to explore it without interruptions from others. These interactions could have the individual child engaging with the toy for minutes on their own. The mixing pitcher was different, as there were fewer and shorter solo interactions, and fewer and much longer small and large group interactions.

Findings: Qualitative Observations and Results

Pre vs. Post Session Briefing. Each session began and ended with a brief discussion of what the students heard; on their way to school or in the moment. Before the session some focused on loud sounds while post session included more nuanced sounds such as the neighbouring rooms. All the interactions and sound designed into the toys were mentioned as favorites. In both sessions all children raised their hand when asked if playing with sound was fun, and again when asked if they wanted to listen to their environment more.

Themes reflected in the Sonascope. The Sonascope was designed as a tube, to be pointed in different directions to simulate the hearing of distant sounds in those directions. *Actions* in large groups were more typical and would be repeated by many children (such as yelling "hello" into the speaker while taking turns, and doing this over and over for up to 8 minutes). In smaller groups the gestures varied more and there was less repetition between children (such as one child looking through the end, and the next child showing a sound to a teacher). Additional actions included looking into it like a telescope, dropping it when it first made sound (out of surprise), or yelling into it to engage with the sound. *Sharing* included children trying to listen simultaneously (such as one on either end), passing it around a group with turn taking, holding it for teachers to hear, or pushing the toy against the glass to the other room for them to hear. Children *recognized* sound by yelling out "its a listening toy!", or defining the sounds they experienced (note misidentification was still considered a recognition action). Children were surprised that the sound changed unexpectedly.

Themes reflected in the Butterfly Racket. The racket was designed to be swooped to catch and record the sound, and blown in to play the sound back. *Actions* included blowing into the speaker, shaking the racket, holding the speaker to their ears, and putting their heads through the racket (catching their friend). Similar to the Sonascope, in large groups the gestures were more typical and would be repeated by many children (such as blowing into the mic while taking turns). In smaller groups the gestures varied and there was less repetition between children (such as one child telling secrets, and passing it to another child to listen). Observed *sharing* did include taking many repeated but very short turns, which would be expected when told to share. However, sharing developed into intentional acts of including friends, such as: showing the sounds to others, one listening simultaneously while another was singing, and one telling secrets to the racket and then giving it to another child. Observations of *sound recognition* with the Butterfly Racket included repeatedly yelling hello, or making funny noises into the mic and telling others "that's me!". The children also started playing with how they made sounds, such as yelling while moving the mic. They recognized that it was their sounds, particularly when telling the racket "secrets" meant for their friends.

Themes reflected in the Mixing Pitcher. The Mixing Pitcher was designed so that sounds could be recorded and "added" into it, stirred, and the mix could be poured out. *Actions* included listening to the stir stick, stirring, shared stirring (up to 10 kids simultaneously), adding sounds with shakers, just shaking shakers, pouring it all out, asking to put more sounds in, putting the pitcher on their head, and putting other toys into the pitcher. In large groups the gestures were attempted simultaneously by many students (such as the group of 10 children holding the stir stick and stirring for 3 minutes). In smaller groups the gestures varied more and there was less repetition between children (one child was dropping toys in, another put the pitcher on their head, another was whispering in, all while taking turns for 5 minutes). As with the other toys, *sharing* involved taking turns, but also included working together to stir, holding the pitcher for others to hear, and asking a friend to add more sounds. *Sound recognition* included individual sounds but also noticing when there were many vs. few sounds, listening to single sounds or pouring it out to hear all of it ("That is all the sounds!").

Discussion of Themes and Observations

One objective of the study was to explore how toys may encourage *active listening* of children, to recognize and engage with their sound environment. The observations show that all the children did engage with the toys as "listening" or generally sound based toys. This basic level of recognition was reached by all the toys. With *friends*, when the children played with toys that incorporated a mic, the children were observed recognizing the sounds of their voice, the voice of friends and other sounds they recorded. However, identification of *environmental* sounds was less apparent. The misidentifying did not hamper their engagement in the toy, but may have contributed to the observed inability or lack of interest in recognizing the sounds as part of a whole environment. When mixing sounds, students acknowledged individual sounds and what they had done but did not discuss the mixture as an environment.

The children all easily *shared* their experience and often their sounds through the objects, by taking turns or passing them back and forth. Children were very engaged with the concept that sound could be manipulated like an object, either while they recorded it or when mixing. However, children did not hold to the *metaphor* as much as they responded to the affordances of the toy. When using the Sonascope, children invented their own (unprompted) interactions based on the *affordances* of the tube: listening on both ends simultaneously, looking into it, attempting to squish the center. These were all actions which focused on listening to and sharing sound experiences but ignored the affordance and design metaphor of pointing to sounds in a extended sonic environment and favored the social affordance for sharing.

5 CONCLUSION

Children are constantly learning new skills by experiencing and exploring their world. Based on these ideas we ask the question: Can we encourage young children‘s awareness of their sonic environment and encourage social listening by designing sound toys that highlight or isolate sounds from that environment? We presented a study using three sound toy prototypes. We observed children from two classes at a daycare (ages 3-4.5) engaging with the toys spontaneously as individuals, small groups, and large groups. Novel actions that created surprise were very engaging, and different ages had different approaches to agency and interest in exploring the affordances of the toys. We found that many aspects of the toys' design seemed to encourage the sharing of experience with the sound and social play with the sound objects. We observed that though the children did not engage with the toys using the environmental metaphors such as pointing to locations for sounds or constructing soundscapes, the sessions did result in students reporting more awareness of the sonic environment. Overall the toys held interest with the children and illustrated new experiences with sound and listening, as indicated in post-session discussions. Future studies will compare these prototypes with traditional sound-based toys (such as pots and pans) and music-based toys to bring better understanding to the design elements that support the development of a child's sonic awareness.

6 SELECTION AND PARTICIPATION OF CHILDREN

The study was held at a daycare center with the consent of the director, where classrooms were selected to host the study based on their age group. The parents of children in those classrooms signed consent forms, and the researchers followed a minor's assent script to ask children for their consent to engage. Researchers regularly told children that they did not need to participate and could end their engagement at anytime, and no one would be mad at them. Researchers also watched for nonverbal cues to indicate their continued consent. The study was held in an open play format so that children were allowed to play with other toys at any time or refrain from engaging by moving to a different part of the room. Even though parents consented to video recording (and were told that data would only be accessed by the researchers and kept in a secure location), no recording of the sessions was allowed by the daycare center. The only data taken were handwritten notes which used no direct identifiers.

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