Thesis project

Designing tangible musical interactions with preschool children

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Abstract

Many cognitive scientists agree that musical play is beneficial for preschool children. They consider music to be one of the most important means to promote preschool children’s learning potential. From an interaction design point of view, music provides opportunities to engage children in collaborative play which in return is beneficial for their cognitive and physical development.

I argue that tangible interaction can facilitate such collaborative and playful musical activities among preschool children and in the scope of this thesis, I explore how this can be achieved. Through the exploration of related projects in this area and my own design experiments at a preschool, I propose a design concept of a modular musical toy for children which I created and then tested in a preschool context with children of different ages. Along the way, I reflect on the peculiarities of children’s behaviors and the aspects of conducting design research with preschool children, since acknowledging these aspects is crucial for working with children as a designer.
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1. Introduction

1.1 Children, music and Interaction design

Children at early stages of development live in a world full of experiences, play and learning. Though their daily experiences children build up their view of the world. Interaction design is the science of shaping the behavior of the digital and physical world, as well as our relationships in it and with it. (Kolko, 2011, p.12). Involving users in the design process in order to understand their true needs and preferences is at the core of good interaction design practice. Children require a lot of attention as they are a very specific user group. In order to design good products for children, designers and design researchers should learn how children develop and what their needs are at different stages of their lives. I believe that applying Interaction design methods and techniques as a framework to work with children can help designers gain better understanding of children as a user group and develop appropriate design solutions for them.

Many cognitive scientists and educators consider music to be one of the most important tools to promote preschool children’s learning potential (Levinowitz, 1998; Sciencedaily, 2006). Among many other things music can boost children’s spatial reasoning (Rauscher et al. 1997, p.5), develop language skills, listening skills and encourages creativity. In this project I intend to combine music
singing and play to provide an engaging experience for children to discover their voices and auditory experiences. I am focusing on preschools as they are important institutions in which most small children spend a considerable amount of time, and in which they learn how to be social and interact with each other and adults. In addition, children attending preschools are at the age where it is essential to expose them to music (Levinowitz, 1998) and help them to overcome difficulties and social discomfort when they play music together.

1.2 Motivation

During the last two years my interest in tangible computing has grown vastly. Introduced by Hiroshii Ishii and Brygg Ullmer (1997) tangible computing merges the invisible world of bits of data with the physical world we live in. I fully agree that embedding computing in the everyday environment and in tangible objects can allow us to advance our lives with technology, yet maintain all the possibilities for rich physical interaction.

I believe tangible interaction is highly relevant for children. Small children reside in a world full of toys and other tangible artifacts. Children use toys or any other physical artifacts as their play objects through which they explore the world. Moreover, interaction with physical objects is essential to develop children’s fine motor skills, as well as cognitive abilities. Toys which are augmented with digital technology can introduce new opportunities for children to learn about the world.

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1 I will use music as a general term for any sound-related activities, which children are able to produce at preschool age, not necessarily melodic in its pure sense.
believe that tangible computing can enhance the environment of children in a non-obtrusive and healthy way.

The role of musical tangible interfaces for children seems to be underestimated in traditional musical program for children. In the guideline for integrating music into the elementary classroom (Anderson, 2009, p.128, p.180, p.269) all sections on technology mentions different on-screen aids and websites, but none of the available tangible musical aids. My research interest lies in combining both interaction design and tangible computing to find out how sound and physical objects can be introduced in a way which is engaging for children. Vygotsky and other cognitive scientists argued that children learn through play (Vygotsky, 1976; Piaget, 1962). In the context of preschool children, who constantly engage in playful activities to obtain new experiences, musical play is a natural way to introduce children to music.

Music is an embodied experience for preschool children - they react to music with their whole bodies (Levinowitz, 1998; Young, 2003, p.54). Tangible interfaces are known to support embodied interaction, as they allow computing to merge in the environment and make it embodied in the space (Dourish, 2001, p.102).

I believe that tangible interfaces and their embodied qualities supports children’s engagement in collaborative musical play, because they provide shareable experience through physical interaction. Tangible objects provide a social play-space for children, so they can learn how to interact with each other, how to play together, and how to share things. Unlike desktop computers and other personal mobile devices, tangible computing supports shared play and the environments in which it occurs (Stanton et al, 2002).

Music is very important for children’s cognitive development. Interacting with music helps developing social skills in children. From my own experience I know that often music education is often forced onto children - especially, in the formal musical school program. In preschools musical activities are presented more playfully, yet quite structured as an activity initiated by the teacher. It seems that there is a lack of informal musical activities which can be performed by the children themselves or together with the teacher. I believe that tangible computing can contribute to this topic. However, the intention of this project is not to teach children music and its concepts like pitch or melody, but to create a general interest in music and facilitate collaborative interaction.

In addition, I was confronted by two other issues, which challenged and at the same time motivated me to research the topic at hand for as part of my thesis work. Firstly, coming from another country (Russia) and conducting research in Sweden brought a language issue to the communication with my target group, because I don’t speak the same language the children speak. And secondly, being an adult I can’t freely talk to the children the way I talk to people of my age. As adults we should be very sensitive when doing research with children and try to understand the way children express themselves without imposing our own interpretations. I challenged myself to explore the intricacies of working with children who speak a foreign language and of how the language barrier influences the research process. Lastly, I was thrilled to be able to contribute to the ongoing
Rösträtt project, which is aimed at exploring new ways for children to engage with music, and collaborate with interaction design studio Unsworn Industries, and Living Lab The Stage at Medea, a media research center in Malmö, who are involved in Rösträtt too.

1.3 Research questions

Even though, it is not in the scope of this thesis to provide a solution for preschools to teach children music, I contemplate that engaging play activities with tangible musical objects can positively influence not only children’s musicality, but also their both physical and cognitive development. Using Interaction design methods in the design work can lead to new means for interacting with music, which can possibly be used in a preschool context as a set of educational tools. These thoughts steer towards the following research question:

How can tangible interfaces for making music and sound facilitate collaborative and playful engaging activities among preschool children?
2. Framing the design space

2.1 Rösträtt

This project builds upon the research findings of Unsworn Industries, a Malmö-based interaction design studio, and Erling Björgvinsson, associate professor in Interaction design working at Medea, carried out for the Rösträtt initiative (Malmö Högskola, 2011).

The aim of the Rösträtt project is to bring together preschool children, teachers, composers, rhythm educators, choir directors, and researchers in order to create a new framework for teachers to introduce preschool children to music and singing. It is a three-year project, which started in Skåne, the southern part of Sweden, and is aimed to spread across the whole of Sweden. The main agenda of Rösträtt is to renew the musical program in preschools with the hope for children to sing more. The project supports a right of children to influence the curricular of the music program at their preschools. No matter of the musicality skills or talent, every child can sing and should be proud of his own voice. Rösträtt explores new opportunities for children to interact with music in a way which is appropriate and easy for them. To find what these opportunities are Rösträtt actively involves children in the project. Moreover, the project team heavily studies the peculiarities of children’s voices, the difference between the vocal cords of adults and children, and techniques of how to sing together with children. The Rösträtt project has a strong user-centric focus, commonly used in interaction design practice. I believe that involving users in the design process, studying their needs, habits and limitations are essential approaches in order to successfully accomplish any design-related project.

Even though we all used to be children at some point in our lives, our past experiences do not give us an immediate understanding of how to design for them. Designers are grown-ups, they are not children anymore and they can’t design for children solely based of their own considerations and recollections. To create child-friendly interaction, children should be involved in the design process (Druin, 1999, p.29). Certainly, designers should ground their design decisions based on their professional design experience, knowledge about the ergonomics of child products and understanding of the physical and cognitive abilities of children. But in the end only children can verify if the product is really suitable for them. And our role, as designers, is to make sure that we ground our design decisions not only in our assumptions about children’s preferences, but on what children really like and what really makes sense to them.

Apart from seeking for the new pedagogic models through which children can enjoy music, another goal of the Rösträtt project is to investigate new possibilities for musical interaction, for instance new musical instruments or interactive music environments. Since interaction design shapes the behavior of interactive objects (Löwgren, 2008) I was excited by the possibility to contribute to the Rösträtt project by seeking the qualities and forms of those objects which could cause preschool children to be engaged and interested in music.
Unsworn Industries and Erling Björgvinsson conducted field studies at Skruttet, a part of Mumindalens preschool in Svedala municipality of Sweden, which is involved at the Rösträtt project. Their filed studies consisted of one full day of observation and three workshops together with the teachers and the children at Skruttet. These workshops resulted in three different themes to define a further design direction: the mobile room theme, which consisted of various interactive musical instruments, the interactive environments theme for collaborative embodied music creation, and the music sharing theme which enables children to listen, remix and share popular music (Björgvinsson, 2011). I was very inspired by their ideas and field findings, many of which strengthened my own observations and conclusions.

The major part of my design process, field work and three design experiments, was conducted at Skruttet. However, the final prototype was tested at a Malmö-based preschool Lilla Maria, because Skruttet was closed for summer holidays. I consider Skruttet as my main source of knowledge, since both the teachers and children were involved in my project for a longer period of time, however being at Lilla Maria preschool had a big influence on my project as well, because it gave me an opportunity to evaluate my final prototype and compare my findings to the data gathered at Skruttet.

Being a part of a larger project gave me an opportunity to use its resources and research findings, yet allowed independence in formulating the research questions, methodology and design directions. Later in the text I will refer to some of the research findings made by Unsworn Industries and Erling Björgvinsson to support my own observations.

2.2 Learning and pedagogy

I am aware that many programs and projects for preschool children are aimed at increasing children’s competences. The existence of such educational preschool programs as famous Montessori practice (Gerald Lee Gutek, 2004) which puts interaction with physical materials at its core, shows the relevance of researching tangible interaction as a mean to promote children’s development. However, I decided to leave pedagogy beyond the scope of this project, because in order to conduct a comprehensive research with the emphasis on pedagogy and education I would need to have a thorough pedagogic background. In addition, in order to notice an improvement or decrease in children’s musical abilities due to interacting with interactive objects, additional research is needed.

Even though I believe that by engaging in playful activities of any kind children have positive experiences which are be beneficial for their cognitive, psychological and physical development, in this project I approach my topic solely from an interaction design perspective.

2.3 Language and communication

All the children attending Skruttet are Swedish-speaking, however, their teachers speak English. Since my abilities to express myself in Swedish are quite limited, it imposed limitation on my direct communication with the children. However, it also
became a challenge for the project and motivated me to overcome. While doing my field research I had to find a work-around and later in the last chapter I reflect on what happened and try to formulate considerations for all future researchers who will be working in similar situations.
3. Design methodology

3.1 The framework

Data gathering in this project was done through a series of small experiments. The iterative process of collecting data through sketching, models and prototypes is generally known as research through design (Zimmerman et al., 2007, p.497). My observations of the children interacting with the prototypes served as a ground for reflection.

Research through design practitioners generally advocates that in order to get data of a higher validity, experiments should be conducted in the field, as opposed to the lab environment (Keyson, Alonso, 2009). I find this approach to be essential when working with small children, as they might behave differently in unfamiliar environments. Bringing prototypes in the context of their potential use is important in order to see how interactive solutions will be experienced in people’s daily routines. This can not be seen in the lab environment, because the experiments are usually well-planned, and are safe from any unexpected interference of the user’s life situations. In addition, people - and particularly children, can behave differently in the lab. One risk is that they would unconsciously try to gratify researchers by trying to be more engaged in the activity than they actually are.

Researching in the field is also essential to understand the environment in which people are living, and therefore to understand people themselves - their true concerns, desires and interests. Ilpo Koskinen et al (2001, p.70) refers to a case in which a group of researchers was working on a project at Vila Rosario, a village near Rio de Janeiro, which was aimed at improving the public health situation of the local people. The researchers started the project by sending a cultural probes assignment, an ethnographic tool consisting of cameras, letters and diaries, to Vila Rosario’s inhabitants. After examining the results of the probes, the researchers realized that it would be impossible to interpret the probes without going to Vila Rosario and talking to the people in their environment. The interviews and observations on the spot changed dramatically the initial direction of the project towards a more low-fi solution, which was more suitable for Vila Rosario. This shows how important it is for designers to conduct research and test prototypes in the context.

I think the idea of gathering data in the field is very much related to my case of working with small children. There are many variables and factors at play in a preschool which means that the prototypes have to be tested in the actual environment to account for the multiplicity of situations in which the children will use it. Some of these situations involve the prototype’s durability, social relationships and conflicts that develop around it, the way it engages different children, or situations in which the prototype is misplaced.

In the guidelines for usability testing with children it is recommended to create a kindergarden environment in their lab, so children would feel comfortable in it (Hanna et al., 1997, p.11). But instead, I believe that the researchers should rather do the opposite and come to the kindergarden, children’s natural environment
which is not staged, but real. Within this project I conducted several experiments in
the preschool, with which I was working. I tried to present all my experiments in a
way that is appropriate for children, which led me to dress up like a robot, have all
the children sit on my lap, read books to them, play with blocks, sing and do other
things, which I would not imagine in my adult environment. I think when children (or
even older people) come to a lab, they conform with the situation and obey the
rules, whereas otherwise the researchers become a guest in the kindergarten and
have to comply with the rules of the children. This can be hard and time-
consuming, but I believe such an approach can unveil many aspects of children’s
behavior and preferences which otherwise could not be seen.

![Figure 1. Researching on children's terms](image)

### 3.2 Involving children in the design process

As Alison Druin (1996) fairly noted, “children are not just short adults”, they have
their own thoughts, visions about the world and the meaning of things. Another
reason why we can't solely rely on our own limited memories from our childhood is
because the world has developed rapidly and the children of today are exposed to
and are familiar with bigger a spectrum of technology from early childhood.

Druin suggested a framework of roles that children can take in the design process -
children as users, testers, informants or design partners (1999, p.4). When children
are involved in the process as users they are provided with existing products that
they try out (Druin, 1999, p.5). Gathered knowledge is used in future products and
as a contribution to the knowledge pool on how children interact with technology
and how they are affected by it. Taking the role of testers, children give their
feedback on pre-released prototypes (Druin, 1999, p.10). Their input is used to
alter prototypes to make a better, more child-friendly version. When involved in the
design as informants children contribute to the process at different stages, as
specified by researchers (Druin, 1999, p.15). Children are usually asked for their
feedback on sketches, existing similar products or low-fi prototypes of the
developing product. Finally, being design partners children participate in the whole
design process and are considered as equal stakeholders (Druin, 1999, p.19).

All these methods have their origins traced in the history of developing technology
for children. Researchers first started to involve children in the process as users
and then more recently let children be a part of the design team. Druin writes that it
would be wrong to say that one method is better or worse than the other - the
methodology depends on the type of research and its context. However, the more
researchers are able to include children in the design process the more child-
friendly their products are likely to become.
Involving children in the design process as partners affords the richest user experience insights. Employing children as partners requires equal collaborations, which means conducting regular dialogue with children and discussing the direction which the design process should take. Although this way of working is extremely fruitful, it is more suitable for the older children, who can participate in the design discussions together with the researchers.

When choosing a methodology for the design process researchers rarely stick to one particular method but often combine several methods. The aim of the current project was to develop a series of experiments, rather than a fully finished product which would then become commercially available. Therefore, involving children in the process as users did not belong to the scope of my project, since there was no end product to use. Due to the age of preschool children (between three to five years old), distance of the Skruttet preschool from Malmö, and the language barrier, I chose to include children in the design process as informants to get inspiration and insights for the design process, and as testers to test the prototypes and observe their interaction. Another reason for these choices was the previous research done by Unsworn Industries and Erling Björgvinsson, whose findings helped me build a basis for my work.

3.3 Children as informants

Since children were involved as informants in the research and conceptualization phases of this project, I would like to elaborate more on this method. When including children in the design process as informants the researcher must herself choose when to seek help from the children, when to invite them into the process, and when to create and test prototypes. These decisions depend on the budget, time frame, context of the project and characteristics of the adult team members. There are several ways that children can be included in the research. They could be asked questions concerning certain design decisions made by adults or general questions, which will help adults to make further decisions. Children could also be asked to test existing technology or low-fi prototypes, so researchers can identify the limitations of their interaction modalities. Feedback could be obtained by asking questions or by observing how children interact with a product or prototype. Information gathering could be also made in a form of a workshop when children are given crafting artifacts or design materials and asked to imagine how the product would work (Xu et al., 2005, p.3).

3.4 Observation

Observing children helps researchers to see the children's complex behaviors and behavioral patterns. Unlike observations in the lab, which are influenced by the hypotheses and assumptions (Gross, 2002), field studies provide an opportunity to observe children in their natural environment which can give a lot more accurate insights about their behavior. It is suggested that it is beneficial to use observation as a research method when working with preschool children (Gross, 2002), since they can not fully participate in interviews or questionnaires.

George Forman and Ellen Hall (2005) suggested five important understandings about children that we can gain when observing their behavior. Observation helps
us discover children’s interests, children’s skills, their level of cognitive and social
development, their strategies for pursuing desired effects and their personalities
and temperaments.

Observing small children can be very tricky, because as adults we take many
things for granted. Children, however, are only starting to explore the world and its
physical constraints - they are excited and confused by things which are hard to
notice for adults. It is recommended to record observation on video and to take
photographs in order to review them later. It is important to pay attention to how
children interact with objects, each other and teachers, notice how children are
playing and who is dominant during play, what language they use to communicate
with each other, and when they are getting confused (Forman, Hall, 2005).

3.5 My design journey

This investigation started from researching literature about children’s cognitive and
physical abilities and limitations, children’s play, aspects of designing technology
for children, as well as studying projects, relevant to the area of interaction design,
music and children. In parallel to that process started my interventions at Skruttet.

I was at Skruttet on four occasions, each visit lasted around three hours. During my
first intervention I got to know the environment, introduced myself to the children
and the teachers, and observed the children’s routines and play. As a part of this
field study I also interviewed of of the teachers, who informed me about Skruttet's
daily activities. After the first contact with children I developed several design
concepts and divided them into several categories. For my second visit at Skruttet I
prepared two low-fi prototypes, which represented two different areas of interest.
During the second intervention I tried them out and observed children's
interactions. The interpretation of the observation results helped me to gain insights
on how children interact with similar devices and what difficulties could be
expected. For my third visit I prepared a creative assignment for the children, which
helped to get some insights on how they imagine interacting with music. The
assignment also extended to my fourth intervention. Lastly, I narrowed down the
area of interest and prepared a more elaborate prototype, which was tested by the
children at Lilla Maria preschool.
4. Children at preschool age

4.1 Cognitive and physical development

Generally preschool age is considered to be between the ages of three and five. However, younger and slightly older children can also attend preschool. The age interval varies in different countries. In Sweden, the country where this research was conducted, children from the age of one up until the age of five can attend preschool.

Children’s development is a highly complex and fast process. This makes it inappropriate to describe the preschool age as belonging to only one category. With only one year in age difference, children dramatically vary in development.

At the age of two, children can walk and jump with both feet, as their gross motor skills develop. As the age of three approaches, their fine motor skills significantly improve. They can pull drawers, dress up and use kitchen utensils. Children enjoy turning pages of books, and playing with blocks. At this age children enjoy making noise, for example, by throwing objects or smashing a newly-built tower of blocks. As the age of three approaches children enjoy stacking boxes and other objects. The character of children’s play at this age is exploratory, focused on learning about an object’s qualities (Ackermann, 2004, p.116). At this age children start to play pretend games together with other children. Children are also able to talk and sing to some extent, clap their hands and move their bodies to express the rhythm.

When turning four years old, children have perfected their abilities to run and jump. They enjoy outdoor activities, e.g. running, climbing, riding the tricycle, or going down the slides. Fine motor skills are notably improved in comparison to the year before - children can use different tools, for example a toothbrush and some of the kitchen utensils. Parents are recommended to introduce “Simon Says” and other educational games to the children in order to develop perceptual-motor integration (Ackermann, 2004, p.124). Children very much enjoy object-mediated and turn-taking games, like playing with a ball. At this age children play together, socialize, and learn concepts such as empathy and social rules. They have lots of fun from “silly” rhymes and funny sounds, especially if they are made by adults. At this age children can sing longer, because their vocal abilities have improved. Songs become more complex and children can combine several songs into one. Some children start to read. According to Jean Piaget’s theories, at this age children are very egocentric (Hourcade, 2007, p.10). They need a strong appreciation of their achievements from adults, e.g. “Look what I made!”. However, egocentrism usually declines as a child becomes older and starts to understand other people’s viewpoints. Children can play with smaller toys, and games with simple rules. They start to actively talk and use their rich imagination. They are curious and ask a lot of questions. However, children still a limited attention span, which makes it difficult for them to focus on the same task for a long time. At this age children can’t hold multiple steps in mind simultaneously, they focus on a present state - their logical skills are limited and problem-solving abilities are not yet present.
As the average age of my target group ranged from three to four years old, for the continuation of the design process the physical and cognitive possibilities and limitation of this age group defined the scope of this research. It is important for designers to understand those limitations and always be conscious about the many things which adults take for granted. This mindset helps to keep the design simple and easily-understood for children. On the other hand, it is important not to make too many assumptions and precautions. That is why involving children in the design process is as essential as understanding their limitations from cognitive theories.

4.2 Benefits of musical interaction

To develop a sense of rhythm and music people should be exposed to musical concepts in their early childhood. Usually children start learning their first songs, playing simple instruments and singing together with other children in preschools. Exposing children to music in their early childhood is essential not only for the growth of their musicality, but also for their general cognitive development. It has been shown that one year of music training noticeably improves children’s memory (Bupa, 2006). In turn, music positively influences their general intelligence level, literacy, as well as the ability to perform in mathematics and other sciences, since those are dependent on their ability to memorize (Sciencedaily, 2006).

Early exposure to music in general and to its concepts such as rhythm, pitch, melody and timbre facilitates extensive development of neural connections in the child's brain. Music lessons are known to boost cognitive performance and enhance vocabulary (Sciencedaily, 2011). Northwestern's Auditory Neuroscience Laboratory suggests that music training can help to avoid literacy disorders. In addition, singing can be an unobtrusive way to teach new words to small children. Singing shifts attention from the correct pronunciation to the rhythm and melody and thus makes it easier for children to pronounce new words for the first time. (Sciencedaily, 2012)

Music helps to improve gross motor skills. Children respond to music with the whole body - they jump, wave their arms, and run around (Jansen, Dijk, Retra, 2006). Music promotes activity and fun in children's everyday life, as well as teaching them to control their bodies and become physically stronger (Levinowitz, 1998). Moreover, group music sessions highly increase the confidence level and help children to learn social concepts (Education Journal, 2010). It is reported that children are also better adjusted to the group dynamics after being involved in musical activities (Young Children, 2000).

Finally, interacting with music and singing makes children have a lot of fun. At preschool age children learn about the world through fun and play. Alison Gopnik, professor of psychology, believes that there is a connection between play, exploration and children’s development of creativity, which was also concluded by Lev Vygotsky (Smolucha, 1992).
5. Play

5.1 What is play

Play is an enjoyable and engaging activity, connected with no material interest. Play is a way to loosen the strings which keep us bound to the reality, create and break new rules, engage in new experiences and look at things from different perspectives (Gauntlett et al., 2010, p.10).

For children, play is a way to "cope with reality". They learn the world around them through playful activities. Children learn how to make sense of how our complex world and how it works through play. Almost all the children’s activities they engage in with or without toys, alone or with each other, can be characterized as play. Vygotsky (1978) argued that by playing children get control of their own learning, familiarize themselves with ‘symbolic representations’ such as drama or visual art, and learn to reflect on themselves. Piaget (1962) considered play as a way to overcome children’s egocentrism. Erikson (1993) believed that play helps children to be autonomous and take control of their own world. In general, researchers agree that play is a vital activity in childhood. It was discovered that children who enjoy playing often are more predisposed to divergent movement, which in turn boosts creative and critical thinking (Trevlas et al., 2003).

There are many types of play. Below are five types, which are common for preschool children (Gauntlett et al., 2010, p.16):

1. Physical play is a type of play in which the whole body is involved. Examples of such kind of play could be wrestling, rolling down the hill, or jumping. These types of activities develop strength and endurance in children, as well as hand-eye coordination and motor skills.

2. Play with objects is an exploration of feel and behavior of objects. During this type of play children develop fine motor skills, reasoning and problem-solving.

3. Symbolic play is an activity in which children learn to express ideas through symbolic representations. For example, this could be pretending to sing in the microphone by holding a colored pen.

4. Socio-dramatic play is a type of play in which children pretend to be someone or something else. First children start to play alone and by the age of 5 start to play with other children, which helps them to develop cooperative and social skills. Children take roles which they know from the adult world, for example, a doctor or a sales-person from a store, and recreate different social situations. This type of play is often called make-believe play.

5. Games with rules are activities in which children stick to certain predefined rules. Children can also invent their own rules and stick to them. These games teach children important social concepts like turn-taking and sharing.
Often several types of play are intertwined and performed simultaneously. For example, a child can use a doll to narrate a story or sing a song, which is play with objects and at the same time classifies socio-dramatic play. Play with physical objects is often accompanied by narration, which characterizes socio-dramatic play as well. Between the age of three and four children start playing games with peers. It is suggested that children play cooperative games without competition as many kids can not stand losing in competitive play (Ackermann 2004, p.129). Even though every type of play is equally important to children’s development, the focus of this project covers tangible interfaces therefore mostly covers play with objects and how this type of play can be enhanced by adding interactivity to the objects.

5.2 Criteria for being playful

To support children’s play with interactive solutions which could be regarded as playful it is important to understand what children’s playfulness actually means. According to Lieberman (1966) there are five factors of a playfulness quality: (a) physical spontaneity, (b) social spontaneity, (c) cognitive spontaneity, (d) manifest of joy, and (e) sense of humor. Thus, this means that to support playfulness an interactive object should leave room for children’s spontaneous reactions and evoke joy during their interaction. Trevlas et al. (2003) concluded that “children’s playful behavior is guided by internal motivation towards a process with self-imposed goals, with a tendency to attribute their own meanings to objects and behaviors, to create fictional characters and to acquire a freedom in producing roles and activities, regardless of externally imposed enforcements”. Of course any kind of interactive digital solution will always impose its own limitations and ways to interact with it, but it is important that it can provide enough freedom for children to go beyond its framing and find their own way to interact with it. To conclude, playful activity is a non-linear process in which the process itself and how it develops is a lot more important that its end result, and therefore playful objects should support this process.

5.3 Free play

Free play is an unstructured open-ended play. Rules or goals in free play, if any, are invented and changed by the children. Unlike football, or computer games, free play allows children to have a full control over its flow. Anything can happen during free play. Objects change their roles, and a wooden cube can become a rocket, and in five minutes could be transformed into a train. Free play is the most natural type of play for preschool children. They start to play with each other and learn how to interact in a shared play space.

I think it is a very challenging task to support children’s free play without imposing rules and limitations through the use digital materials. There is no directive whether designers should focus more on inventing structured games or supporting objects and spaces for free play. More importantly, I think that in any case the design should provide enough freedom and empower children.

In my design process I explored both very open-ended and more structured activities. Even though each activity was always framed with an introduction, which would make it more structured, as time passed activities would shift from more
structured to more open-ended. This shift in activities and children’s play is very common for children at preschool age. Fluidity of activities was also found during the observations at Skruttet conducted within the Rösträtt project. It was reported that the activities constantly shift from informal to more formalized gatherings (Björgvinsson, 2011).
6. Designing technology for preschool children

6.1 Technology and children

Public opinion about the influence of technology on children’s development shifts rapidly with time and technological advancement. Researcher’s areas of interests are shifting from questioning how technology affects children to the development of guidelines for designing for the youngest user groups. To me, this signifies acceptance of the fact that technology invades our lives from early childhood. Today children are called “digital natives”, as they are “born digital”, and they start interacting with technological devices from an early age (Prensky, 2001). As designers, we can take advantage from this early adoption of technology and enhance the way children learn and interact with the world around by thoughtful embedment of computation in children’s toys or activities.

It is not given, however, that all activities children do, from reading books to playing outside, should be enriched with technology. In fact, most of things children learn from are analog. However, as designers, we have a responsibility to ensure that if some children’s toys, activities or environments could benefit from adding computation to them, then all the design decisions shall make sense for children, so that they can really benefit from them.

It is essential to understand the main needs and preferences of children when it comes to interacting with technology. Various studies (Wyeth, 2006; Zaman, Abeele, n.d.; Jansen, Dijk, Retra, 2006) suggest the following qualities that are essential for interactive systems for children:

- interactive technology should provide possibilities for creative expression or embody constructive capabilities;
- technology should be open for different uses and to re-design in order to support rapidly changing play context;
- technology should allow for social interaction and collaboration, as well as provide possibilities for discovery-oriented solitary play;
- children should have a sense of control over technology: they become fully engaged in interacting with technology if they can understand it. For that, interaction should be easy to learn for children;
- technology should provide multiple forms of interaction: children are more engaged with interactive systems if there are several ways to interact with it;
- interaction should provide fun and enjoyment for children: children learn by doing, and therefore it is essential to keep them motivated and engaged in the interaction;

I used these guidelines to steer myself in the design process. Based on the evaluation of the available musical products for children (Chapter 7) and the results of the three design experiments (Chapter 8), I used the collected data to create and evaluate an interactive system which embodies these qualities.
In general, I think that - as a rule of thumb - technology shouldn't be embedded for the sake of it, but for a good purpose. This applies to all age groups, but for small children whose bodies and minds are still developing it particularly important. For example, it is not recommended to use non-interactive screen-media, which could be easily substituted by a book or a picture (NAEYC, 2012).

In any event, technology should support curiosity, creativity, cognitive development, active lifestyle, socializing with other children, and not seclude children from such activities. Tangible interaction supports those requirements, as it provides a shared play space open for many children to join, and supports active embodied interaction with objects, which affords active play.

6.2 Toys and digital technology

Toys are physical playful objects for children. Toys can often have a personality, they evoke emotions in other people. Toys are also a child's first personal belongings. Centuries ago they used to be material leftovers or stones. Today there is a huge toy industry mass-producing toys. Toys are getting serious, and our expectations for them are rising. From just “a thing to play with” toys evolved into the tools for learning: they became the ways to introduce children to the complex and technologically advanced adult world (Maaike, Lauwaert, 2009). Besides the physical qualities of a toy, like its shape, color and texture, toys also can be valued for their playfulness, educational potential, or even ethics of use.

Many researchers, as well as cognitive scientists, emphasize the importance of play with toys and physical objects. Druin and her colleagues noted that adding interactivity into physical objects allows to get the “best of both worlds” and expand traditional physical play with what the digital world can provide (Revelle et al., 2005, p.2052). Digitally-augmented physical toys for children are especially relevant today now that children are becoming increasingly interested in computers and, in particular, touchscreen devices, like mobile phones and tablets. While desktop computers and touch-screen devices can still provide good educational and entertaining content, the interaction possibilities are limited in comparison to interacting with physical objects. The physical world can give us so much more compared to the 2-dimensional world of screens. Grasping, squeezing, pressing, throwing and many other ways to interact with the physical world not only provide rich patterns of play, but are simply a key to the development of fine motor skills. It is understandable that digital media are so luring for children - they are indeed full of magic, talking animals, and fantasy worlds. That's why embracing the idea to combine both worlds in order to create a playful environment with both physical qualities and digital potential appeals greatly to me.

6.3 Tangible toy over computer or phone applications

Interaction with screen-based interfaces is now familiar to even very young children. They expect “magic” to happen on the screen of devices they come across, but today's technological possibilities give as an opportunity to go beyond

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2 This issue was thoroughly discussed by Victor Bret in his critique on touch-screen visions of the future of interaction design (Bret, V, 2011).
the small screen of a mobile phone. “Away from the traditional GUI desktop into the spaces and places that people more naturally inhabit” approach (Marco et al., 2009, p.103) is something which should be always kept in mind, especially when designing for small children, who are to explore the whole world around, and not just a small screen in front of them.

Music is an embodied experience for children. The experience of interacting with screens (especially with phone applications) is completely immersive for children, and while being concentrated on interacting with the screen itself, there would be no space for corporeal reaction to music. Screen-based interaction does not support collaboration as much as tangible interaction. When a group of children is using a computer or a phone there is always one person in control, while others can only comment on the interaction.

There is no consensus on how screen-based digital media influence children’s behavior. Many people think it will boost analytical skills, others urge that it will decrease the ability to solve complex problems (Mashable, 2012). I believe that even though screen-based interaction with carefully designed digital applications can be beneficial for children, tangible interaction is still crucial for the development of children. To conclude, there should be a healthy balance and divergent play environment.

There is also an opinion that while non-digital toys can take many roles (a plastic cone can serve as a rocket), toys with digital abilities will always remain its original one (Wyeth, 2006, p.1228), which will not be adjusted to the constantly evolving play situations. I believe that it is not accurate for all cases, and it depends on the way in which technology is embedded in the toy, and which role it takes. I believe that digitally-augmented physical objects and toys still maintain their physical properties and be freely involved in expressive play. Thus, for example, Lena Berglin (2005) reported that she when was probing form and size of the toys in her project Spookies, children’s behavior towards the objects was different depending on the size and look of the same objects.

Toys can also play an important role in children’s lives as empathic “friends”. Such objects and toys are called transitional objects (Ackermann 2004, p.110) and they help children to deal with fears such as the fear of darkness. Typical transitional objects are teddy bears and blankets.

6.4 Toy design industry

Often due to commercial interest toy producers lack a clear denotation of a toy’s purpose and definition of a proper age group (Zhang, Peng, 2010). Failure to position a toy’s age group results in a boring or, on the contrary, too challenging experience for children, granted that children with even several months age difference can significantly vary in cognitive competences.

Another problem of the toy design industry is that companies are looking for the next “big thing” to sell, and not for fulfilling children’s needs in play. Brendan Boyle shared in his interview that the toy industry is too focused on how adult parents buy toys for their children, rather than creating something that children really want to play with (Moggridge, 2007, p.343).
While commercial products are often too general to suit specific children’s needs, toys and play environments designed by researchers often embrace other kinds of issues. For instance, they could be too complex and bulky to be tested outside of the laboratory environment (Marco, Cerezo et al., 2009), or are too expensive to produce.
7. Related work and projects

Tangible interaction is beneficial for children's play because it supports collaborative social interaction, provides many various ways of interaction, supports exploration through trial and error (Xu et al., 2005, p.2). In this chapter we will zoom into tangible interactive systems for children, which allow them to interact with music and sounds.

7.1 Tangible sequencer

Music Blocks (Edutainingkids.com, 2003) produced by Neurosmith is a tangible sequencer targeted at preschool children. Music Blocks consist of a platform, several cartridges with different melodies, and five cubes with buttons on the each side. To make music cubes should be inserted in special slots. Once a cube is in the slot, and the button is pressed it starts playing an audio clip. Switching sides of the cubes applies effects to the melody. Music interaction is also based on mixing the samples by pressing buttons on the facing side of the each cube. To keep cubes stable in the slots special magnet connections are used. I think that Music Blocks offer great possibilities for simple music composition. However, children can only play with the melodies which come with the cartridges. Children can not record any of their own melodies, neither can they use their own voice to record samples. The product still has an educational value for small children, because it makes them work with different colors and shapes.

On the contrary to Music Blocks, Zoundz (Zizzle Zoundz, 2009) is a tangible musical instrument which allows its players to record their own samples. Zoundz consist of a set of differently colored and shaped objects and a special platform with a speaker. When these objects are placed on a platform they add samples to a music sequence. By pressing two touch-sensitive buttons of the platform, it is possible to record your own voice-sample, which can be later adjusted with all kinds of effects (pitch, tempo, etc.). The design of Zoundz is very minimalist, and looks like a musical instrument from the future. In addition to sound, Zoundz constantly gives feedback with light and voice comments, which makes it look even more futuristic. Even though Zoundz is not aimed at a preschool age group, I think the possibility of recording your own samples and tweaking them with different
filters gives you even more possibilities for music creation than in the previous example.

Another interesting project is Siftables (Merrill et al., 2007). Siftables are a set of cubes enabled with small screens, which wirelessly communicate with each other. Siftables are different from the two previous examples, because the cubes interact directly with each other. Siftables work with applications developed for them. One of such applications is LoopLoop (Stimulant, 2012), which is used for making music. To influence the music sequence cubes should be places next to each other. Tilt and touch also change music patterns. This application would be very advanced for preschool children, but I believe that there is certainly a quality in the direct interaction with objects. Objects are not bound to a specific slot in the platform, but can be freely moved around and shuffled. Even proximity of the objects to each other can influence music output, which offers a possibility to experiment more and change the music output very fast.

I believe that all previous examples of tangible sequencers provide enough possibilities for creative music expression. The key common quality for these three examples is modularity of the input objects (tangible cubes and shapes). It allows experimenting with different combinations of these objects and consequent music outcomes. Modularity also makes collaboration possible, since many children can interact with these objects at the same time. The variety of the forms of interaction complements modularity. The objects can be manipulated independently (placed on the platform, tilted or shifted) or in relation to other objects (sensing proximity, combined with other objects). In the case of Zoundz it is also possible to add your own voice to the music, which adds another layer of interaction.
Spacial positioning also influences the interaction. Music Blocks and Zoundz are bound to their platforms, and the input objects will not work unless they are put on the platform. Even though the platforms in both examples are relatively small and could be transported, the play space will always be limited to the position of the platform. Interaction in this case resembles a board game. Siftables on the other hand are bound to each other, still can be used independently. It puts the emphasis on the interacting with the objects, rather than interacting with the platform. In addition, it allows for more possibilities to use the full potential of tangible interaction: children can explore cause and effect relationship not only based of which objects are involved, but also how close they are to each other.

7.2 Modular instrument

Alle Meine Klänge (AMK) by PKNTS (Yanko Design, 2008) is a modular toy concept aimed at preschool children, which consist of small modular units with buttons, and accompanying desktop software. The units stick together with magnets. With the help of the software children can upload music samples to the units, which then can be used independently or in combination with each other. Each component is responsible for playing one sound sample or applying one effect. The sound can be activated by twisting or pressing the buttons. It is also possible to record your own voice and store it in one of the units.

![Figure 5. AMK](image)

Unfortunately, there is not much information available on this project to draw conclusions on usability. However, I believe that its simple and minimalist design combined with simple interaction could be suitable for small children. As it was concluded for the previous examples, modularity adds many opportunities for music composition. Manipulation with the units also develops fine motor skills.

Contrary to Siftables, the units in AMK are connected physically. When several pieces are connected together they become one solid instrument, which can be easily hold in hands to manipulate and transport, but on the other hand it limits collaboration possibilities, since only one child can be in charge. However, since each unit can be used independently children can still interact with it together, if not all the units are connected at the same time.
Modularity is a way to support constructive and creative play. Modular toys are highly flexible and can be easily transformed into something else. This can support rapidly changing play environment in preschools.

7.3 Soft music interface

Music Shapers (MIT Medialab, 2001), originally called Squeezables and Embroidered Musical Balls (Weinberg et al., n.d.), are a set of the soft balls which act as a music interface for collaborative performance. To start playing music one or several balls should be squeezed or stretched. Music Shapers are intended to substitute knobs and sliders on electronic music authorship software interfaces. The authors of the project argue for a more immersive experience which can be achieved with this new type of interface.

![Music Shapers](image)

Figure 6. Music Shapers

Similar to Zoundz, Music Shapers were not specifically designed for the preschool age group, but meant to be used by children of all ages and novice music players. Unlike Zounds, the soft body of Music Shapers’ allows an affordance for small children to start interacting immediately, because of their natural tendency to squeeze things. Unlike all previous examples, Music Shapers use materials’ properties to open up the whole potential of tangible interaction. Children can explore the relationship between the force with which they squeeze Music Shapers and the music outcome.

Being a soft toy ball, Music Shapers can have a function outside its original purpose. For example, they could be used as a pillow or a soft ball for games. In the messy preschool environment, where children’s desires and activities shift fast it is important that things can lose their original function and obtain a different one. Previously we stated that supporting reframing the design to add additional functions is an essential quality for designing for preschools. Even though children can easily achieve that with their imagination, it is good to encourage these transformations.

7.4 Animalistic instruments

BeatBugs (Aimi, Young, 2004) is a part of MIT’s Toy symphony project, the main purpose of which is to bring together children, orchestras and music engineers in order to create new interfaces for collaborative music performances. The Toy symphony project has the same intent as the Rösträtt project: creating music with
novel music instruments, which can be used by children without a music background.

Beatbugs are a set of rhythmic instruments for collaborative performance. It is made in a form of a bug and fits in a hand. To record sound with Beatbugs you only need to tap the surface of the bug in a rhythmic manner. Then the rhythm is recorded, and it becomes possible to control the pitch and rhythm by pushing the bug's whiskers. Beatbugs can communicate with each other, so it is possible to control another Beatbug's pitch and rhythm with the one you're holding in your hands. In order to start playing together two people need to turn face-to-face and continue pushing their bug's whiskers. This interaction is both fun and very social. Again, this project is more suitable for older age groups, which acquires a motivation to learn and perform meaningful musical pieces. However, the metaphor of a bug, interaction technique of tapping its body and moving its whiskers also makes sense for younger users. Even though Beatbugs also produce an electronic rhythm, the sound is a lot merrier and pleasant than for example Zoundz. It has a very specific, recognizable sound, which differs from other digital instruments for children.

![Beatbugs](image)

Figure 7. Beatbugs

The way in which collaborative performance is realized in the Beatbugs project is very engaging. Once one player taps a rhythmic pattern on his Beatbug, it gets randomly sent to the next player, who decides to keep it and sends the pattern to the next player or to modify the received pattern and broadcast the new version. This back and forth interaction motivates players to be attentive to the sound and makes them prepare to react to the music in any given moment.

MusicPets (Tomitsch et al., 2006) is an exploratory research project which allowed children to record sounds and their voices to the soft toys. The prototype included two tangible platforms for composing and playing back music and a set of stuffed toys for music transmission. To identify the toys the platforms comprised RFID-readers, and stuffed toys had RFID-tags attached to them. The authors of the project observed a group of twenty nine children (from two to seven years old), and based on their observations they concluded that children have a lot more fun creating music than listening to it. The results also showed that the children used the toys to record secret messages and had a high level of engagement.

Animalistic design unites these two examples. Children's toys often resemble animals, people, or fantasy creatures with a personality, which promote affective relationships to them. For example, a teddy bear is one of the most popular toys
among children. I believe there is a potential to explore how affective design influences musical interaction among preschool children and to find if there is a connection between affective musical toys and playful interaction. It was found that modern children see technology as fundamentally human, a friend for both playing and studying (Latitude, 2012). What if technology could also become children’s friend for creating music and sounds?

7.5 Embodied metaphors

Marble Track Audio Manipulator (Bean et al., 2008) is a marble track tower toy which was augmented with technology. This installation gave children the possibility to compose music by manipulating sounds and adding effects to them. The authors of the project intended to create a “creative, playful and engaging encounter with music”, which matches the intention of my project.

![Figure 8. Marble track toy](image)

To create music children simply let the marble go down the tower. The type of sound effects depended on the form of marble track, which interestingly embodies form-effect coupling in the sound composition. For example, delay is represented through the curved track, which makes a ball move along the track over a longer period of time. The reverb effect is made with a funnel. The amount of time, during which the ball goes through the funnel represents the reverb time.

Bakker et al. (2011) made a series of prototypes aimed at identifying embodied metaphors and their potential for teaching abstract musical concepts using tangible objects. It was suggested that properly designed embodied metaphors for tangible interaction can stimulate the process of understanding abstract concepts in children (p.448). Even though the prototypes were evaluated by school children, I believe that the system could also be beneficial for a younger audience, perhaps with some more simplifications. I think this connection between physical properties of the installation and the musical output could be valuable for music interfaces. The metaphors used in Marble Track Audio Manipulator would be hard to comprehend for preschool children, but more straightforward musical analogies could teach children to understand abstract cause and effect relationships.
7.6 Conclusions

Researching relevant commercial products and research experiments gave me an understanding of the current variety of tangible interactive musical solutions for children. However, it also revealed that there not so many musical products designed specifically for preschool children, which shows that more research in this area is needed. While looking into all previously described examples I found some interesting considerations which inspired and further framed my design process.

1. Clear and simple interaction for creating and playing back music is essential. Children still have underdeveloped fine motor skills. Products developed specifically for preschool children (e.g., Music Blocks and AMK) consist of big pieces and have big buttons, which makes it possible for small children to easily interact with them.

2. Considering children’s tendency to take things apart and lose components, it is essential to consider fixing components to each other or to the main platform. It also makes the project less dangerous for toddlers, who tend to put things in the mouth.

3. The theme of modular toys with cubes and shapes seems to be quite present on the market, while using toys for music-making is uncommon. I believe that interacting with affective musical toys can create empathy between children and toys, and therefore increase children’s engagement with music.

4. With combinatorics and modularity it is possible to achieve infinite possibilities for music making. Elisabeth Lindqvist, a teacher at Skruttet, confirmed that preschools children usually repeat the same activities over and over again, this helps them to learn. Modularity and constructive capabilities can make repetitive actions more interesting for children, and help them to enjoy same toy over and over again.

5. Direct manipulation of independent objects (e.g. Siftables and AMK) can provide more possibilities for collaborative play and support fluidity of activities in small group interactions. Thus children can form small groups of two people while playing with such objects and then continue playing all together if they wish. I believe that there is more potential for music creation in this type of interaction versus using a platform-based interactive instruments (e.g. Music Blocks and Zoundz).
8. Design process

8.1 Skruttet

I started my design process by going to Skruttet to introduce myself to the children, and teachers, as well as to get myself familiar with the environment and the routines of the preschool. This observation took place on the 9th of February 2012.

There are six teachers and around thirty children in total, whose age varies from two to five years old. There are a few older children who will go to primary school next autumn. The atmosphere is very friendly and democratic. No one is forced to do something undesirable - children are free to decide what they want to do. The daily activities are driven by the children's interests. For example, if somebody saw a nice bird outside and suggested to go out, then it is time for outside activities.

The usual day at Skruttet starts with breakfast and some related activities, like collecting and counting stickers from bananas. Then during the day the children are divided into small groups for formal group activities. Each of the groups is busy with games or crafts. Each of the teachers takes care of one group. It should be mentioned, that all teachers at Skruttet are very kind, and professional in their way of working. Each of the teachers has her own favorite activity to do with the children. One is very good at crafts, another in telling jokes and stories. What is really particular, none of the teachers has a musical background, and nobody can play any musical instruments. There are no formal music classes at Skruttet, however, teachers introduced numerous musical everyday practices and games to the children. I don't see the absence of musical education as a concern, but rather as a great opportunity to design for the environment in which interacting with music should be engaging and not overwhelming both for the children and for the teachers.

Sometimes the children participate in activities where all children and teachers play together. Some children also prefer to play on their own, while others always play in small groups or together with the teachers. Genders are usually mixed, however,
sometimes boys play separately with cars, and girls dress up dolls together. Ages are also usually mixed, and younger children can play with the older ones. Bringing children of different ages together is central to holistic learning, in which they can learn from each other, learn how to understand other’s viewpoints and how to be a good friend (Björgvinsson, 2011). I observed that the older children had a strong empathy towards the younger ones - they took care of the small children and were involved in resolving conflicts. Therefore, designing play objects which support collaborative play among preschool children of different ages is a valid objective. During the previous field studies at Skruttet, Björgvinsson (2011) and Unsworn Industries discovered that arranging such joint activities for children of different age is a challenging task. During my design experiments I attempted to discover how this divergence in the age influence interaction with musical toys.

There were many activities and games which really fascinated me. One of them was a reading session. Children sat in a circle and the teacher started to read out loud with a dramatic intonation. From time to time she showed children the pictures in the book. The children were responding to the story with the voices of the animals from the narrative (e.g. meowing and barking). All the children were engaged in the listening process. Later, when I was playing with the children during the day, some of them wanted to continue the reading experience, and asked me to read a book for them. The high level of engagement with the story during the reading session shows that the children enjoy activities orchestrated by the teachers which also require their active participation.

There are many soft plush toys, soft blocks, puzzles and books at Skruttet. There is also a desktop computer, and one light table with a big magnifying glass. The children enjoy using it to look at dried leaves and feathers. The computer is appreciated by most of the children. I saw a group of six children playing some educational game on the computer. They were sitting all together around the screen and seemed very engaged. However, the computer is not an easily accessible toy - the teacher should give permission to use it. This brings about the issue of access to the play environment. Not only the computer, but some other expensive electronic devices can only be used with the teacher’s approval. Björgvinsson’s earlier field work as part of the Rösträtt project exposed one of the reasons for that gender issue: boys tend to claim ownership over the expensive toys and will not share them with girls, that is why their use is regulated by the teachers (Björgvinsson, 2011). Since the objective of the Rösträtt project is to democratize play amongst children, this observation has led to valuable insights regarding how children behave towards each other while in the presence of particular types of toys. My research builds on this knowledge while aiming to support collaborative, equal and playful engagement.
Preschool children enjoy playing iPhone’s and iPad’s a lot. The teachers explained that they install various applications on their own phones and allow the children to play with them. I’ve conducted several interviews about the children’s interest in phones and computers, and the teachers responded quite positive about the way children are engaged by these objects. The teachers believe, that technology is the future, and that children must learn how to interact with computers from early childhood. However, they advocated for a balance in doing activities. One of the teachers said that “children should not be inside (playing with computers) all the time, but they shouldn’t be outside all the time either”. I gave my own phone to the children to play with. I observed that children were very cautious while interacting with it, the "adult’s world" artifact, while they engaged in active and messy play with non-interactive toys.

There is a lot of attention towards teaching children ethics. Together with the teachers, children made a world map and learned about other countries by celebrating national holidays, like Chinese New Year.

When it is warm, the children spend several hours playing outside. They bike, swing, run around, roll down the hill, create sand cakes, and do many other messy activities. In the open space where children are exposed to many different activities which other children are doing the fluidity of activities is particularly present. I observed that if somebody was seen engaging in a new form of play (for example,
hitting the wooden floor with a hammer), other children would immediately join. The same goes for indoor activities as well: children rarely spent a lot of time doing one thing, as well as engaging with the same group of children. It is a challenge for designers to support this rapid change of interests.

Lastly, when I asked the teachers what children like most of all, they said that they like animals, “everything that is connected to music”, treasure hunting activities, and helping adults.

In general, like many other preschools, Skruttet is a chaotic and noisy place, full of children whose mood and interests shift rapidly. Things can get easily lost, however, children are very familiar with the space and know where most of the toys are. The fact that music is not formally taught is an interesting challenge, which gives a possibility to be very open and experiment outside of a formal structure of most of the curriculums. Supporting collaboration could be tricky because of the age and gender differences, but at the same time it is essential to bring children together so they can learn from each other. There is a correlation between engagement and joint activities, since children tend to move from one group to another while playing.

Interestingly enough, I found almost all my observation very much similar to an ethnographic study conducted in an Australian preschool (Wyeth, 2006). Wyeth described similar daily routines, for example, group indoor and outdoor activities, highly flexible activities planning, fluid and evolving activities, immersive but short-lived engagement in activities (p.1227), which shows that children at this age behave very similarly, despite their geographical position.

8.2 Design experiments

Being at Skruttet, talking to the teachers, observing and interacting with children gave me lots of inspiration for my design process. Also, investigating related projects helped me to reveal certain patterns in design of musical objects for children and, discover areas which are not yet covered by existing work.

My work started with several design experiments and ended with a more refined prototype, the design of which was based on the feedback from all early experiments, as well as an analysis of the related work examples.

To decide on which experiments to conduct, I’ve sketched many different ideas, related to both sound-enabled objects, physical interaction using the whole body, different contexts of use (inside, outside, in small groups, alone, etc.). After reviewing their properties and trying to find similarities, I categorized them into two major clusters of ideas - concepts in which sound was mediated through toys, and concepts in which sound was mediated through body (with a help of physical artifacts).
Next are the descriptions of the experiments, which relate to both chosen categories.

**8.3 Sound-Enabled Toys**

For the first experiment I chose to prototype how children would interact with music, which is mediated through the plush toys. Earlier in the text I have referred to the role of a toy in children’s lives. Toys have always been a part of childhood.
Means of play, sources of learning and sometimes even reasons for conflicts, toys are a necessary part of a preschool environment.

I wanted to explore how having sound embedded in such familiar objects as plush toys could influence children’s engagement and interest in playing with sound, and, with the sound-enabled toys in particular. Could children develop a stronger sense of attachment to a toy, if it was interactive? Would it be interesting for children to hear their own voice through a speaker in a toy? Would they construct dialogues between the toys? With these questions in mind I started to prepare for my first design experiment.

For the experiment five plush toys were enabled with a sound-recording component - Olympus VN-3100 dictaphones. The dictaphones were hidden in soft cases with color-coded control buttons (record, stop and play). Cases also had straps sewed to them, which allowed them to be fixed on the toy’s shoulders. As an additional way to fix dictaphones to the toys I used velcro tape. I tried to make the soft cases with the dictaphones look like small backpacks. All of the toys embraced a specific character or an animal, there was a sheep, a dinosaur, a teddy bear as well as two characters from the famous cartoons - a yellow bear Winnie-the-Pooh and a sloth Sid from Ice Age.

Figure 14. Sound-Enabled Toys prototype

With these sound-enabled toys the children could record different sounds, their own voices or sing songs. To start recording you should press the record button, then press the stop button to stop the recording, and then press the play button to listen for the recorded sound.

8.3.1 What happened during the experiment

When I arrived at Skruttet my bag with prototypes was immediately noticed by one of the children. He kept asking me “When are we going to play with the toys?”. 
Then, to avoid chaos, the teacher divided all children in two groups, from eight to ten children in the each group. Each group spent about forty minutes interacting with the prototypes.

We started the session with the first group. With the help of the teacher we explained to the children how they could interact with the prototypes. We didn’t insinuate any specific game to play with the toys, but rather just showed how to record, stop and play back the sounds. After the first group had played enough with the prototypes, we invited children from the second group.

![Figure 15. Children interacting with Sound-Enabled Toys](image)

Overall children from the both groups were engaged in interacting with the prototypes. Both groups explored the prototypes on their own as well as tried playing a singing game with the teacher. While observing children, I found several interesting patterns in their reaction towards the prototypes:

- when children first got the toys in their hands, the majority thought that the dictaphones were cell phones. They constantly tried to separate ‘the phone’ from the toy to use it for ‘calling’. This could be because the form of the dictaphones together with the buttons slightly resembled a phone. However, it seemed that the children were more excited about the idea that inside these bags there could be ‘phones’ instead of recording devices. Later when the children tried to record their first sounds, they became very excited and did not refer to the toys as phones any more.

- the interest in the toys increased exponentially; more children became more confident with the toys and their interest increased while observing others playing with the toys.

- smaller children (around two years old) could not manage the interaction. Mainly, they couldn’t understand when to press the record button when the teacher asked everybody to do so. I assume, the main reason was their age and the complexity of the task. Moreover, it was very noisy, and some children could simply not hear the task.

- when some children pressed the record button, then didn’t say anything. Probably because they didn’t know what to say or were too shy to speak. Then after some time they normally said something and pressed the play button, but because of the silence in the beginning, there was a delay in playback as well.
Children couldn’t make a connection between the silence and them not saying anything, and thought that the device was broken.

- some children spoke very softly in the microphone, almost whispering. Maybe they tried to tell a secret to the toy, or simply were too shy to say things aloud. As a result, the recording was hardly audible, especially considering the noisy environment.

- the level of engagement was high when the recording was successful and children could clearly hear their voices. They usually laughed and continued playing, thus making other children interested as well.

- the flow of buttons how I presented them ‘press record, then press stop, then press play’ was too confusing for many children. However, some children accidentally figured out that it was actually not necessary to press the stop button in order to play back the last recording.

- the feedback sound of the dictaphones was also noticed by the children and made them curious. Each time one presses a button (record, stop or play) there was a feedback sound (blip), however it didn’t cause any major interruptions in the flow of the experiment.

- the children were excited to sing and then listen to the popular songs they knew. First the teachers initiated to record children’s favorite song Manboy by Eric Saade. Children knew and loved this song, and later were engaged in singing it over and over again.

- the character of the toys influenced the results. For example, one girl wanted to play with Winnie-the-Pooh, but she couldn’t get it at the moment, because somebody else was playing with it. This made the girl very angry. She refused to play with another toy, as the teacher proposed to her, and went to the other room. Another boy recognized a sloth from the Ice Age animation, which made him very happy, because it was his favorite character. It shows that children create a personal relationship with toys and a toy’s character impacts child’s empathy towards it.

8.3.2 Analysis

In general, children understood how to interact with the toys quite quickly except the younger ones. The fact that the dictaphone was connected to a toy and was supposed to be its integral part was not clear to the children. Perhaps, this happened because the cases were a little bit loose, and the dictaphones could be easily taken out. Many children did so, because children usually take things apart.

As I previously heard from the teachers, children at Skruttet like it a lot to play with mobile phones, and sometimes the teachers give them their own phones. The children got very excited when they thought there were phones inside the cases, because they played with phones before, and they liked it. I am not sure if modern

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3 I left this toy at Skruttet after the experiment.
children are always more excited about phones versus usual toys, or if it is just because for children at Skruttet phones were associated with some special moments when the teachers allowed them to play with their own phones, but it seems that today “a phone” is a solid part of children’s toy repertoire. This also signifies that new toys were understood by the children in relation to other toys which are familiar to them. When they saw a new unfamiliar toy they related it to a toy they knew - a phone, because for them it looked familiar. With time the children understood how to interact with it, and did not associate the Sound-Enabled Toys with phones any more.

It is interesting how I hoped that the toy would be a center of attention, and the case with the dictaphones would serve a functional purpose of augmenting the toy with sound. The children, however, were interested in the dictaphones more, whereas the toys firstly were discarded. Besides the children’s interest in phones and screen-based applications, it also says something about how essential the integrity of all components is. For example, first the children were holding the dictaphones in their hands, while the toys were hanging upside down, and were not involved in the interaction. The role of the prototype transformed from being an animalistic toy to a phone for recording sounds. I wonder if the children would be more (or less) engaged if the control buttons were integrated directly in the body of the toy.

Still, once we sat in the circle and the teacher and me showed how to record a sound, children started to play with the toys as well. As soon as they became learned how to interact with the prototype, they didn’t try to separate the dictaphones from the toys anymore. A more formal setting influenced the way children interacted with the Sound-Enabled Toys. At the same time, explaining what are these toys and how do they work help children to understand the new play activity, and therefore their engagement in it.

It is also possible that the children were shy to interact wit the Sound-Enabled Toys because of me, since I was unfamiliar to them, and I could not talk to them in their own language. During my later experiments at Skruttet children seemed to be a lot more confident when I was around.

When later I listened to the audio recordings created by the children, I discovered that there were more than fifty files from all of the dictaphones. The first ten files were usually me, trying to perform a song to show how the recorders work. Then there were several soft children’s voices, almost whispers. And then later the voices became louder and the children performed big pieces of the popular songs - mostly, “Manboy” and “I will be popular” by Eric Saade. The children rehearsed the same song many times. Some children experimented with their voices for example by altering their pitch. One girl even sent a personal message to “a friend”, which shows children’s empathy towards the toys. I wonder what caused such empathy and intimate relationship with the toy.

Interestingly enough, although the experiment was a shared activity in which children were involved together, it was not really a collaboration as a joint effort to reach one goal. However, was observed that the children were exchanging the toys...
and forming small groups of two-three people to play with the toys together for a short amount of time.

Overall, the interaction with the toys was relatively easy for the children (except for the very small children). They understood how to record a sound and even found a shortcut (skipping the stop button). Some children tried to experiment with the sounds in a playful manner by producing funny sounds with their voices. Hearing back these funny sounds made children have a lot of fun. It became clear that the design of the toys matters and does influence children’s attitude. I didn’t notice children using sound recorders as a mean to give a ‘voice’ to the toys and act a dialogue between the toys. However, the time was not sufficient enough for much experimenting, perhaps, if the toys would stay at Skruttet for a week, the children would find different ways to play with them. One of the most important observations were certain patterns of interacting (soft speaking and delay in speaking), which confused the children while they were listening to their recordings. This behavior should be considered when designing toys with sound recording possibilities. Another important observation was that for small children sequential interaction is hard (press buttons in a certain order). It should be considered both when designing toys for small children, and for designing toys which could engage different age groups.

8.4 Magic Socks

For the second experiment I wanted to see how children would interact with different combinable sounds which they can activate through physical movements. Previously it was noted that children respond to music with the whole body. When children hear music they react with spontaneous movements like jumping and clapping hands. Also the previous field studies at Skruttet showed that corporeal experience of sound for children is as important as hearing it (Björgvinsson, 2011). Therefore, it was decided to conduct an experiment to explore the relationship between music, tangible objects and body movements. The experiment was framed in a way that children could wear a pair of special “magic socks” and hear music each time they jump.

To make the choice of sound more interesting I prepared six pairs of colored socks and six different pictures (a cat, a frog, a ghost, a rocket, an alien, and a kangaroo). I glued pictures on the small tags and put a sticky velcro on the back side, which then was attached to each pair of socks. Each picture corresponded to a specific sound (a cat to a cat meow, a ghost to a spooky sound, and etc.). All the sounds were prepared beforehand and programmed in a way that they would be played when a certain key in pressed on my laptop. The children were asked to wear a pair of socks, depending on which sound they would like to hear. The experiment was conducted with a Wizard of Oz method, so for children it would appear that the sound is played each time they jump, but in reality I was secretly pressing a key on my laptop.

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4 Wizard of Oz is a research method where users interact with a prototype which they believe to be functional but which is actually faked or secretly operated by another researcher (Green, Wei-Haas, 1985).
I was interested to compare the children’s reaction to the previous experiment with the toys. Would they be more or less interested to create sound in such a way? How will the children choose the socks? Will they try to combine different sounds? Will they try to jump in a way to make a certain melody? Is there any possibility for collaboration?

8.4.1 What happened during the experiment

The Magic Socks experiment was conducted with the same two groups of children, who had played with the sound-enabled toys in the previous experiment. The teacher and I explained to the children that these socks were magic, and they would make sound if you wear them and jump.

After we explained how the socks work, the first child took a pair of socks with an alien tag and put them on. After a couple of seconds of waiting he started to jump and I started pressing a key on my laptop, which I kept hidden behind my back.

I was worried that the children would see the laptop and that would be a reason for them to lose interest in the experiment. But once they heard the sound, more children became interested in trying out the socks and nobody payed attention to my laptop.

When the second and the third child chose their socks and started to jump, it became very noisy, but at the same time the children had a lot of fun. They kept jumping for several minutes without a break.

They stopped jumping to change the sound. First, the boy tried to take off the socks and put the other ones on, but the sound tag came loose and fell to the floor. Then the boy just took the tag from the other pair of socks and attached it to his socks, because it was a lot easier. He also tried to combine two tags together (one tag on the right sock, and another tag on the left sock).
While these three children were jumping, others were laughing because of all the funny sounds. They even started to mimic some of the sounds with their own voices.

8.4.2 Analysis

In general, I noticed that the children had a lot of fun while jumping in the magic socks. It is hard to say if the excitement was a consequence of the act of jumping or the sound feedback (since many children were laughing at some sounds and also mimicking them).

In retrospective, I feel that the experiment setup was too limiting - there was only one type of physical movement, and no possibility to affect different qualities of sound with the movements. I felt that jumping was quite exhausting for children, because they jumped actively for several minutes, but after that didn’t try it again. Also, the children who jumped were very concentrated on jumping itself, while those who sat still were laughing and mimicking the sounds.

Because the children swapped the tags, instead of changing the socks, it shows that they understood the correlation between a picture on the tag and a sound, and that the sound was not dependent on the color of socks.

Interestingly, one boy tried to experiment and jumped first on the one foot with one tag attached to a sock, and then switched and jumped on another foot with a different tag. This shows that bodily experience encourages self-expression among preschool children.

Another issue was that it was quite hard for the children to put the socks on and off. They were very tight, and the children had difficulties putting them on with their undeveloped fine motor skills. This consequently also distracted the children from the musical experience, because the process of changing socks took a lot of time and effort.

Also, having the voice recording functionality has proven to be successful in the previous experiment. In this setup, the children couldn’t control the sound with their voices. I felt that this possibility was lacking, especially when some children started to mimic the sounds coming from the speakers with their own voices.

This experiment was more task-oriented compared to the previous experiment, since children were asked to engage in a specific action - jumping. This created a less open play setting, but on the other hand children started to engage in the experiment quite fast.

As a result, this experiment showed that having physical artifacts while controlling music with body movements complicated the interaction for the children. In the setup of my experiment, it was hard for the children to exchange socks and tags, and jumping was too tiring. However, I think the results were mostly influenced by the limited range of movements and difficulties with the socks. Having no physical artifacts while interacting through body actions was successfully implemented in
the Funky Forest (Watson, Gobeille, 2007) installation, where children could control the ecosystem of the forest just with their bodies. This type of interaction is, however, outside of my thesis scope. For my future work I would consider to experiment with musical interaction with pure bodily control.

8.5 A Mission From Space

Children at preschool age experience problems with answering why-questions (Abeele et al, 2007). By reformulating the question “Can you show me your toys?” instead of “Why do you like playing with toys?” the researcher can get interesting feedback from children. Children at preschool age can not fully reflect on their experience, and the understanding of abstract concepts is hard. Children’s reflection is only possible through action (Abeele et al, 2007). That is why I chose to gain additional research information in a form of a creative assignment for kids, which would unveil children’s ideas about musical instruments and sounds. I intended to gain insights on how children perceive sound, what they find the most interesting, which musical instruments they could imagine.

Previously in one of my interview sessions the teacher told me that children enjoy treasure hunting activities, as well as activities when they are asked to help with something. Inspired by this advice I decided to present my assignment kit as a parcel which arrived at Skruttet from Space with a call to help a robot named Roboten get back music and sounds, which were stolen from his planet Planeticus Kosmocus4.

I used a big cardboard box to make a space parcel. To make the box look appropriate for something which arrived from space, I wrapped it in tin foil paper. Inside the box I put a dvd with a recorded video message, colored pens and pencils, scissors, glue, lots of colorful paper, voice recorders (the same which I’ve used in the Music-Enabled Toys experiment, but this time there were no toys), and a picture of Roboten.

Figure 17. The parcel from space
To make the video message I had to make myself a robot suit and filmed myself against a black background. I asked Livia Sunnesson (a native Swedish speaker) to voiceover the message to the children, as if Roboten would speak Swedish. I hoped this way it would be easier for the children to understand the task, since in the previous two experiments it was really hard for me to explain the prototypes to the children.

In the video Roboten told the children that there was only one way to get music back to Planeticus Kosmocus4 - if children at Skruttet would draw different musical instruments and record their favorite songs with the help of the sound recorders and send them back to Space. After the end of the experiment I put all the drawings back in the box and told the children that I will deliver it back to Planeticus Kosmocus4.

8.5.1 What happened during the experiment

The whole group, approximately twenty children, was gathered in the biggest room of Skruttet. The teacher set up the projector and explained the purpose of our gathering. Then we took the dvd from the box and showed the video on the big projection screen.

The children were very enthusiastic during the movie. We showed the video twice, so children would really understand the assignment. After they watched the video for the second time, the teacher repeated the task slowly again, then everybody took paper and pencils and started to draw.

The teacher asked every child who had finished his drawing what kind of instrument it was and how it worked. She took notes for me and wrote them on the back side of the drawing. Since drawings mostly looked like random shapes and lines, without the children’s interpretation it would be impossible to draw any conclusions. I was fascinated how interesting many of the drawings were. And I am very grateful to the teacher who talked to the children in Swedish o get their explanation.
In addition, I’ve received several dictaphone recordings created by the children. This time since all of them were familiar with the interface of the recording device, the children used it more confidently. They did not have any issues with the buttons and did not have any long pauses either.

The session lasted for about forty minutes. Because we were in the big room with sport equipment and slides, it was very noisy. While some children were drawing and recording sounds, others were running around, playing with the ball, going down the slides, throwing the pillows, and playing the piano. After the course of thirty minutes almost everybody was playing with the ball, and only a few children were still drawing. Having a big group like this makes it very hard to keep everybody engaged in doing one thing. Later the teacher repeated the drawing session in a smaller group of children.

I could not evaluate how much children really liked Roboten or if they believed he was real. However, the teacher told me later that children liked him a lot.

### 8.5.2 Drawing results from the big group

Almost every child contributed a drawing. Needless to say, at preschool age children usually make very abstract drawings, however, they had a clear idea of what they wanted to draw. After interpreting the teacher’s notes, I divided the children’s drawings in two categories. The transcribed notes are listed below.

**Conventional instruments:**

1. You pull the strings (shows by sliding his finger across the paper) to make music. (Oliver)
2. Instrument. You blow to hear different sounds. (Emmi)
3. Trumpet which sounds “ho ho ho” (demonstrates with her hands and mouth how to blow and make sound). (Nic)
4. A guitar. You pull the strings to play. (Isac)
5. Maracas - shake gently, then it sounds. They do not sound the same, because one if larger then other one. (Isak)
6. Microphone. You sing in it and here comes the sound. (Liam)
7. Guitar - you put it in your hand and play here. (Anders)
8. Trumpet. You blow here. (Jacob)
9. You strum the string to play. (Liam)
10. To play you take the pen with the little ball and drag it on the strings (Emilia)
11. These are the drums, they sound different. (Eda)
12. Guitar. You pull the strings to play. (Anton)

Imaginary instruments:
1. An audio crocodile. (Tobias)
2. Maracas with 4 sides and a stick. You hit it with the stick when playing. (Emilia)
3. An audio crocodile. You blow in the tail. (Alicia)
4. A kind of guitar that you blow in to play. (Josefine)
5. Glass maracas are shaken up and down. Box maracas are shaken up and down. (Melker)
6. A set of rods that you play on. (Linnea)
7. A bag that you can play with. The paper rustles. (Eda)
8. From Oliver to Space (title of the drawing). This is a piano-guitar. You hold it against the handle and then play with your fingers. (Oliver)

The children mostly drew instruments which they were familiar with (e.g. guitars and maracas). Interestingly, the drawing session showed that children can understand embodied qualities of sound. For example, Isak associated the size of the instruments with the volume of the sound. It is interesting how they also copy each others ideas. For instance Alicia drew an “audio crocodile” after she saw that Tobias did that first. The drawings also showed that children combine different patterns of interaction which they are familiar with to form a new way of interaction - Josefine made a guitar in which one should blow to play. I found that one
personal message “From Oliver to Space” to be truly charming. This occasion and generally high level of engagement of children in the experiment activity shows how important a story is which accompanies our designs for children. A story can evoke personal connection and empathy, and engage children in interaction. During one of my conversations with the teacher at Skruttet she said that a story around an activity or a toy for children could be as important as the activity or the toy itself. Previous field work also showed that the teachers at Skruttet often define everyday activities as something very special, for example, a play in a sandpit as a journey to another country (Björgvinsson, 2011). Thus framing of activities is important for children’s engagement in them.

Figure 21. Oliver’s piano-guitar

The recordings which were left on the dictaphones contained both children songs and popular songs, laughs, giggles, and other funny sounds. The funny sounds and giggles were the consequence of the amusing atmosphere in the room. The songs which children have recorded were the same popular songs by Erik Saade - the constant children’s favorite.

8.5.3 Drawing results from the small group

When we conducted the second drawing session in a smaller group, it was around four children drawing at the same time. The environment was a lot more calm and the children were engaged in drawing for a longer period of time. The children were asked to invent a musical instrument and send it to Space. Similar to the previous drawing session the teacher took the notes while the children were explaining their drawings. The notes are listed below:
1. A piano. You make sound by moving fingers on the keys. (Linnea, 4 years)
2. You can shake it and it plays Twinkle Twinkle little star. (Tobby, 3 years)
3. This is a rock music band. It plays rock. You just have to put a tape in and HammerFall’s\textsuperscript{5} music comes out. It just sounds like drums and like this “Hmmmmm Hmmmmm”. (Oliver, 4 years)

4. Guitar and drums. (Fillip, 5 years)

5. You play like this (\textit{shows with her hands}), but the instrument has no sound. (Theresa, 3 years)

6. That is the band. That is where you put the band. You do like this and it sounds like a guitar. (Jacob, 4 years)

Figure 22. Fillip’s guitar and drums

The children’s ideas that were collected in a small group were not much different from the ideas collected in a big group. Still the children mentioned pianos and drums, which are familiar to them, as well as regular interaction patterns (e.g. shaking, pressing the keys). Obviously children at this age have a lot smaller baggage of knowledge than adults. This questions children’s actual role in the design process, and what is their true input. Earlier I said that involving preschool children in the design process as equal partners is hard they can not contribute to the process on the equal terms with adults, which is now verified by the results of this experiment. It is still valuable to obtain input from preschool children, and I believe no good design could be done without children’s involvement in the design process. However, it is the responsibility of a designer to understand the age limitations and possibilities of children at their age and involve them in the design process accordingly.

As an additional exercise the teacher asked children to think which songs or sounds they would send to Space. The children and the teacher sat around in the circle and everybody had to answer the question about their favorite songs or sounds. The teacher was writing what the children were saying and put all the notes in the small box, wrapped in a tin foils (the teacher wanted to continue the space theme in this session too). Below is the list of children’s ideas transcribed from the notes:

1. Guitar, “I will be popular” song and the sound of wind. (Jacob, 4 years)

\textsuperscript{5} A Swedish rock band.
2. I like harp music the most and piano. (Emilie, 4 years)
3. I have to think about a song. (after a few seconds she sings a song). (Selma, 4 years)
4. The Hello Kitty song. (Athena, 3 years)
5. “I will be popular”. Hope they like it. (Liam, 5 years)
6. “Manboy” too. (Liam, 5 years)
7. A party sound! “Yeah its my birthday!” (Helga, 4 years)
8. Music is fun. (Nic, 3 years)
9. Rock’n’roll band and a door music - it’s when you shut up the door. (Oliver, 4 years)

Most of the children preferred their favorite popular songs. It might be, that music for children is something that they can if not understand, but at least relate to. And it is easier to relate to a pop-idol, which the older brothers and sisters are listening to, than, for example, an abstract sound. It is also influenced by the tendency of small children to share interests and copy each other’s opinions.

8.5.4 Analysis

It is possible to get a lot of information out of children’s drawings if you listen to what children are saying while they draw or ask them to explain the drawing when it is finished. As I already stated in the beginning of this report, my communication with children was mostly happening through the teacher’s translations. So first the teacher had to write down the notes of what the kids said, which she translated them to English, and only then I got the chance to interpret her notes. This chain of transformations of initially ambiguous oral reflections produced by the kids certainly has influenced the result. And, unfortunately, I did not have a chance to catch all those small comments which the children made.

However, even considering all the limitation of the experiment’s setting, I was very inspired by the results. Even from those translated notes it was possible to observe certain patterns, for example, children’s interest in a particular pop-song.
Interestingly enough, nobody had made a drawing of a mobile phone, considering children’s enormous delight in phone applications.

In general, the way the assignment was presented to the children was quite successful, and most of the children seemed interested and involved in the process. From observing how the children were involved in drawing pictures and imagining songs for Roboten, it shows again the potential of combining music interaction in preschool with fictionalizing or creative framing of music activities.

One of the issues that emerged from observing the children’s engagement in the experiment is big group dynamics. The first drawing session was conducted in a big group of children, which heavily influenced their engagement. Half of the group lost the attention very fast - they started to run around and play with the ball, while the other half was busy with the drawing assignment. Many experiments with children made by other researchers are usually conducted in small groups in order to have the situation under control. I tested my previous prototypes in smaller groups as well. It was indeed a lot easier to observe children. However, in real preschool environment children could be gathered in bigger groups often and then children’s behavior changes a lot faster. They are getting bored and distracted easier. Even if an idea or a design is intended for a smaller group, I think it is beneficial to still put it in such an environment to see how that idea or design might fit. For example, when some children started to play with a ball, others became exited and started to throw the sound recorders like a ball. As soon as the context changed, the roles of the objects changed too.

8.5.5 Method evaluation

Choosing a video performance as a way to overcome the language barrier in presenting an assignment worked well, however, having somebody who speaks the language is essential to take notes and ask children questions. It is especially relevant at preschool age when children are still developing their ability to reflect on their activities, and when they certainly can not write yet. I aim to investigate the validity of the method with older children (or even adults) in the future.

I hope that somebody will take it further and implement a similar story-lined strategy of gathering data from preschool children in a long-run project. I believe that adjusting research methods to a specific user group is essential, especially when working with small children. A Mission From Space assignment was successfully fictionalized and caused a high level of engagement among the children. Similar engagement caused by the framing of activity was also observed during the Magic Socks experiment. The children became interested in the experiment, right after they heard the word “magic”. One boy even asked the teacher later if those socks were really magic, and then told that he had never seen something like that before.
9. Turning knowledge into action

Once the experiments with the Sound-Enabled Toys, the Magic Socks, and A Mission From Space were completed, the collected data helped me to conduct the final experiment to explore the research objective of facilitating collaborative and playful engaging activities through tangible interfaces for making music among preschool children. The last experiment in my design process helped to gather the final data, draw conclusions and elaborate on the possible use cases of the proposed design solution, as well as reflect on the peculiarities of working with preschool children as a user group.

9.1 Learnings from research and the conducted experiments

The goal for the final experiment, as well as many design decisions, is based on the insights collected as results from my earlier work within this project. After comparing the results of the Sound-Enabled Toys and the Magic Socks experiments, it was concluded that the use of tangible objects while engaging with music is more rewarding when the music is mediated through the objects, whereas adding the possibility to control music through body movements and tangible objects is making things more complicated for preschool children.

The experiment with the sound-enabled toys also showed that recording children’s voices and then playing them back is an enjoyable process for children. However, it takes time for children to get familiar with a new toy and a new way to play, which may cause children to be confused and frustrated. It is especially relevant when children have to use their own voice to interact with the new toy, because they become very shy to speak or sing. It was found later that, as time passes, the children are becoming more comfortable with singing and experimenting with their own voice, as well as with new people in their environment, that is why it is important to allow soft children’s voices sound loud, rather than trying to change children’s singing patterns.

It was also found out that the meaning of the toy is fluid, and changes while children interact with it.

The Magic Socks experiment revealed that children enjoy experimenting with sound though combining different objects (in the experiment they were the sound tags).

A Mission From Space experiment showed that children associate playing with music and sounds with tangible interaction, like pulling strings, shaking or blowing. The issue of group dynamic was also found: children are active in big groups and tend to join other children in their play. That is why in order to create an engaging toy for a kindergarten environment, it is important that the design facilitates group interaction, however, playing alone should be also possible.
I found modularity to be a valid way to support both collaborative and solitary play, as well as support possibility for expressive and constructive play. The earlier discussed projects Music Blocks and Siftables, as well as other popular construction toys, e.g. LEGO (Lego.com, 2012), show the relevance of introducing modular toys in children’s play. However, there is not much research in the area of modular musical toys for children available. This shows the relevance for designers to explore if playful and engaging musical play can be achieved with modular musical toys. For preschool children modular toys offer infinite possibilities for creativity and provide a delightful experience (Ackermann, 2004, p.138), a feel of control over their own play, and a possibility to continuously iterate while playing. Children enjoy taking things apart, break and build over again - they learn through this process. That’s why, blocks and shapes which offer possibilities for constructive play, are one of the most common toys for preschool children.

However, while discussed modular musical toys (Music Blocks, Siftables) are cube-shaped, robust and focused on mechanical interactions like pressing buttons or shifting objects, something abstract like sound might not necessarily comply with that pattern. Even though previously mentioned products seems to be successful among different audiences, I saw the necessity to create and test my final prototype, which would explore affective aspects of modular interaction. As a result, I created the Sound Friends, a set of soft creature-like modular music toys, as opposed to design cube-shaped modules.

### 9.2 Sound Friends

Sound friends is a modular musical toy, which consist of several blob-like creatures with long hands, each of which has one musical ability - either adding a sound to the whole melody or applying an effect to it. One of the toys has a microcontroller inside and has the ability to record children’s voices. To record a sound, a child should press the button, say something, and then release it to stop the recording. This will create a sound loop. Now it is possible to start experimenting and add other samples or effects. To add an effect or a sample to the sound loop, a child must attach an effect toy to the main loop toy. In this way modularity is performed - creatures are connected by “holding each other’s hands”, like true friends would do. I hoped that in this way it would be possible to frame musical play as a play with friendly toys, which then would open possibilities for children to imagine how these friends could play music together.

There are several aspects of the Sound Friends’ design which differentiate it from the other available products. Firstly, being modular in functionality, but solid in piece it is intended to facilitate collaborative musical play, in which each piece has its own character and can be used in an independent play. Secondly, the design of creature-like toys shifts away from the cube-paradigm. By making this experiment I wanted to unveil if a design which has the musical potential of Music Blocks could offer possibilities for playful interaction like it could be with non-interactive toys. In addition, I intended to evaluate Sound Friends’ impact on children’s engagement and involvement in musical play and the way modularity support collaborative play in a preschool context.

Below are elaborations on the key design decisions:
“Big enough not to be lost, and small enough to be taken outside” was the advice I’ve received from one of the teachers at Skruttet. With the medium size of the toys children are not bound to the classroom as the one and only play space. If sewed from a water-proof and easily-cleaned material, in summer the toys could be taken outside to explore the ambient soundscape. Complemented by the size, the ability to work wirelessly is also an important feature for this design. The current prototype was intended to be a proof of concept, and the wireless functionality was not achieved. However, if taken further, it would be essential to make the toys work wirelessly.

Character
Since these toys are not intended to teach music but rather facilitate play and dialogues between children, I decided to choose likeable and soft creatures, to whom children would sing or whisper their songs, over robotic and mechanical cubes.

Figure 24. Early sketches of Sound Friends

I decided to design creatures specifically for this experiment and not use ready-made toys (unlike in the Sound-Enabled Toys experiment) for several reasons. Firstly, ready-made toys were not designed to be embedded with technology. Diverse design and unnecessary details can confuse children, which can influence the evaluation of the results. Secondly, when designing specifically for the idea certain details can be taken into account, for example, feedback LEDs. Lastly, design is important in creating the right feel of the toy, which can be also evaluated and criticized during the testing session.

6 While working on this project I remembered many things from my own childhood. For example, that I had a doll theater and a bag with many different hand puppets. My favorite were a hedgehog and a fox, particularly because of the way they looked and the feeling of their scratchy surface. I didn’t like the others as much.
Another issue is that existing toys bring their stories to the interaction. For example, as it happened during the experiment with the Sound-Enabled Toys, one boy recognized Sid, a toy from Ice Age, and was attached to this toy because it was his favorite character from the movie. These stories behind the existing toys could also have an interesting and unexpected impact on the interaction, but for this prototype it was important to see the results which are not affected by other factors.

Every creature had a body with long hands. Long hands make the creatures look funny, and extend the play space (children can sit in a circle or in a row and still use the toys), which opens more possibilities for playful interaction: toys could be worn on the neck, on the body, or wrapped around trees. The length of the hands could be extended with special tube-like add-ons. To test the prototype I creates two creatures and two tube-like hand extensions.

![Figure 25. Finished Sound Friends prototype](image)

**Connection between units**

There are two ways to create a connection between units in modular toys - wireless, like bluetooth or infrared communication (e.g. Siftables), or physical, in which objects are physically connected to each other or to a main platform (e.g. Music Blocks).

I chose to connect units physically to emphasize the relation of the objects to each other, because of the fluidity of activities and the fact that children assign different meanings and functions to their toys. Unlike Siftables, my prototype is going to be used in a messy space, with many other toys around, therefore, it is important to clearly show which toys belong to the same group. In addition, when connected, instead of being a bunch of small toys, they become one big toy. I found this transformation very interesting to investigate further.

There are many different ways to implement physical connection in modular toys, for example, metal buttons, magnetic snaps, conductive velcro, etc. Initially I decided to use magnetic snaps, because it would provide the necessary sturdiness of the connection, wouldn't require much fine motor skills from children (unlike buttons), and would be very fast to connect and disconnect, which is essential to create a smooth musical experience. However, when I built the connections, it did not work as smoothly as I expected. It was hard to achieve a stable connection for all five inputs, because I used a wooden plate which didn’t have enough
suspension to keep all five magnets connected. Moreover, the glue which I used couldn’t hold the magnets, and they fell out of its’ holders within a week.

For the sake of making a working prototype, I decided to use conductive velcro instead. I stitched conductive thread onto usual velcro and connected the thread to the wires. The connections were more stable than in the previous version, however, the interaction of opening and closing velcro was less smooth compared to snapping magnets together. I used a T-shaped velcro to make it easier for children to connect hands as it is important for a proper identification of the toys. I hoped that children would try to match two shapes and therefore connect two hands correctly.

For the potential final version of the prototype I would still consider to use magnetic snaps instead of velcro, because it is easier to connect magnets and the connection remains sturdy. I would consider using springs and some sort of cushions to which magnets would be attached. In this way, I hope, it would be possible to achieve the desired connection.

Figure 26. Failed version of connections with magnets

Figure 27. Velcro connections
Music output
In total I created four toys, each of which had its own musical function. The first creature toy could record sound and voices and play them back as loops. The second creature toy would start playing a small piano composition. One of the tube-like toys would make the pitch of the current melody higher, which would make the voice loop sound especially funny. Another tube-like toy would start playing a funky beat sample.

It is possible to listen to some of the melodies produced by the prototype here: http://soundcloud.com/soundfriends-1/sets/soundfriends

Prototyping platform
The musical part was prototyped in Max/Msp (Cycling 74, 2012), and the electronic part was prototyped on the Arduino platform. Max/Msp (Arduino, 2012) was a software of choice because it is a fast visual programming language, which is mainly used for music and media creation. Max/Msp allows to change and test values on the fly, without a need to run the code through a compiler, as it is in the text-based environments. This allows flexible and fast manipulations with values, which is essential when working with music.

9.2.1 What happened during the experiment

I tested the Sound Friends prototype at the preschool Lilla Maria in Malmö. Unfortunately, I could not test the prototype at Skruttet, because most of the teachers and children went on their summer vacation. But the atmosphere at Lilla Maria preschool is very similar to Skruttet. However, very young children (two-three years old) are separated from those who are older than three years old. Their daily activities are very similar to Skruttet as well: they have indoors activities in the morning, which are more formal gatherings, after lunch children are engaged in free play activities inside or outside, depending on the weather.

I had a chance to test the prototype at Lilla Maria two times with two different groups of children. The first group was very young, with children from two to three years old. In the second group children were as old as most of the children at Skruttet: from three to four years old.
First test
The first experiment was conducted in a group of twelve children, who were two and three years old, and four teachers. We gathered all together in a small room, and sat in the circle. I introduced my concept and showed how the toys work. Then the first boy tried to record sound with the prototype. The interaction with the prototype seemed quite complicated for the children. The boy pressed the record button and did not say anything. But after several attempts the children managed to record their first sound loops. When the children heard their own voices they became very delighted. Later, the teachers and the children sang a song all together and I was the one to control the voice recordings. I showed to the children how to connect the toys and add a melody to the sound loop, but they could not do that themselves. Still the children sang along with the teachers and were surprised to hear their own voices. In general, the children's reaction was positive, but it was hard to notice a distinguishable delight. Later I learnt from one of the children's parents that the children were in fact very excited about my experiment and expressed their impressions to their parents.

Figure 29. First test at Lilla Maria

Second test
The second experiment was conducted in a group of seven children from four to five years old, and three teachers. I introduced the prototype and some of the children tried to use it. However, at first the children seemed less engaged, and did not interact with the prototype much. Then the teachers and the children sang a song together and I kept the record button pressed, like we did in the previous experiment with the younger children. After that the atmosphere became more informal, the children were laughing when they heard their own voices. During their singing one of the speakers fell on the floor. The teachers immediately improvised and said “oooh”, so that on the recording later it was possible to hear the sound of a falling speaker and then exclamation “oooh”. When we played back the recorded song, this accident made both the children and the teachers laugh every time they heard the sounds of the falling speaker and “oooh” exclamation in the sound loop. After that I stepped aside and let the children interact with the prototype themselves. The children were very much involved in the play: they recorded a lot of sounds and tried to connect several toys together.

The children’s engagement in the play increased gradually with time. Their involvement became highly active: children started to jump and use the toys as their pillows, they were smashing the toys with their hands and covering them with their bodies. They were engaged in a very active physical play with the toys, and it was clear they were having a lot of fun during the course of it. It was surprising that
the children humanized the toys and started to talk to them: when one boy jumped on the toy so it stopped making sound he kept saying “Förlåt... Förlåt...” (from Swedish - “I am sorry...”) addressing the toy. The children also used command phrases like “Sluta!” and “Pråta!” (from Swedish - “Stop it!” and “Speak!”) to interact with the toys. The sound output produced by the toys made children laugh a lot and facilitated their engagement.

The children understood that it was possible to connect the toys together. However, the way it was realized in the prototype was difficult for children. I hoped that the T-shaped velcro would help children to understand how the toy should be connected. However, the children could not comprehend how to connects shapes, and connect the toys in an unsystematic manner. This brings an important observation - there was no “right” or “wrong” connection between the toys for children, once the toys were anyhow connected the children expected the music outcome to happen. I saw a girl who made a circle from a tube-like toy and was playing with it. The current prototype did not support that each toy would have autonomous sound abilities, they could only work if they are connected to each other. However, this observation shows the importance of such functionality mainly to support fluidity in a group interaction, when children switch between playing in a group and playing on their own.

Another important finding was that the children assigned different functions to the toys. A girl made a circle from the long tube-like toy and put it on her head, thus from being a hand extension for the sound creatures it became a crown for wearing it on the head.
9.2.2 Analysis

Overall, both the children and the teachers enjoyed interacting with the Sound Friends prototype. Even though in the first experiment children had difficulties recording the sound by themselves, they enjoyed group singing and then hearing their own voices. I envisioned that at this age children would have difficulties interacting with the prototype, because the similar situation happened during the Sound-Enabled Toys experiment at Skruttet: the two-year old children could not understand the sequence of actions to record the sound. It is hard for children at this age process multiple step directives, because of their limited audio processing abilities. Only by the age of three children can understand easy multiple-step directions (Seefeldt, Wasik, 2006, p.56).

At Skruttet I was mainly working with the children who are older than three years old. The Sound Friends prototype was designed for that age group. However, I believe that interactive sound toys could be used by younger preschool children as well, if teachers would orchestrate the process and would help children to interact with toys. It is hard for children at this age to operate interactive toys, which require multiple steps, themselves but they enjoy the audio feedback that the toys produce. The teachers at Lilla Maria pointed that hearing children’s own voices is very beneficial for children’s development.

The interaction with the button to record the sound was challenging for the children in the first experiment. I tried to design it as “kids-friendly” as possible: big, so it could be easily pressed with the whole palm. But the interaction was very tiring for the children as they could not keep the button pressed for longer than ten seconds. I consider that the button paradigm was too complicated for two-year old children. It would be interesting to investigate eve more embodied interaction. For example, the sound loops could be recorded by squeezing or hugging the toy instead of pressing the button. I think that for smaller children the recording of the sound loops should stop automatically, because it is very hard for them to bear this step in mind when they record a sound. However, then it will not be possible to record a long song in this case.

The age difference was important to assess the interaction. Two tests in different age groups showed that both very young and older children could interact with the prototype and enjoy their play, though the older group obviously displayed more independent and skilled interaction. The fact that I could not fully assess the enthusiasm in the group of children shows that observation as a method to collect data is not sufficient for children younger than three years old. It is important that designers talk to the teachers or, if possible, the parents of the children, as they are the people whom children trust and share their true experiences.

The fact that both age groups (but in particular the youngest one) started to interact with the prototype after the teachers initiated to sing and record a full song which the children were familiar with. This could be explained that at this age children can not make informed decisions by themselves - it is a challenge for them to think several steps ahead like adults. Therefore, they can not conclude that if the toy supports recording and playing back functionality, then to enjoy the toy they can try
singing their favorite song. For that they need either more time for exploration or an a teacher’s encouragement and involvement.

The design of the toys as a set of likeable creatures did influence the children’s attitude. I believe such incidents when the children talked to the toys as they were alive add another emotional level to the musical play, which makes play activities more personal. The material of the toys and their size are also influenced the way the children treated the toys. Because the toys were very soft and light the children were throwing them and jumping on them. Similar observation was made by Berglin when she reported that the children were throwing the toys which were very light (2005).

The way the children tried to connect the toys together questions how comprehensible the design should be. From the musical play point of view the fact that it was hard for children to understand how to connect the toys interrupted the sound exploration. On the other hand, many popular children’s games for developing logical thinking such as giggle puzzle games make children experiment with shape comparability and teach them to find the right piece through trial and error exploration. Depending on the design objective researchers should choose whether to provide a smooth uninterrupted experience or to challenge children’s logical skills by introducing design limitations. Still, while observing children’s play I ascertained in the potential of magnetic snaps for the toy’s hands, because the magnetic attraction would help children connect the toys easily, while velcro definitely required more developed fine motor skills.

Lastly, the reoccurred shifting of the toy’s functions and meanings allows us to conclude that designers should be aware of this phenomena because it will have an impact of the way the interactive object is used by the children.

9.2.3 How Sound Friends could be used

The current version of the prototype works only as a proof of concept. Every toy could have a microcontroller inside, and could be used independently. The interaction could be enriched with different sensors, like stretch or pressure sensors. The design of the toys can be more complex as well, for example, a toy can have several different hands, allowing to attach more than two other toys to it. A more advanced prototype could be used in a variety of situations and, perhaps, even games. I imagine several use cases for the Sound Friends prototype, which would be interesting to test as a continuation of this project.

Figure 32. A stretch sensor

Wearable instrument
The toys could be worn on the body to dance together with the sound. During the second experiment at Lilla Maria one girl connected the long arm toy in a circle and put it on her head like a daisy-chain.

**Sound catcher**
The toys can be used outside. For example, it could be attached to a tree to catch bird sounds.

![Figure 33. Wearable instrument](image1.png)  ![Figure 34. Sound catcher](image2.png)

**A game for several children and a teacher**
Children sit in a circle and play a game, similar to a reading session at Skruttet. Each toy is responsible for a sound or effect. The teacher orchestrates the play, e.g. “And now the frog sound came to visit a dog”, in which case the child who holds a toy with a frog sound should connect to it to a toy which has a dog sound. This type of game could teach children to memorize sounds and collaborate.

![Figure 35. A game for several children and a teacher](image3.png)

**Walking rope**
Long toys could be connected together and become a rope, which is normally used in Swedish preschools when children are going for a walk outside the territory of a preschool. Children could control the sound by squashing the rope, or stretching it.
10. Reflections and discussion

In my project I tried to research how tangible interaction for making music and sound facilitates collaborative and playful activities among preschool children. To investigate this I went through an exciting design journey in which I encountered various aspects of working with preschool children which I believe are important for designers who will further work with not only musical playful activities but children’s play in general.

Three early design experiments, the Sound-Enabled Toys, the Magic Socks and A Mission From Space, helped me to gain useful insights about children's interaction with musical toys, while the final prototype Sound Friends helped to strengthen my early conclusions from the early experiments and draw conclusions about the use of tangible musical toys in children's play. Through the reflection on my design process I contemplate the considerations for interaction designers in their future research for children and with children.

10.1 Tangible interaction in children's collaborative musical play

The results of my design experiments showed that toys could be a way to get the “best of both worlds” for musical collaborative play. Physical toys facilitate a shared play space in which children can interact collaboratively but also independently without leaving the rest of the group. Both literature review and the outcomes of my design experiments verified that children’s play is a constantly changing, fluid process - children flow in and out of the group, collaborate and then play on their own. In this way, I conclude that in order to support children’s engagement in collaborative play activities interactive design solutions should support both collaborative and solitary interaction. To support this aspect of collaborative play among preschool children I proposed a set of musical modular toys - the Sound Friends. I conducted two play tests with the children, which proved that the modularity and the autonomy of single modules' functionality could be a potential solution to support collaborative musical play. The tests showed that the children engaged in the play with the toys both in small groups, and on their own.

I believe that implication of toys in the context of musical play is an interesting area for designers to investigate further. Toys are open for reinterpretation and new uses. My design experiments and observations showed that it is very common for children to assign new functions and meanings to their play objects, which in return impact children’s engagement in play activity as well as supports fluid group dynamics. Using toys is also good for framing play activities. I noticed that children’s engagement in the activities in influenced by the way the activities are introduced to them. The positive level of engagement because of the fictional
framing was observed in the Magic Socks, A Mission From Space, and the Sound Friends experiments.

The test of the Sound Friends prototype together with the children at Lilla Maria preschool proved that recording and playing back children’s voices supports playful interaction among both the children and the teachers. Children have a lot of fun from hearing looping sounds, funny audio effects and samples, and the variety of those encourage musical exploration. We can speculate that by placing the Sound Friends in a preschool permanently it would provide children with playful interaction which supports transformability, help them gain more courage in their own abilities concerning singing and experimenting with sounds, and teach them to make more complex musical interactions just by exploring and playing.

With the Sound Friends concept, a set of modular musical soft toys, I provided a different perspective on how musical modular interactive objects could look like and how they could behave compared to the existing products. I believe that such creature-like likeable toys support playful musical activities and open possibilities for further research for the new means to support collaborative tangible musical play among children.

10.2 The aspects of design research with preschool children

Design research with children is a challenging task for interaction designers. Interaction design practice implicated that users should be involved in the design process as it is a way to gain valuable insights about users’ true needs and interests. As an interaction designer I shared this approach however while working with preschool children I encountered two different aspects of it.

Preschool children can not be equal partners in the design process, because they can not adequately reflect on their experiences and express their points of view. Therefore, children’s needs and interests are either gained through observations, which are of course then interpreted by the adults, or through talking to the adults who can have a trusted opinion about children’s needs and interests - their preschool’s teachers or their parents. This of course brings design research to the border of designing with or for children. I believe that it is the responsibility of a designer to find the best way to approach such a sensitive user group. Before starting my design process I anticipated that if working in situ, at a preschool, I would be able to understand my user group best. However in the process I found that it is more complicated than that. Small children could be reluctant to new experiences, new toys, and especially new people. For researches, it then becomes harder to evaluate children’s engagement and experience. A solution for these situations is patience, because children will become more enthusiastic with time, and collaboration with the teachers or parents, who can help researchers to understand children’s reactions. Therefore, in order to conduct research with children it is essential to observe them in their natural environment and cooperate with trusted adults who spent a lot of time with them.

My communication with the children in this project was also complicated because I can not speak Swedish, the language the children speak. Involving the teachers in the design process helped me a lot to gather data and draw conclusions. But to find another solution to this circumstance I tried to fictionalize A Mission From
Space experiment, and presented the assignment to the children as a movie in their native language. Obviously, I still needed the teachers’ help to interpret the children’s inputs, but I discovered that framing the research in such a way also increased engagement among the children thus helped me and the teachers to collect more data. I see the potential for interaction designers to fictionalize design research and frame it appropriately for the user group, because such approach can increase engagement among the users and create empathy towards the researcher, thus it will help to increase users’ involvement and their interest in the research. To conclude, in order to create child-friendly products designers should conduct a child-friendly research. I believe this approach could be valuable to research not only for collaborative musical play among preschool children, but also for the whole field of interaction design.
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