

TSI (Teething ring Sound Instrument): A Design of the Sound Instrument for the Baby

Naoko Kubo*, Kazuhiro Jo, Ken Matsunaga

Science of Sound Culture
Kyushu Institute of Design
4-9-1 Shiobaru

Minami-ku, Fukuoka 815-8540 JAPAN

Tel: +81 92 553 4400

E-mail: nkubo@lifedesign.co.jp, kjoe@acm.org, it3k-mtng@asahi-net.or.jp

*DAIICHIHIKO Co., ltd.

ABSTRACT

In this paper, we will describe the TSI (Teething ring Sound Instrument), a new sound instrument given to babies, which consists of a teething ring, a knob, an I-CubeX Digitizer [1] and a computer which processes MIDI messages. The TSI is designed to bring music experience to baby with the movement of the babies reflex sucking motion. We provided the TSI to a baby and observed her action to the TSI and her reaction to the generated sound. This experiment showed the high potential of the TSI.

KEYWORDS: Baby, sound instrument, interaction, pressure sensors, teething ring, sucking motion

INTRODUCTION

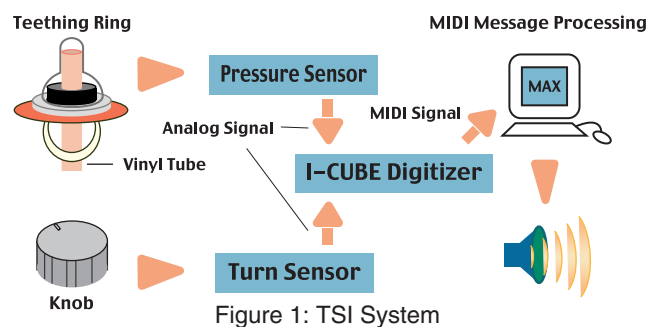
The instruments which stimulate the sense organs of a child using sound are GaraGara, Poppen, xylophone, harmonium, etc [2]. Above all, the Japanese traditional sound instruments, GaraGara and Poppen, are usually recognized as both musical instruments and toys, and only a single sound can be enjoyed in elementary operation such as by shaking or sucking [4]. By contrast, though it is possible for musical instruments such as harmonium and xylophone to produce melodies, rhythm, and harmony, training is necessary, and it is difficult to produce a musical performance by babies who have immature knowledge or ability to play. The baby is able to perceive the change of the melody and the rhythm, and distinguish the consonance dissonance [5]. The TSI is designed as a new sound instrument for baby. It stimulates baby's faculty of perception, and brings musical experience to baby with underdeveloped sensory motor-control functions.

TSI SYSTEM DESIGN

The target age of the TSI is 0-3 years. The features of the TSI are described below:

1) Children from birth to 3 years old in the sensory-motor stage, develop the faculty of recognition by interacting with the outside world [6]. By playing with the TSI, various structures such as musical concept and causality are sensuously acquired. Use of the TSI also stimulates the development of sense organs and faculty of perception.

2) In order to enable the baby to have a musical experience, the sucking motion from the prenatal period is utilized.



Hardware

The TSI system consists of a teething ring, a knob, an I-CubeX Digitizer and a computer. The teething ring uses a nipple made of silicon. It is connected to a pressure sensor in a vinyl tube. The pressure sensor detects change of the air pressure in the tube when the baby is sucking the nipple. Taking safety into consideration, by lengthening the tube, the electric system is at a safe distance from the teething ring. The knob uses a turn sensor that consists of a variable resistor. The analog signal, which is detected by the pressure sensor and the variable resistor, are converted into MIDI messages by the I-CubeX Digitizer, and transmitted to the computer. In the computer, a MAX [3] processes the MIDI messages and generates the sound.

Software

We are designing the following applications using MAX: *Harmonic* and *Melodic*. Each application of the knob's turn angle corresponds with 5 kinds of tone color patterns.

Harmonic

This consists of a "basic part" and an "expansion part". Pitch corresponds to the change of the sucking pressure. When the teething ring is strongly sucked, a higher note rings. The "basic part" consists of a simple 3 note C-major chord played melodically in the form of a simple musical scale. This is something the baby can identify and enjoy. In the expansion part, the note changes with every suck. When the sucking motion is repeated, ascent, descent are repeated. The change of the notes can be enjoyed even by the reflexive sucking motion. Therefore, this is ideal for use from the baby's initial stage of growth.

Melodic

This application is intended for the young, somewhat cultured child accustomed to a certain degree to Western tonal music. When the baby begins to suck, a melody with a simple rhythm made on the basis of tonality structure of the Western tonal music begins to sound and stops when the sucking motion is finished. The target age of *Melodic* is over 1-year-old. This is the age when the tonality schema acquired so that the perception of a rhythm or a melody can be performed pertinently.

INTERACTION

When a child grows and develops cognitive abilities, interaction with the outside world is very important. The TSI encourages interaction between the parent and baby by dividing the operation into the teething ring and the knob. The tone color of the notes, which were sounded by the baby, is altered by the parent turning the knob. In this way, the interaction of parent and baby is produced, presenting an opportunity for both to connect with each other through the mutual creation of sound.



Figure 2: Example of the TSI Interaction

DISCUSSION

We provided *Harmonic* to a female baby of 9 months and her parents. In the beginning she held the teething ring in her mouth while barely sucking. However, through the encouragement of her mother, the baby gradually became accustomed to the teething ring and began sucking. After about 15 minutes, she noticed that the notes were being rung by herself. She gazed at the mother happily while

continuing to suck synchronizing her leg motion with the sound. Though it was not possible to say whether the baby noticed that the tone color changed while the father turned the knob, the baby seemed very happy with the musical interaction. By using the TSI, the baby was able to enjoy the musical experience of the recognition of the sound produced sound by her own voluntary sucking motion. This made it possible for the parent and baby together to enjoy the musical result. The TSI introduces a new form of interaction between parent and baby.

FUTURE WORK

We are considering various possibilities for the potential use of the TSI from the sucking stage. For example, as mentioned above, the TSI allows the babies the pleasure of producing sound by themselves. We feel that a sense of music expression can be cultivated if the growth of the baby can be encouraged through the use of the TSI. The TSI is designed on the basis of the structure of Western tonal music. However, in the future, by considering the natural sound of a particular environment, we intend to utilize other tone rows from different music systems. Tone rows such as the Indonesian perog musical scale and the Okinawa musical scale can also be incorporated thereby extending the range of the baby's perception. This can also encourage the development of other faculties of perception such as pitch sense, tonality and rhythm. We would like to focus on babies from various cultures such as Asia, Africa, and the West as subjects. By following and monitoring various children's growth, we want to observe the relationship between the effects of the TSI on a large number of babies in order to examine their perceptive abilities. On the basis of these results, we intend to develop various new applications of the TSI in the near future.

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