sssnake: a remote multiplayer toy for children

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Figure 1: The two sssnake prototypes

ABSTRACT

sssnake is a soft toy that allows multi-user play over distance as well as single users playing alone. It has a haptic interface and can connect children (especially during the COVID-19 pandemic) while avoiding the usage of screen-based media. It combines social interaction inspired from online gaming with a playful way to learn about music and instruments. We present a handcrafted prototype manufactured from e-textiles, wool and grape seeds. The sssnake prototype was evaluated in a user study with ten children aged between one and eight years. The study showed that online-connected soft toys can be an extension to traditional possibilities of socializing and play.

CCS CONCEPTS

• **Human-centered computing** → **User studies**; **Empirical studies in HCI**.

KEYWORDS

e-textile, soft toy, play, music, social play

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1 INTRODUCTION AND MOTIVATION

During times of a global pandemic like COVID-19, children in particular suffer from social distancing and the resulting isolation and boredom, which can negatively influence their mental and social development. The Copsy study [6] examined the impact and consequences of the COVID-19 pandemic on the mental health of children and adolescents in Germany. Compared with the year before the pandemic, more children stated that they perceived their quality of life to be reduced. In addition, psychosomatic complaints occurred more often, such as irritability, problems falling asleep, headaches, low spirits or abdominal pain. One of the likely causes is almost certainly the lack of social contact and group interaction that normally occur at kindergarten or school. To counter the lack of physical get-togethers, the motivation for sssnake was to provide a way of connecting and communicating with each other within the given contact restrictions. Beyond a pandemic, virtual communication is

a potential long-term application for other usage scenarios, such as separated friends and families, or for children who have to stay at home due to an immune deficiency or other illness.

Many screen-based media allow communicating over a distance, like video calls or social media. But for very young children these possibilities are neither appropriate nor recommended, [2] and an excessive use of computers, smartphones and TVs is linked to childhood obesity and associated diseases later in life [10]. Because of that, sssnake provides physical play and a haptic interface without a screen.

Making music is one of many approaches for combining learning with fun. Learning an instrument has many positive influences on children's development, [5] like practicing motor skills and getting a better understanding of music and musical theory. However, making music in a group or with a teacher has hardly been possible since the beginning of the pandemic. sssnake aims to offer children a simple and playful introduction to music under these circumstances. Two instances of sssnake can further be paired to play together over a distance.

Figure 2: The sssnake prototype

There are already many ways to initiate contact and maintain relationships over long distances. Some are very close to natural conversation and were already widespread before the pandemic, such as audio and video calls, while other ways of communicating are more abstract, such as CuteCircuit's Hug Shirt, [1] a shirt that uses sensors to transmit heat and heartbeat from one person to another, or various products for couples in long-distance relationships such as interconnected lamps or sex toys [4]. Here, a nonverbal interaction takes place between the two users of the product, which is also the approach sssnake takes with its design.

The combination of soft toy and musical play has been implemented in several products, such as the Mimi DoReMi. [9] Piano mats [8] combine music and movement while playing. WORM-E creates a playful approach for children to engage with the digital, facilitating the development of movement and motor skills [3]. There are also several examples of e-textiles used as musical input devices. Wearable textile sensors translate movement and gestural interactions into sound [7] and give the foundation for wearable instruments [11]. However, these applications are made for and tested with adult users, whereas sssnake particularly addresses children between four and nine.

This paper shows the prototype created, explains the practical and technical realization, and presents the results of a user study. The user study investigated how intuitively children from the target group are able to understand and engage with the concept of nonverbal communication over distance, and the playful and musical aspect of the prototype. The results indicate that the concept of nonverbal online communication can extend traditional ways of socializing and give opportunity to new ways of playing together.

2 DESIGN PROCESS

The goal behind the design of sssnake is to provide children with a way to play together despite the constraints of a lockdown. Therefore, the social aspect and design of communication between users was the main focus. Making music together, as in bands, orchestras or choirs, allows children who enjoy music to pursue this hobby together with their peers. In order to create the best possible approximation to these real-life examples, it is important that the prototype can be used well and intuitively for making music and that it is fun to play with, but also that online communication functions smoothly and does not interrupt play.

The most important questions that were to be answered by this research and the user study were to what extent virtual shared play can help children satisfy the need for social contact and shared play, and how connected one actually feels with the play partner and to what extent it can replace direct contact.

While designing sssnake, several non-functional prototypes were created, ranging from differently sized and colored snakes as well as using different techniques like sewing and knitting, to other animals such as octopuses. This helped to evaluate the visual design for the final prototype and to determine what size would be usable for children, which was decided through a mini user study. The snake-like shape was chosen because it fits the arrangement of the sensors.

3 THE SSSNAKE PROTOTYPE

The toy has the shape of a snake (Figure 1) and is interacted with via touch sensors located on the toy's surface (Figure 3). The sensors are arranged similar to a piano keyboard or a xylophone. There are several instruments and sounds available to choose from. As long as both paired snakes have an internet connection, they both produce the sounds that one of the users generates. Thus, a player hears what they play themselves as well as what the other person plays.

Playing with the toy is similar to playing with a real instrument, but the interaction goes beyond this: on the one hand, it is mobile and robust, easy to be lifted and moved. This enables physical play in addition to musical interaction. On the other hand, it is soft and flexible, which allows it to be used as a cuddly toy. Because of

its visual design, resembling a snake, it can be played with while ignoring its musical functionality and can be incorporated into play with other toys.

Available sounds include a variety of instruments to choose from by pressing the eyes of sssnake. The intention behind the sound design was to give creative freedom to children and take them serious as musicians. There are five melodic instruments: chimes, a sound similar to a synthesizer, a harp, a pipe organ, and a bass. There are also drums and percussion for rhythmic play and a 'snake mode', which, when activated, will make the toys produce snake noises. This supports playing with the toy as its animalistic counterpart. While it may at first seem counter-intuitive to press the eyes of a toy, this provides a clear distinction between sound-producing input areas and modality changes, thereby avoids accidental changes of sound during play, and makes use of elements that are on the sssnake's body anyway.

The body is made from wool and the outer layer is crocheted. This allows for more stability than a sewed soft toy because the cables can be knotted to the crochet pattern. The touch sensors are made from gold, silver and copper. The prototypes are filled with grape seeds, which is heavier than fiberfill or wool and makes the haptic experience more interesting.

Inside sssnake, there are three components: a Teensy 3.6 with a Teensy Audio Board, an Adafruit Feather Huzzah and an Adafruit 12-Key Capacitive Touch Sensor Breakout. They are protected by a 3D printed case (Figure 2). The Teensy is a USB-based development system for microcontrollers. As it contains a library for sound processing, it is especially suitable for audio projects and handles all audio-related tasks. The Adafruit Feather Huzzah has a Wi-Fi chip and handles the online communication with the other toy. It fetches the current status of the instrument from the other two components and sends it to the other toy, and, in return receives the other toy's status, which it forwards to the Teensy for processing. The Adafruit Capacitive Touch Sensor Breakout has 12 touch inputs. However, as the toy has 15 touch sensors, three of the Teensy's touch inputs are used in addition.

There are 13 touch sensors on the sssnake's body. Each represents a semitone in the octave. Two sensors are on the prototype's tongue. They are used to move one octave higher or lower. The eyes are push buttons to change the current instrument.

The communication between the two toys runs via Wi-Fi and simulates synchronous communication, similar to a phone call. When one child plays a note, its toy sends a message to the other toy, which in turn will also play the corresponding sound. There is no live audio stream, but the current state consisting of the played note and chosen instrument is encoded in a message, which allows for an almost immediate communication between the toys.

4 USER STUDY

In order to trial how well the communication across distance works compared to playing together in person, a user study was carried out. Two scenarios were tested: First, children played together in a room. Here they had the opportunity to understand the interface and try out the individual instruments. After about 20 to 30 minutes, they were separated and the WLAN connection between the toys was switched on, so they could play together while being in different rooms.

The timing was very flexible and largely left to the children themselves. They were given the freedom to speak up at any time if they needed a change in the game, if they wanted to continue playing, or if they felt like doing something else.

As this project was realized during the Corona pandemic, the evaluation phase overlapped with a partial lockdown in Germany, which made planning and execution difficult. Due to the restriction that no more than two households were allowed to meet, only siblings could be study subjects.

The study was conducted with ten children in total, five boys and five girls. The children were between one and eight years old. There were four sibling pairs, three of them were age five and seven and one of them age one and five, and the remaining two children aged three and eight played in a pair with an adult. Four children were from households that place a high value on early musical education, and had previous musical training such as playing an instrument or singing in a choir.

During the evaluation, particular attention was paid to how and for how long the children played with the prototypes, whether their utterances while playing were positive or negative, and how long it took them to understand the interaction. Many of the anticipated ways of playing could be observed during the study. For example, all children visibly enjoyed exploring the entire range of instruments and making music with them. They were jamming together and playing a question-answer or call-and-response game, where one child composes a melody and the other one has to repeat it. Some children also played with it like they would with a snake plushy and made use of the zoomorphic aspect of the design. More than half of the children asked if the user study would be repeated, and they could play with the sssnake another time at the end of their playtime. One of the mothers also reported that her son had mentioned it a few times afterwards and asked if he could play with it again.

The children also discovered possibilities of interaction that were not foreseen, but nevertheless worked. Three of the children used the mobility of the toys and held them like different instruments, like a guitar or like a clarinet, instead of just putting them on the floor. There was also great popularity of an interaction that involved stroking the snakes' bodies very quickly, resembling a glissando when playing the piano.

We found that those children that played in their children's room or on the floor found more creative and diverse ways of interaction than those that happened to play sitting at a table, where there was more hesitation to move the sssnake around. In two cases one of the children took a break from playing with sssnake, but then continued to interact with it after around 10 minutes.

It was also noticeable, that children with prior musical training found new interactions inspired by playing an instrument, while children without this training found new interactions with no relation to music, such as exploring what kinds of touching would activate the touch sensors or playing with the sssnake in combination with other toys. Children who already had experience with playing an instrument could repeat melodies more easily and were able to identify which instrument they were currently playing.

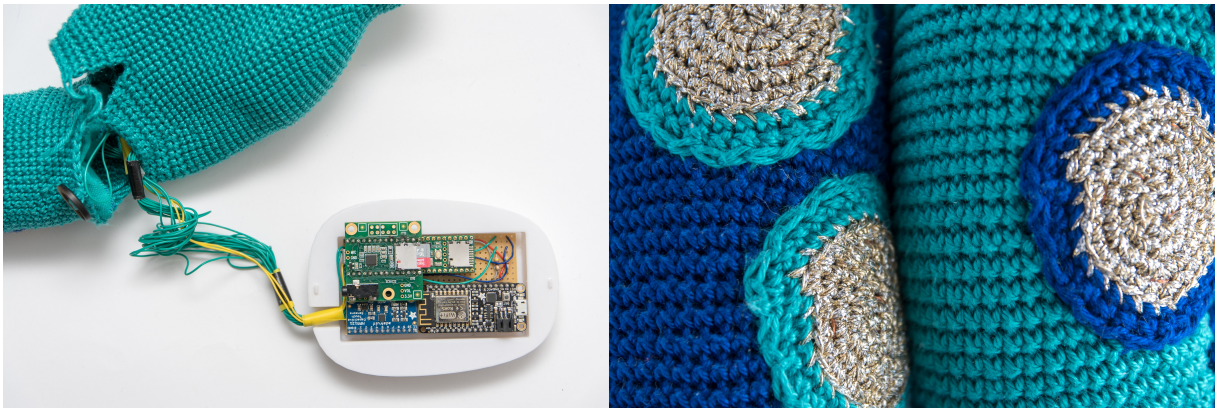

Figure 3: The technical components are located inside the head (right): a closeup of the materials used (photos by Elise Weiland)

Figure 4: A child playing with the sssnake during the user study

The user study was carried out mainly to find out how well the design of abstract online communication was received and what differences could be observed when playing together and separately. When switching from playing side by side to distant play, the children adjusted to the differences quickly and understood the concept well. Since real contact is essential when playing and virtual contact is only a substitute for it, the assumption was that playing together in real life is more fun. The social component proved to be very important and most of the children voiced that they preferred playing together in the same room. However, the children were open to playing together online and quickly understood that they could listen to each other and send melodies. This communication possibility was then taken up in the play activity. It further revealed creative new ways of interacting that would not be possible otherwise. For example, two siblings pretended to talk on the phone while sitting in different rooms.

5 CONCLUSION

sssnake is a haptic online multiplayer toy that enables children to play together regardless of any restrictions the pandemic puts on their ability to meet up and be in close physical contact. It adds to traditional means of long-distance communication by giving users a playful activity that can be done together instead of just talking or messaging. As the user study has shown, sssnake offers many positive qualities to its users by combining social play and learning.

Extensions of the prototype include adding a channel for verbal communication in addition to the musical play. This could make communication between players less abstract and would be closer to co-present play. This channel could be realized via a sampler function to send short voice messages, which could be incorporated into the music, or a video transmission of the respective users in parallel with the toy, for example via Skype or Zoom. These changes to the communication would certainly improve the concept. Furthermore, popular play patterns and musical education games, such as the call-and-response melody replay could be integrated into the software as an option, or a given rhythm for children to improvise over. For an initial prototype and its first evaluation, however, the idea has proven itself and provides a basis for further developing the concept.

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