BodyBeats: Whole-Body, Musical Interfaces for Children

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Abstract
This work in progress presents the BodyBeats Suite—three prototypes built to explore the interaction between children and computational musical instruments by using sound and music patterns. Our goals in developing the BodyBeats prototypes are (1) to help children engage their whole bodies while interacting with computers, (2) foster collaboration and pattern learning, and (3) provide a playful interaction for creating sound and music. We posit that electronic instruments for children that incorporate whole-body movement can provide active ways for children to play and learn with technology (while challenging a growing rate of childhood obesity). We describe how we implemented our current BodyBeats prototypes and discuss how users interact with them. We then highlight our plans for future work in the fields of whole-body interaction design, education, and music.

Keywords
Tangible interfaces, children, whole-body interaction design, learning, instrument, play, patterns, music, health

ACM Classification Keywords
H.5.2 Information interfaces and presentation (e.g., HCI): Haptic I/O, Prototyping, User-Centered Design.

Introduction

The BodyBeats Suite project represents our effort to design and build tangible, electronic interfaces for children that incorporate play and whole-body physical activity while helping children recognize, mimic, and create patterns. Currently, many children learn about patterns through visual and auditory activities (such as singing along to songs). By developing prototypes, we seek to expand the possibilities for combining pattern learning and physical play. The three electronic instrument prototypes in the BodyBeats Suite provide multiple means to explore patterns through whole-body activity. Now, in addition to seeing and hearing patterns, learners can experience patterns through their own body movements.

We are exploring ways to demonstrate that the technology often cited as a contributor to childhood obesity [4], [9] can be used to create compelling, whole-body, physical and social interfaces that encourage children's play and learning while providing healthy exercise. To this end we have combined insights gleaned from two lines of research: physical interfaces for children's play [1], [6] and musical interfaces for children [2].

In creating the BodyBeats prototypes, we began investigating how electronic instruments can engage young learners (and musical novices such as ourselves) in learning to make music. None of us are musicians (our background is in education and tangible interface design [5]); therefore, we agreed to design electronic musical instruments with a low barrier for entry (so that novices and virtuosos alike can begin creating musical sound patterns quickly). The following paragraphs describe how the prototypes we implemented afford novel interactions, incorporate play and learning through one's body, and complement the primarily visual and auditory computer interfaces used in education today.

BodyBeats: TrampleBeats, MixMatrix, and Ringalings

Our decision to design the BodyBeats Suite to support musical novices (users with a low level of musical expertise) in creating music, learning patterns, and playing using whole-body, physical activity was motivated by an unexplored design space for electronic musical interfaces (Figure 1).

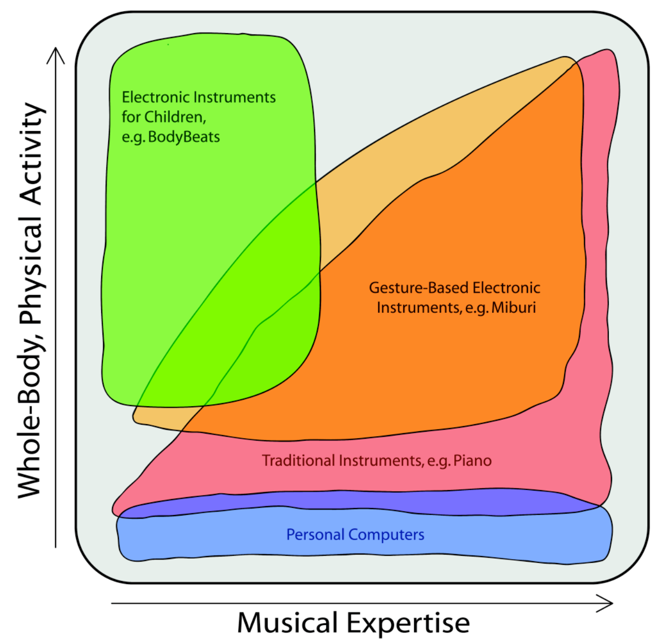

Figure 1. Design space for musical instruments.

A preliminary review of existing electronic musical instruments suggested that few have the quality of promoting a high level of whole-body, physical activity while requiring minimal musical expertise.

Our design space maps musical instruments along two axes: whole-body, physical activity and musical expertise. Traditional musical instruments (e.g. pianos or guitars) are designed for precise interaction; players usually require a high level of expertise with their instrument before they are able to play them well, while being very physically active. Newer, gesture-based, electronic musical instruments (e.g. the Yamaha Miburi [10] or Michel Waisvisz's The Hands [8]) are similar to traditional musical instruments in this respect, though different in the way that they create sound.

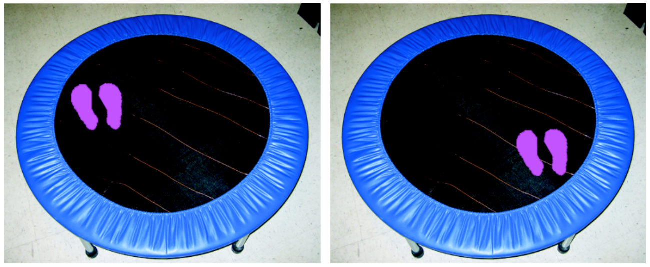

Figure 2. TrampleBeats. When the user lands on the surface of TrampleBeats different locations will trigger different tones or sounds.

BodyBeats is a suite of three electronic instruments that represent our exploration in interaction and creating musical sound patterns. The first electronic instrument prototype is TrampleBeats (Figure 2), a small trampoline augmented with electronics capable of transforming the sound of jumping into the sound of a beating drum. TrampleBeats is a body-scale instrument (i.e., the whole body is used in the interaction) that requires aerobic activity to play. To use TrampleBeats, a user jumps on different areas of the trampoline surface—each jump causes different pre-selected (or recorded) sounds to play through computer speakers.

MixMatrix (Figure 3) is a sheet of push-pads that occupies a large portion of one or more walls in a room and acts like a large step-sequencer. (similar to software step-sequencers such as the Fruity Loops [3] program). To use MixMatrix, one or more users extend arms (or heads, etc.) to press and hold one or more push-pads. As a computer continually scans (from left to right) to discover depressed push-pads, each push-pad pressed during a given scan generates a unique pre-selected (or recorded) sound thus creating musical patterns.

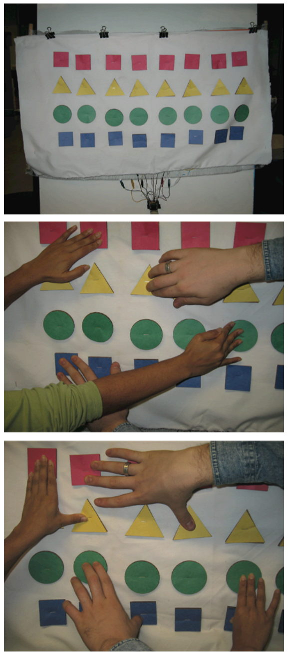

Figure 3. MixMatrix. Multiple users can create more complex sounds.

Ringalings (Figure 4) is a set of accessories worn on the body that trigger recorded sounds in response to customizable gestures. To trigger the sounds, users shake their wrists (and sometimes also shake additional, non-instrumented body parts). Our initial

Figure 4. Ringalings. Different body positions trigger different sounds.

implementation features bracelets; however, we plan to incorporate extra accessories such as belts and anklets.

To differentiate our instruments and explore variations in whole-body interactions, we moved the locus of interaction from the body-scale TrampleBeats interface (beneath the users' feet) to the room-sized MixMatrix (on the wall). For Ringalings, we switched the locus of interaction from the users' environment to their bodies. Ringalings provides a body-as-instrument, gestural interface.

Implementation and Interaction

Each prototype in the BodyBeats Suite uses the Scratch [7] programming environment to translate sensor data into synthesized instrument sounds and trigger pre-selected or recorded audio. Each prototype is connected to a PC running Scratch through a Scratch sensor board.

TrampleBeats produces different sounds depending on where the user's feet (which connect to a ground wire) come into contact with the trampoline's surface. Users can program in Scratch to make these sounds correspond to different pitches for a single instrument, or multiple instrument sounds.

Users play TrampleBeats by jumping on it and landing on different points along the trampoline surface, thus triggering different sounds. The trampoline surface is 100cm in diameter, suspended by 36 steel springs. A Nickel Chromium (NiChrome) wire changes resistance depending on where the user's feet contact it—different numerical values associated with this varying resistance can be programmed to trigger different sound events. Six copper wires lay across the NiChrome wire and each corresponds to a different resistance value, thus they act like frets on a guitar.

TrampleBeats is designed to support structured play, where the user follows a set pattern of cues; and less-structured play, where the user can explore variations in sound and jump independently of set patterns. Our plans for future versions of TrampleBeats are to add more sensitive, low-profile sensing mechanisms as well as lights. The lights could illuminate sections of the trampoline surface, cuing the user to create set patterns of music, or leading the user in a "follow the leader" game mode.

MixMatrix is a room-sized step-sequencer. Users play this prototype by pressing the colored push-pads on its surface and listening to the resulting patterns of looped sound. Similar in design to software step-sequencers, MixMatrix controls loops of sound with 32 7cm push-pads arranged in 4 rows of 8. Each row corresponds to a different percussive sound (based on the unique resistance value of each push-pad).

We designed MixMatrix to encourage multiple users to collaborate. Though advanced users are free to modify how MixMatrix behaves, our prototype initially plays sounds only while a push-pad is depressed. Therefore, to press more than 4 or 5 push-pads at a time (assuming users don't employ their feet) multiple users must play together. Our implementation of MixMatrix measures 80cm long, though we envision future iterations to occupy a larger space on one or more walls and utilize more push-pads capable of producing more complexly layered sounds. Future implementations of MixMatrix could include projected displays allowing users to manipulate the sound to a greater extent, as well as bringing the input and output from the system closer together.

Where TrampleBeats and MixMatrix are instruments one plays with his or her body, Ringalings turns the body itself into an instrument. To play Ringalings, users first link sounds to body positions and gestures (currently using the sound features of Scratch). Then, users recreate gestures to trigger associated recorded sounds.

Our prototype is composed of two bracelets for each arm. One stationary bracelet contains a reed switch that connects a circuit in the presence of a magnetic field. The second bracelet moves freely on the arm and is lined with magnets. Currently, users move their bodies and arms to manipulate the bracelets in order to trip the reed switch sensors that trigger sounds to playback in Scratch. Future iterations of Ringalings prototypes will place record and playback functions inside the bracelets. In order for the system to sense more complex gestures, we will explore additional accessories with more sophisticated sensors. To keep our interactions simple, we will avoid the complex issue of mapping gestures to audio output in favor of allowing users to generate their own gestures that link to customized sounds.

Educational Objectives

In this section, we explore the formal learning objectives of the BodyBeats Suite. A key goal of BodyBeats is to help children explore patterns on two levels: close learning and transfer learning. The first level, or "close learning," is the recognition, mimicry, and creation of patterns in sound. The prototypes provide children (and interested adults) with direct experience in manipulating beats and rhythms. As children jump on TrampleBeats, they begin to associate patterns of jumping with patterns of sound. Through Ringalings, children associate moving their limbs with specific sound sequences. Children using MixMatrix can see and feel how holding their arms in various positions corresponds to repeated loops of sound.

The second level, or "transfer learning," refers to the more ambitious goal of helping children hone their ability to recognize, mimic, and create patterns *beyond* sound. Identifying and manipulating patterns is a fundamental skill required for a wide variety of learning, including reading and math. In school settings, children typically examine patterns through visual symbols and auditory activities. For example, students will learn the sound that "at" makes, and through a combination of written and verbal exercises, will learn how to read "rat," "sat," "bat," "cat," and "hat." If these students were wearing Ringalings, they might draw their hands close to their chests to pose like a rat and cause a computer speaker to emit the word "rat." If a student extended an arm in a scratching motion, they might trigger a computer to playback the word "cat." A student flapping their arms to mimic flying could hear "bat." The students learn about the same sounds but use more of their bodies to create their own patterns. We expect that this new avenue for learning through one's body will provide a novel way to sharpen children's fundamental ability to recognize, mimic, and create patterns.

Conclusion

We have presented BodyBeats, our ongoing exploration of electronic instrument design. We have described how our prototypes afford whole-body interaction and opportunities for learning music and patterns. We have also highlighted research areas that we would like to address further such as play, learning, and tangible interfaces for the whole body.

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