MOTIVATIONS FOR INTERACTION: A STUDY ON CHILD-ROBOTIC TOY INTERACTION

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ABSTRACT

MOTIVATIONS FOR INTERACTION: A STUDY ON CHILD-ROBOTIC TOY INTERACTION

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One of the main target groups for social robots is children. There are various robots designed for children under the category of robotic toys, usually designed to look like a pet and interact with children using sensors, a monitor and software component. However, in order to create successful interactions between a child and a robot, there must be a stimulus for children to interact with them. A study was conducted with the aims of identifying the levels of social bonds occurring between the child and robotic toy, and determining the features of a robotic toy that motivate children for interaction. For this end, 14 children participants were observed during play with a robotic toy with two game options. The 14 children were chosen from two different age groups (4-5 year-olds and 8-9 year-olds) to play with a robotic toy in their school. The data was subjected to quantitative and qualitative analyses, revealing the successful and problematic features of the robotic toy and its games, and the types of interaction displayed by the children. The types of interaction were categorized as physical interaction, facial expressions and looking directions, and communication. Among the differences identified between the interactions of the two age groups were durations of interaction, level of engagement with features of the toy, types of physical interaction, guidance and communication requests from the researcher, and the personification of the robotic toy for the younger age group. In the light of these results, a set of suggestions for designing a robotic toy for successful and engaging interactions are made.

Keywords: Child-robot interaction, robotic toy, participant observation.

ÖZ

ETKİLEŞİM İÇİN MOTİVASYON: ÇOCUK VE ROBOTİK OYUNCAK ETKİLEŞİMİ ÜZERİNE BİR ARAŞTIRMA

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İnsanlarla birçok ortamda etkileşmek üzere tasarlanan sosyal robotların önemli hedef kitlelerinden biri de çocuklardır. Piyasada ve araştırma için kullanılan çocuklar için tasarlanmış birçok örnek bulunmaktadır. Bunlar genelde bakıldığında, bir evcil hayvana benzeyen, sensorlerle donatılmış, monitor şekilde yüz veya gözlere ve bir yazılıma sahiptir. Fakat, bu robotlarla başarılı etkileşimlerin sağlanması için önemli olan çocukların etkileşim için motivasyonudur. Robotik oyuncak ve çocuk etkileşiminde ortaya çıkan sosyal bağın seviyesini, özelliklerini çocuğun etkileşim için motivasyonunu, çocuk gelişimi ve çocuk robot etkileşimi literatür araştırması ile birlikte inceleyen bir araştırma yürütülmüştür. Bu amaçla iki farklı yaş grubundan oluşan 14 çocuk (4-5 yaş ve 8-9 yaş) kendi okullarında, iki oyun opsiyonu olan bir robotik oyuncakla oynamak üzere seçildi. Elde edilen veriler, nitel ve nicel araştırmaya tabi tutuldu. Ortaya çıkan sonuçlar, robotik oyuncağın ve oyunlarının başarılı ve problematik özelliklerini, etkileşim çeşitlerini, yüz ve beden ifadelerini, görsel temas ve iletişimleri hakkında bilgi sağladı. İki yaş grubu arasında etkileşim süreleri, meşgul olma seviyeleri, fiziksel etkileşim çeşitler, araştırmadan talep edilen yönlendirme ve iletişim gereksinimi ve daha küçük yaş grubu için oyuncağı kişilik verme belirgin farklar olarak görülmüştür. Sonuçlar ışığında, başarılı bir etkileşim sağlayan bir robotik oyuncak tasarımı için önerilerde bulunulmuştur.

Anahtar Kelimeler: Çocuk-robot etkileşimi, robotik oyuncak, katılımcı gözlemi.

To my family...

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Social robots, which are considered to be a transition forms between living creatures and products, have started to occupy bigger roles in different environments. In the last decade robots obtained highly enhanced sensory abilities, cognitive skills, autonomy and safety of use with the help of technological advancements and successful integrations of artificial intelligence (Fernaeus et al., 2010). These developments, sophisticated designs and a higher level of mimicking human abilities contributed to their acceptance by the society in public and domestic environments. In recent years, the aim was to find ways of developing robots which learn new skills, master them and teach them to others. Those principles promise a great potential for the future. In order to use this potential, the human-robot interaction needs to be further improved and expanded with transdisciplinary methods.

One of the main target groups for social robots is children. In the recent studies it was found that children react to social robots more intensely and can create an engagement more efficiently compared to adolescents or adults (Belpaeme et al., 2012, Ros et al, 2011). There are already some examples of robots designed as a companion for children in the market or for research purposes. A social robot can be, for example, a companion for a child with diabetes to ensure the stability of her/his conditions and assist her/his to take care of themselves properly (Henkemans et al. 2013). It can be a playful and educational robotic toy for teaching colors, animal names and sounds for younger children, such as Ixi-Play (Dirkx, Bart & Ruud van de Aalst, 2014). Just like toys usually designed for preparing children for the real world, a social robot could prefer them for social life, teaching social manners and interact with them using the basic principles of social interactions.

1.2 Problem Statement

Like in every case, there must be a stimulus for children to be engaged. Child -robot interaction studies focuses on improving and suggesting stimulus for children for better interactions. Tanaka et al. (2012) suggest that, over time, a social robot designed to interact with humans, starts to act repetitively without showing signs of human traits, like an overly-developed machine, fails to engage people in interactions. In a study conducted by Leite et al. (2009), it is suggested that in time, a robot with predictable actions fails to motivate children to engage. In their study, they suggest that a robot designed for children to interact with should suggest new behaviors over time to keep them motivated.

The term 'child' includes a wide range in age. According to WHO ("HIV/ AIDS: Definition of key terms," 2013) a person above a year old and below the age of 19 can be considered as a child. However, the age between ten and nineteen is considered the adolescence stage for a child. As deducted from this definition, child is a broad term. However, in child development, even a difference of one year in age can contribute greatly to a child's behaviors and skills. For that reason, it is important to take the age differences of children into consideration when designing interaction between a child and a robot. Furthermore, Sharman et al. (2004) stress the importance of knowledge in child development and observing children in order to understand their actions.

For this end, two different age groups with remarkably different behavior patterns were selected to be observed for the study. The younger age group which is 4-5 year-olds are addressed as "preschoolers". At these ages, children highly creative and even some of them might have imaginary friends. They can be recognized as at the stage of adapting to interacting with other peers, and have a little social relation with people other than their family members. On the other side, 8-9 year-olds are the older age group with improved skills. They have already started their formal education and have social relation with their friends. Furthermore, they have improved motor skills which can help them to be involved in many activities.

This thesis aims to investigate ways to improve engagement and motivations for children to interact with a robotic toy. For this objective, a literature research on child development has been carried out a market research on robotic toys were made and a field study has been conducted.

1.3 Research Questions

The main question of the thesis is:

- How can the design of robotic toys be improved for motivating children for interaction?

The sub-questions are:

- What are the developmental, behavioral and play capabilities of children at the ages of 4-5 and 8-9?
- What are the current robotic toys' features used for motivating interaction?
- How do the tangible features of robots impact the child's interaction with a robotic toy?
- What are the types of interaction occurring during play between a child and a robotic toy?

1.4 Aim of the Study

The study aims to point out the obstacles and improvement opportunities in the field of child-robot interaction. Children of different ages are used in the study to investigate the differences in their interactions with a robotic toy. The conclusion from the study will contribute to the field as a guidance for designers who would like to design a robotic toy for children considering different age groups and their capabilities, aiming to create the desired sustainable and engaging interactions.

1.6 Structure of the Thesis

The thesis consists of six chapters. The first chapter gives an introduction to the research field, the problem, raised questions and aim of the study. Moreover, before

getting a start into exploring the literature, it provides definitions of important concepts mentioned in further chapters.

Chapter 2 includes literature researcher on child development of the two age group (4-5 year-olds and 8-9 year-olds). The research on child development divided into 4 categories: social and emotional capabilities, language and communication capabilities, cognitive capabilities and movement capabilities. Each categories' effect on a child's play behavior is also described in this section. At the end, differences and similarities of these two age groups are explained briefly.

Chapter 3, is about Human-Robot Interaction. In this chapter, the field of Human-robot interaction, child-robot interaction, robot applications and metrics used for evaluating the interaction are discussed. After these information, social robots, bonding with a social robot explained with some examples. At the end, robotic toys designed for children are included together with a market research.

Chapter 4 describes a field study carried out with a robotic toy. The study was conducted with 14 pupils in their school. Two different age groups of children were invited to participate in the survey. They were asked to play two card games with a robotic toy (Ixi) and then requested to explain their experiences to their classmates. The chapter illustrates the expected outcomes, planning, setup and the process of the study. In the end, findings for each participant are presented.

Chapter 5 includes the findings of the study conducted with Ixi. Findings are presented for each age group separately in terms of the successful and problematic features of the games and interactions occurred during the sessions.

Chapter 6 is the final chapter incusing the general conclusions and discussions. This chapter aims to answer the research questions constructed in the first chapter and includes design suggestions for a robotic toy improving motivations for interaction.

Finally, the documents used for the study can be found in the Appendices.

CHAPTER 2

CHILD DEVELOPMENT

In this chapter, it is aimed to explain the behavioral and social analysis of children in different age groups. In child development each year has a significant impact on a child's behavioral capabilities, social interactions and play activities. Therefore, it is important to understand different ages and their development in order to design engaging interactions.

People who are in the same social group interact with each other or interact with other individuals who belong to other social groups by using various methods and techniques of communication. According to a psychological research social interaction requires some key functionalities such as recognition of other individuals, the ability to find a mate, to be able to comprehend someone's place in the social hierarchy, to cooperate with others, form and maintain allegiances (Frith & Frith, 2001). This fact underlines the strict relation between mental capacity, perception, and social interaction. Mental capacity and level of intelligence are considerably lower at early ages of a human. As the child grows, mental abilities and understanding evolve, increase and most importantly, change (Bayley, 1955). The reflection of these mental changes can be witnessed in behaviors and actions. Through the earlier parts of human life span, mental and physical changes are relatively faster and much recognizable. In the light of this information, it can be assumed that the behavioral traits of children in early childhood and late childhood must be examined separately to get a clear picture.

2.1 Behavioral and Social Interaction of Children in Ages between 4-5

The children aged between 4-5 are usually called preschoolers because that particular age interval includes children who are preparing to start formal education in one or two years depending on country and teaching system. Researchers examine child

development and behavioral analysis under few categories. It is beneficial to collect data under few categories to understand what children of this particular age interval are capable of in terms of social interactions and behaviors.

The categories below mentioned are taken from a research made by United States Centers for Disease Control and Prevention ("CDC", 2009)

- Social & Emotional Capabilities
- Language & Communication Capabilities
- Cognitive Capabilities (Learning, Thinking, Problem Solving)
- Movement Capabilities & Physical Development

Considering the high child development speed at these ages, it might be a good idea to examine the capabilities for age 4 and Age 5 separately to get a better understanding of differences and similarities ("American Academy of Pediatrics", 1997).

2.1.1 Social & Emotional Capabilities of Children between ages 4-5

Frost et al. (2005, p.134) state:

> During the preschool years, children increasingly understand themselves as individuals: in addition, they understand themselves a part of a social world.

At the ages of 4-5, a child's social and emotional developments are highly influenced by the family members and friends around them. According to Frost et al. (2005) social and emotional capabilities can be discussed under these categories: Self-concept, self esteem, self-regulation of emotions, empathy and social competence.

One of the main concepts to discuss in social capabilities is self-concept, being aware of oneself (Hughes, 2009). A child at this age interval, starts to understand that s/he is an individual with own characteristics. S/he starts to feel a great self-esteem with the help of their evolved physical skills. Starting from the preschool years, a child starts to understand his/her feelings and the development of empathy. Frost et al. (2005) state that children at these ages are able to show support for a family member

or a friend. They also add that a child in this age group can understand others' emotions and is able to console them using their language skills as well as gestures.

At the age of 4, a child starts to prefer to interact and play with other kids more than spending time alone and able to cooperate with other children ("Raising Children Network", 2016) The child also expresses what s/he likes and what s/he is interested in. At this age children start to understand empathy. They start to feel and relate to their friends' feelings.

At the age of 5, the child gains the desire to become friends and please others. S/he starts to show signs of independence (exploring nearby areas or visiting neighbor by her/himself). Moreover, the child might be extremely demanding or very cooperative depending on personal choice (Hughes, 2009).

By the age of 5, a child is better at controlling their emotions and expressing them verbally. Instead of being impulsive, they are better at expressing their anger or annoyance with verbs (Charlesworth, 2013).

At these ages in general, children are at the stage of learning how to express their emotions. They start to get better at gestures and talking instead of being violent (Frost et al., 2005).

2.1.2 Social & Emotional Capabilities and Play of Children between Ages 4-5

As mentioned previously, children between ages 4 and 5 start to include other peers in their play activities. At the age of 4, a child shows social play elements as they might still play alone but they share, lend, are able to take turns inviting others to their activity and communicating (Hughes, 2009). A 4 year-old can engage in cooperative play which means playing a game together with another peer or peers to reach a common goal. While playing this game, they can assign roles to each other for instance while building a city using playing in a sandbox (Hughes, 2009).

As the child grows their play activities becomes more cooperative. At the age of 5, the play size groups starts to expend. A child can engage in a play with more than 3

children. A child can engage in sociodramatic play with peers. They can use their imagination together. While playing this game they usually choose roles like being a family member or a carrying out a known occupation. It is also suggested that props used for dramatic play should not be strictly structured to leave space.

2.1.3 Language & Communication Capabilities of Children between Ages 4-5

According to the sources, the child at the age of 4, is able to say first and last name fluently. S/he knows basic rules of grammar, just like the correct use of “he” and “she.” S/he can memorize basic songs and nursery rhymes; sing and say them whenever they want. Furthermore, grammar capacity allows her/him to tell stories (Hagan, Shaw & Duncan, 2008).

A 5 year-old child is capable of saying her/his name and address fluently (Frost et al., 2005). She/he can build full sentences and tell a simple story using them very fluently and precisely. Compared to a 4 years old child, she/he knows more advanced rules of grammar and can use the future tense.

2.1.4 Language & Communication Capabilities of Children between Ages 4-5 and Play

According to Frost. et al. (2005) language in play can be categorized into two: play with language and language used in play. When language is the main element of play, there are many examples. At the early ages, children can use language for making animal sounds and they can use language for telling jokes or rhymes.

Frost et al. (2005) state that "when language is used as a tool in play, it is necessarily a social event." (p.133). Language and communication become a tool in games such as pretend and dramatic play. When children at this age interval play the pretend play, they can use language to tell extended storylines and different characters, roles and talk about the events.

In dramatic play, communication and language have an significant role for children to carry out. Child imitates the tone of voice and expressions of the character they are

representing (Frost et al., 2005). Puppets can be props while using the language skills.

Children at this age group cannot verbalize their emotions as well as adults but they can express them in play activities. They can do this in both solitary and sociodramatic play. Sociodramatic play is more intense in expressing emotions (Hughes, 2009).

2.1.5 Cognitive Capabilities of Children between Ages 4-5

Cognitive capabilities are about learning, thinking and problem solving. Frost et al. (2005) state that "between the ages of 4 and 7, the preoperational child enters the intuitive thought substage, when primitive reasoning begins." (p.126). This means a child is able to focus on one certain thing but not two at a time.

A 4 year-old child knows some colors and some numbers. S/he can understand the method of counting. S/he has the perception of the concept of time and can remember a story partially. The concepts of “same” and “different” can be understood by him/her. S/he can visualize and draw a person with 2 to 4 separate body parts can start to visualize and copy capital letters. Also, S/he can play board or card games (Frost et al., 2005).

There are some improvements in terms of cognitive capabilities at the age of 5. A 5 year-old child can visualize and draw a person with at least 6 separate body parts. S/he can print some letters and numbers and understands basic general concepts like food and money. Also, s/he has a better understanding of geometric shapes compared to a 4 years old and has the ability to copy them ("American Academy of Pediatrics", 1993).

2.1.6 Cognitive Capabilities and Play of Children between Ages 4-5

Cognitive skills are supported with play activities. At this age interval, a child has a very intense imaginary and creative world. S/he uses this during their sociodramatic play activities (Hughes, 2009). This type of game allows him/her to imitate the real world in a very creative way. To support this play activity, dolls or stuffed animals

can be the play materials. A child at this age interval can enjoy dressing according to their dramatic play role or dress their dolls. S/he can also enjoy playing with house equipment toys. Also at this ages, a child can participate in simple board and card games (Frost et al., 2005).

2.1.7 Movement Capabilities & Physical Development of Children between Ages 4-5

Children at this age interval compared to the previous years, have rapid developments in fine-motor and gross-motor abilities. These developments allow them to feel secure and self confident in their physical movements ("American Academy of Pediatrics", 1993).

A 4 years old can jump and stands on single foot about 2 seconds and capable of catching a bouncing ball. S/he can cut with adult supervision, pour and mash her/his own food (Frost et al., 2005).

There is a significant improvement compared to a 4 years old, at the age of 5 in terms of movement and physical capabilities. A 5 years old can stands on a single foot for 10 seconds or longer. S/he can jump, swing and climb. And even maybe able to skip in some cases. She/he able to somersault and use a fork and spoon. Also, can use table knife under adult supervision. She/he can go the toilet by herself / himself without any parent supervision. She/he enjoys singing, dancing, and acting (Hughes, 2009).

2.1.8 Movement Capabilities & Physical Development and Play of Children between Ages 4-5

Fine-motor skills are about the coordination of hands and fingers. At the age of 4, children are able to engage in many activities. They are able to play with toys with large buttons, play block building with different shaped pieces (Hughes, 2009). At the age of 5, a child is interested in displaying his/her skills. S/he can be interested playing with realistic tool toys like workbench with tools, playing cards, table games and board games with dice which is luck based rather than strategy (Hughes, 2009). They can also enjoy playing with transportation toys.

Gross-motor skills involve the usage of large muscles that allow to children to move, run, hop and climb. At the age of 4 and 5 their physical developments allow them to play chasing games. Their gross-motor skills also allow them to hit and catch a ball.

2.1.9 Key Findings on the Behavioral & Social Interaction of Children in Ages Between 4- 5

Children at this age interval learn and experience in the methods of expressing themselves and share their emotions with other individuals. They use different methods to express themselves like talking, singing, drawing, painting, using body gestures and telling fictional and imaginary stories. They like to sing, dance and act ("Raising Children Network", 2016).

At these ages some children have imaginary friends. Playing is a vital part of their lives. This is how they learn and explore their feelings. Playing is also an important method of learning for them ("American Academy of Pediatrics", 1993).

They discover the sharp distinction between truth, reality and fantasy. They might tell lies. It might be for a purpose or non-purpose. They become curious about their bodies. They perceive the concept of opposites. They can understand numbers, mostly in order of 10. They like being physically active for most of the time (Frost et al., 2005).

2.2 Behavioral and Social Interaction of Children in Ages between 8-9

The children between ages of 6 and 9 are usually categorized as the 'middle years' of the childhood era pedagogically ("CYWHS", 2016). It has been seen that there are some notable differences and similarities in behavior and development among children aged 6-8 and aged 9-11. According to some resources age 8 signifies the end of first part of middle years of the childhood and 9 is the start of another era for the development of the child ("CDC", 2009). On the other hand, they are both considered to be in the transition era to puberty and have some similarities. Due to this change of development, the ages 8-9 are considered to be grouped together.

The categories of child development and behavioral analysis used for ages 4-5 in Section 2.1, will be used similarly for this age group (8-9) for sustaining consistency and relevancy. Those particular categories are mentioned below again for being a reminder:

- Social & Emotional Capabilities
- Language & Communication Capabilities
- Cognitive Capabilities (Learning, Thinking, Problem Solving)
- Movement Capabilities & Physical Development

2.2.1 Social & Emotional Capabilities of Children Aged 8-9

According to the sources, at the age of 8, a child starts to think individually and has a stronger sense of person-hood. At this stage, signs of being competitive and signs of independence are observed. S/he shows more importance to friendship and has a tendency to become more cooperative and enjoying teamwork. At this stage S/he shows more interest in peers and adults outside of the family. S/he grows a desire to be liked by others and seeks for acceptance of others and wishes to become part of groups. As they start to understand what others think and feel, they can to express empathy. At this age, children can express their emotions and the reasons behind them (Lee, 2016).

At the age of 9, a child starts to build more complex and stronger relationship with people. S/he has an increased peer relationships and a stronger emphasis on having friends. A 9 years old child has the ability to cope with more emotional and social pressure from other people. S/he is more aware of her/his body as the puberty approaches, and S/he might have anxiety problems about appearance and social acceptance. S/he can work cooperatively on group projects ("American Academy of Pediatrics", 1993).

2.2.2 Social & Emotional Capabilities and Play of Children Aged 8-9

Children at this age interval prefer to cooperate and play together with their peers. They enjoy group activities with a certain interest. They can play structured role play

games using accessories and real-life like activities to support their play (Frost et al., 2005).

2.2.3 Language & Communication Capabilities of Children Aged 8-9

At this age interval, the language and communication skills continue to develop and get complex. At the age of 8, a child can follow and participate in more complex conversations. An average 8 old child learns almost 20 new words each day, most of them has been acquired reading or listening. S/he discovers new ways to express him/herself and can use alternative communication and self-expression methods: writing basic and short stories, making more complex drawings, learning an instrument. His/her has attentive to digital devices like computer, mobile phones, etc. and has the ability to learn their basic functionalities (Lee, 2016).

A 9 years old has language abilities and speech patterns start to look similar to adults. S/he can understand what appropriate social behavior is and behaves accordingly ("CDC", 2016). S/he enjoys sleepovers with friends and starts to categorize friends with various criteria and communicate with them according to that. A 9 years old child develops more sophisticated ways to express different feelings compared to an 8 years old.

2.2.4 Language & Communication Capabilities and Play of Children Aged 8-9

A child at this age group has a better understanding of words. S/he can play with words having two meaning and understand and use it in jokes or riddles (Frost et al., 2005).

Pretend game is a popular activity at this age interval. A 8 or 9 years old child can prepare advanced story lines and plan their play in detail (Frost et al., 2005). They are good at storytelling and can include their dolls and toys to support their game.

2.2.5 Cognitive Capabilities (Learning, Thinking, Problem Solving) of Children Aged 8-9

At the age of 8, fast and rapid developments of mental capacity and skills are observed. An 8 years old starts to learn better ways to express his/her feelings and experiences. S/he is less focus on his/herself and more concerned for others. At this stage, she/he has a better understanding of the relation between cause and effect and has lots of questions about the things around her/him. Furthermore, s/he can solve basic math problems (Hughes, 2009).

A 9 years old develops the capacity to deal with pressure and challenges at school and becomes more independent from family and relatives. S/he can build stronger empathy with others and shows attention and curiosity to others' opinions. His/her attention span gets longer compared to an 8 years old. S/he can have a hard time to wait for anticipated events and expects an immediate reward. At this age, the child can be interested in participating family's decision-making process. S/he can read various genre of literature works and capable of understanding more complex math concepts like division, geometry, and graphs ("CYWHS", 2016).

2.2.6 Cognitive Capabilities and Play of Children Aged 8-9

The cognitive skills of 8-9 years old and their play activities are more patterned, logical, and in order compared to the preschoolers (Hughes, 2009). Their play activities can be shaped with rules. They can likely to play games with cards, board games which follows certain play rules and also is competitive. They can even create new game rules while playing.

2.2.7 Movement Capabilities & Physical Development

At this age interval a child gains a higher level of flexibility, balance and agility (Hughes, 2009).

An 8 years old child is highly active and uses advanced patterns for travel (hop, leap and jump). S/he can travels in fast speed and change direction avoid others. S/he can create her/ his own dance movements and performs a simple dance with rhythm and

can perform a better and more mature form of leaping. Furthermore, S/he gets better at sustaining balance (Hagan, Shaw & Duncan, 2008).

At the age of 9, a child can combine movements and control objects efficiently (Frost et al, 2005). S/he understand personal space and defines her/his own area. At this age, a child understands the concept of moving in relation to a group (when playing games or dancing) and there is a rapid physical development and muscle gain as the puberty approaches.

2.2.8 Movement Capabilities & Physical Development and Play of Children Aged 8-9

At the age of 8-9, a child is highly active and involved in various activities. They can engage more in outdoor activities. They can participate in sports activities involving grouping or support more individual activities like swimming and tennis (Frost et al, 2005). They also enjoy activities with high level of effort such as biking and chasing. Their motor skills allow them to get better in a favorite sports activity.

2.2.9 Key Findings on the Behavioral & Social Interaction of Children in Ages Between 8- 9

Children at the ages of 8-9 show empathy for others. They know proper social behaviors and try to behave accordingly. They have an attention span of about one hour per session. At this stage, they develop the ability to work cooperatively on group projects. They can learn and improve themselves in abstract concepts and math ("American Academy of Pediatrics", 1993).

They enjoy having new friends and being part of social groups. They can classify friends and relationships. They possess much higher motor skills and use them (for activities such as drawing, and playing a musical instrument). They have increased stamina for highly physical activities (Hughes, 2009). They understand the need for proper hygiene and apply it. They enjoy reading books in different genres.

CHAPTER 3

HUMAN-ROBOT INTERACTION

Human-robot interaction (HRI) studies focus on designing, optimizing and evaluating the communication between humans and robots (Fong et al., 2003). The reason to interact with a robot is mainly to accomplish a certain task while working cooperatively with it. However, Goodrich & Schultz (2007) state that human robot interaction can be shaped differently and it is highly influenced by the distance between the two parties. The distance of interaction is categorized into two different types: remote interaction and proximate interaction.

Remote interaction is where the robot is controlled by the humans to accomplish a certain task in another environment (Scholtz, 2003). In this type of interaction, the robot's mobility, physical interaction and communication are important factors in the interaction.

The proximate interaction occurs when a human and a robot are in the same environment. In this interaction type, the robot can be an assistant, a companion, etc. This type of interaction requires both physical and social interaction in order for both parties to cooperate.

3.1.1 Applications

There are many areas that robots are used to work with humans, do tasks that they are not willing to do. Sheridan (2016) categorizes the applications into four different categories:

Doing Routine Tasks under Human's command: Robots controlled by humans to perform certain tasks. This type of application includes robots used in manufacturing assembly lines.

Tele-operators: These robots are also remote controlled by humans however their tasks are different. They are designed to perform tasks in places that are hazardous or inaccessible by humans, such as undersea or space. Their mobility and physical abilities are vital.

Automated Vehicles: Robots used in this category operate as self-driving cards, rail vehicles and commercial aircrafts where humans are their passengers. Trusting their autonomy and their ability on decision making are recent topics that are under research (Guillet et al., 2014).

Assistive and Educational Robots: This type of robots include robots designed for entertainment, teaching, providing assistance for children, elderly and disabled people. Assistive robots are one of the highest profiles in the area of Human-Robot Interaction studies (Sheridan, 2016). They are designed to assist and offer service in a close proximate to humans. The interaction shaped in this application, includes a peer-to-peer relationship. However, to be in the same environment and cooperate with robots requires the users to feel comfortable and have a certain level of trust in them. Thus, the studies in this field mainly focus on the social dimensions of the interaction.

3.1.2 Social Robots

Fong et al. (2003) categorize two different types of robots and their relation with research fields as shown in Figure 1. Collective robots represent a significant number of robots interacting with each other to finish a particular task cooperatively. Social robots, on the other side, are robots that interact with both humans and other robots and expected to show 'social manners' depending on their role. While collective robots need other robots to be recognized as substantive, social robots are like individuals and can involve in peer-to-peer interactions. Fong et al. (2003) subcategorized social robots depending on their level of sociability and interactions (Figure 1).

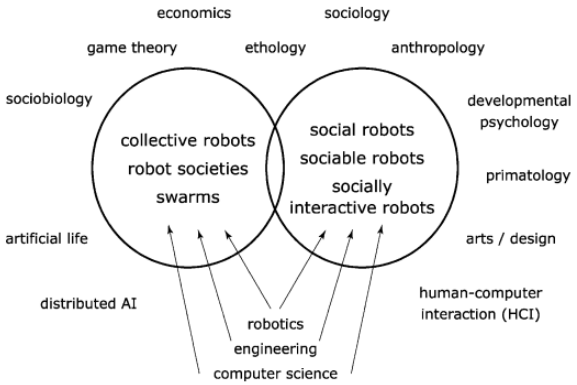

Figure 1 "Fields of major impact. Note that “collective robots” and “social robots” overlap where individuality plays a lesser role." (Fong et al., 2003, p. 145)

Social robots can have different roles. In the recent years, they have been designed as assistants, companions, and educational partners, as well as toys (Wada, 2005; Fernaeus et al., 2010). Their traits are generally described as follows:

Adaptability: Social robots can adapt, learn or imitate and improve through their lifespan (Breazeal, 2004).

Social Understanding: One of the most important factors of social robots is having social skills. They are expected to understand themselves and the relationships with others. They can record and share experiences and understand feelings (Breazeal, 2004; Dautenhahn, 1998).

Socially responding: Social robots can perceive and react to their social environment.

3.1.3 Design Approaches for Social Robots

From the perspective of design, the social robots and their development approaches are discussed in two main approaches, Biologically Inspired Design Approach and Functionally Design Approach (Fong et al. 2003).

Biologically Inspired Approach: With this approach, it is aimed to develop robots using knowledge from social sciences such as psychology, ethnology and sociology. These fields are used as guidance to develop robots with abilities to mimic and

perform live-like social behaviors (Bar-Cohen & Breazeal, 2003). The embodiment of biologically inspired robots are created by taking examples from real-life creatures. The main goal of these robots is to provide a full socially interactive experience to the users.

Functionally Design Approach: Functionally designed robots only show social capabilities as a reaction to human behavior (Steinfeld et al., 2006). They are designed not to be stand-alone life-like creatures but rather to bring social experiences when they are approached. Thus, this approach does not focus on understanding and implementing artificial intelligence. Their design approach is to use mechanisms that superficially have social abilities. They can provide a short-term social experience to humans.

3.1.4 Common Metrics used for Evaluating the Social Interaction

From social sciences to computer engineering, several fields with different perspectives are involved in creating and developing social robots (Steinfeld et al., 2006). Thus, how to evaluate the success of the interaction between humans and social robots is a topic of discussion. There are five main metrics used for evaluating the interaction that are applied in several researches with social robots.

Characteristics of the Interaction: This approach includes examining and assessing the interaction by diving it into the micro-behaviors (Dautenhahn & Werry, 2002). In their study with autistic children, Dautenhahn & Werry (2002) use this technique and analyze video recording and divide the interaction into micro-behavior codes such as gazing, touching, and operating the robot. They state that using this method for child-robot interaction studies can be a successful method for evaluating the interaction since children are not desired to be assets with questionnaires, likert-scales or interviews.

Persuasiveness: Evaluating the persuasiveness can be a method in the cases of the robots designed to have a therapy or behavior changing goals.

Trust: The trust concept is an important factor for humans to collaborate with robots. It is a metric used for evaluating where there is a need for human's adaptation in a new environment.

Engagement: In social interactions, engagement is an important factor for creating successful interactions (Steinfeld et al., 2006). Therefore, one of the key metrics for social interaction is measuring the engagement. To measure this, duration of interest, acquisition time, dialog and emotional expressions are used for analysis (Thrun et al., 2000).

Compliance: Compliance in terms of physical appearance and features are important in certain tasks and environments. It can have a significant influence on the amount of cooperation between a human and a robot for example, in a case where a social robot is in the role of an assistant (Goetz & Keisler, 2002).

3.2 Child-Robot Interaction

The interaction between a child and a robot is different from an adult's interaction with a robot since a child's social and behavioral developments are incomplete. Furthermore, children's perception of 'robot' can be different than adults. According to Belpaeme et al. (2013), children do not interpret a robot as a mechanical device like adults but rather they tend to see life-like characters in them. Thus, studies with children and robot are considered as another field, Child-Robot Interaction abbreviated as cHRI.

There are many applications of robots designed for children. The main applications are categorized and mentioned below.

Field of Education: Using robots as tutors for children is one of the application and research fields in cHRI. The motivations for this field is that when the effectiveness of screen-based technologies come together with an embodiment, successful experiences can be achieved (Janssen et al., 2011).

Health Care and Therapy: Recent studies showed that one the most effective fields for social robots is healthcare and therapy (Baxter et al., 2011, Belpaeme, 2013).

Animal assisted therapy (ATT) is a method used for patients improving their social and emotional mood. However, some hospitals and therapy centers do not accept animals to be there because of hygienic concerns. For this end, robot assisted therapy method is a method tried as a replacement for ATT. Some studies on children with diabetes and supporting robots which are designed to both support their treatment and teach how to treat themselves, had promising results showing a potential in this field of application (Sabanovic, 2013).

3.2.1 Robotic Toys

Robotic toys are defined as robots designed for usually children to interact with, with the intention of enabling them to spend activities such as play, creativity, playful learning, entertainment, and relaxation (Fernaeus et al., 2010). While doing so, robotic toys have to socially interact with children. Many robotic toys come in the shape of animals. There are also some humanoid examples and some do-it-yourself kits to create a personal robotic toy.

The qualities that separate robotic toys from other toys are that:

- ***They have sensors.*** Robotic toys have sensors helping them to perceive the actions around them and to respond.
- ***They have a software component.*** These components may allow them to connect to other smart devices or the World via the Internet.
- ***Robotic toys provide tangible experiences.*** Unlike other smart devices with software that children use for same activities, robotic toys provide tangible experiences that can support their motor skills development.

3.2.2 Evaluating Child-Robot Interaction

Evaluating child-robot interaction can be more challenging compared to the adults for several reasons. Firstly, different methods such as questionnaires, interviews and Likert scales are applicable to the adults; however, these methods may not work with children. They may tend to give answers to please the researcher. In some cases, their linguistic skills may not be enough to express their opinions. As an alternative, Belpaeme et al. (2013) suggest the usage of some parameters such as the duration of

interaction, the physical distance, and the form of their statements. Also, dividing the sessions of interaction into micro-behavior patterns can be an alternative for evaluating the effectiveness of the interaction (Dautenhahn & Werry, 2002).

Belpaeme et al.(2013) also state that an important factor in evaluating is to measure if the desired aim is met with the results. In cases of education, it is easy to measure the knowledge before and after and make a comparison like in a study conducted in Taiwan with an English teaching assistant robot (You et al., 2006). However, in the case of being a companion or a robotic toy, it is rather harder to make an assessment on performance which is a part in cHRI yet not fully addressed.

3.3 Social Bond

Humans are social creatures who usually tend to live in groups or communities. There is a certain set of emotional, cultural and humane bonds which members of these communities or groups build with other members of these communities. Hirschi (1969) states that social bonding occurs in four phases: attachments, involvements, investment and belief. Humans build relatively stronger and more emotionally powerful social bonds with people whom they are really close with, like family members, spouses or close friends. On the other hand they build relatively weaker, emotionally less powerful yet still meaningful social bonds with other people who are not much close to them, like colleagues, neighbors and community members. A recent research made by UNC Chapel Hill researchers has shown that social bonding with others is a necessity and it even has an important impact on one's health ("UNC Lineberger", 2016). However human beings are not the only ones we build social bonds with. We build social bonds with animals, especially with pets: cats, dogs, parrots, etc. (Brown, Richards & Wilson, 1996). It is safe to assume that many people who share their own home with a cat or dog, do not consider them differently from their family members.

Human beings can also build social bonds with objects, places and pieces of art they are deeply attached to (Waytz, Epley, & Cacioppo, 2010). As it can be seen from the information above, they tend to build social bonds with non-living objects with

which they do not have the possibility of getting into interaction. Robots can be considered within the scope of non-living objects at first sight. However considering the level of interaction and human-like attitude they are capable of now, they can be considered as the technological constructions which a human being can build social bonds with. In the remaining sections of this chapter, the real life scenarios of the social bonding with robotic toys will be examined.

3.3.1 Social Bonding with a Therapeutic Robot

An example of social bonding with a robotic toy is the interaction between elderly people at health service facility and seal robot Paro (Wada, 2005). One of the places where the research takes place is the Toyoura Town Medical Care Center, at the department specialized in taking care of elderly people. The research states that a special type of therapy which is called animal assisted therapy (AAT), that is focused on increasing the physical and psychological health status of elderly people, is popular and quite common in the United States (Wada, 2005). However it is mentioned that in Japan animals do not get permission to get into therapy centers and health institutions for health concerns. For that purpose a special kind of therapy robot has been used to treat the patients and elderly people in Japan by using animal assisted therapy technique. The robot is named Paro. Its body design mimics a small white seal. Paro moves by itself autonomously like a real seal; it moves its head and body around, looks at a certain place and makes movement gestures. Paro also reacts to touch, e.g. it shows appreciation when its body is petted. Paro also can recognize sound and gravitate towards when its name is mentioned.

Figure 2 A Group of Elderly Interacting with Paro (“Paro Robots US Inc.”, 2014)

Figure 2 shows two elderly people who are interacting with Paro. The research conducted in Toyoura Town Medical Care Center shows interesting results in terms of building social bonds with a robot. The paper claims that the elder people in the facility started to willingly interact with Paro from the very first day (Wada, 2005). They call its name, they pet Paro, stroke its body and kiss it. The research also claims that Paro has started to become a common topic for chat between elderly people and their care givers. They have started to make comments about Paro's body and how it looks. Elderly people gave Paro new names which are “Maro” and “Maru”. Considering how we give nicknames to people we love and care about or we name our beloved pets, this giving a new name incident gives an important clue about the level of social bonding between the elderly people in the facility and Paro. The research mentions the example of an elderly lady with dementia, who had depression as well. She decided to interact with Paro with her own consent and as a result, there has been some noticeable improvements on her health in short term. Another

example shows that another elderly patient treated to Paro like it is her grandchild. Considering the strength of the social bonds we tend to build with family members, this is a very interesting achievement of social bonding with robot. Figure 2 shows a very important sign of social bonding with a robot: an elderly lady in the facility kissing Paro.

Figure 3 An Elder Lady kissing Paro (Wada, 2005)

3.3.2 Social Bonding with Nao

Another example of social bonding with a robot comes from Aurora Project, a project designed for autistic children to increase their social skills ("The Aurora Project", 2013). The method used in this project provides support for the autistic children. The robots have been used to interact with the autistic children and encourage them to build social bonds with them. The robots that have been used in the research came in different shapes and sizes: a humanoid robot (real life size / doll size versions) and a dog robot (real life size / doll size versions). Children with autism are usually known for being socially passive or in other words socially isolated. They usually tend to ignore the other people around them, especially the ones that they do not know well and mostly try to avoid any possible social interaction chances with them. The research aims to improve their social interaction

capabilities by using robots. For the research, a stress-free environment has been built to avoid any distracters to cause problems for the possible interaction of autistic children (Robins, Dautenhahn & Dubowski, 2005). The room also has been designed to provide an important amount of freedom for the child-robot interaction. A series of experiments have been made in this environment. It is important to note that the various experiments took place under different conditions, with different robots and with different numbers of children to witness the changing results under different conditions to examine their effect.

Figure 4"Don interacting 'exclusively' with the robot, whilst Andy tries to ignore Don. Don actively seeks exclusive interaction with the robot, whilst Andy waits for exclusive opportunities to interact." (Robins, Dautenhahn & Dubowski, 2005, pp 3)

Figure 4 shows the interaction of two autistic children with the robot (Robins, Dautenhahn & Dubowski, 2005). Don is the older child and Andy is the younger one. While interacting with the robot, Don wanted to interact with the robot by himself and did not want Andy's company. Andy wanted to interact with the robot, yet Don prevented him with physical gestures, like using his arms to block his way to interact with the robot. As a result of this, Andy gave up and only tried to interact with the robot when Don was away. This small experimentation shows two things: the common tendency of autistic children to shy away from human interaction and their tendency to interact with a robot. Don liked the robot so much, he wanted to interact with it exclusively by preventing Andy. On the other hand, Andy still tried to interact with the robot and seeking for chances to getting in touch with it despite the prevention attempts of his older and physically larger friend. Autistic children usually find people unpredictable, so that makes the whole interaction with people problematic for them. This incident shows that both kids had built some kind of casual social bond with the robot, which is a much more predictable friend candidate with predictable and less varying degrees of interaction.

Figure 5 Six month later, Billy is ‘dancing’ again." (Robins, Dautenhahn & Dubowski, 2005, pp 5)

Figure 5 is taken from another session of the same research (Robins, Dautenhahn & Dubowski, 2005). Billy is the participant of the session and he is an autistic child. Bill has interacted with the same robot two times in six months. During the first trial Billy has passed from in front of the robot while making dance movements. In the next session after six months he made the same dance gestures and passed from in front of the robot in the same way. Also it has been claimed in the research that Billy has made his own unique goodbye sign towards the robot. The researchers take those behaviors as the sign of a social bond between Billy and robot. It strictly resembles the gestures we make when we encounter people with whom we built social bonds yet had not seen for a long time. It was clear that Billy had some kind emotional and social special place for the robot in his own memory.

In this section two different examples of social bonding with robots have been examined. Two examples contain people from two different age groups, cultural roots and health situations; yet both of them showed similar results in the end. Under certain conditions people take robots no different than other people or pets and they build social bonds with them.

3.4 Robotic Toys: Product Survey

The toy industry has transformed into being one of the key industries which shows slow but consistent growth year by year for last few decades. According to a recent report by NPD group United States toy market, which represents the biggest domestic toy industry in the world, the toy industry has shown %7 growth in 2015 and reached to 19.48 billion dollars in size ("Toy Association", 2016) The same

report estimates that the sales of "Youth Electronics" generated about 600 millions of dollars revenue in 2015. This data is meaningful for research purposes of this paper because robotic toys are usually considered as a subcategory of youth electronics section. According to the report, youth electronics constitutes about %3 of the whole toy market, which is a low percentage but leaves considerably big room to improve in the future.

This particular section focuses on the market research for robotic toys. The robotic toys mentioned in this section are chosen from the most popular robotic toy in the market or soon to be. Some of them also were selected to be reviewed because they were used for research purposes previously. These robotic toys were used in researches with elderly or children with special conditions (Wada, 2005, Henkemans et al., 2013). The results of these studies were promising, which drew attention in child-robot interaction studies and found to be worth mentioning.

3.4.1 Robotic Toys with Physical Appearances

Robotic toys have one important point in common: they all have some kind of significant physical form factor and can get in physical contact with people, other living beings and objects around them. The most significant and noticeable examples are listed below.

3.4.1.1 Nao

Figure 6 Physical Representation of a Nao Unit ("Softbank Robotics", 2016a)

Nao is a programmable robotic toy which is designed and developed by Softbank Robotics ("Softbank Robotics", 2016a). The development of Nao has started in 2006 and has been continuing since then. The robot has been designed in an iterative approach and has been updated four times since the release of the first version. Nao had been made available exclusively to academic institutions at first, then following revisions have been released commercially.

Nao is a human-like robotic toy. The creators have mentioned about seven key abilities of Nao, which make him socially interactive. Moving is the first of those abilities. Nao can move around the environment he is in with the help of its legs and also maintains its balance while moving and standing. Nao is also capable of expressing emotions. Nao is equipped with various sensors in different parts of its body, so it can sense what is around and behave accordingly. Nao has the ability of hearing and speaking with the help of its speakers and microphones. Nao is equipped with high-resolution cameras, so it can see the objects and living creatures

around it. Nao has the ability to connect to the Internet and digital devices around it via Wi-Fi and obtain data from them. Nao has been equipped with a specially designed software which allows it to mimic human behavior via showing artificial intelligence. However, in this case, artificial intelligence term is used for complex sequences of scripted events, but not a completely autonomous digital intelligence (Softbank Robotics", 2016b).

As mentioned above, Nao is currently in its fifth version under the title of “Nao V5: Evolution Robot” and is commercially available for sale with a price tag of 9500 dollars ("RobotLAB Inc.", 2016). Nao is not adopted by masses yet and only 9000 units have been sold in total since now.

3.4.1.2 Pepper

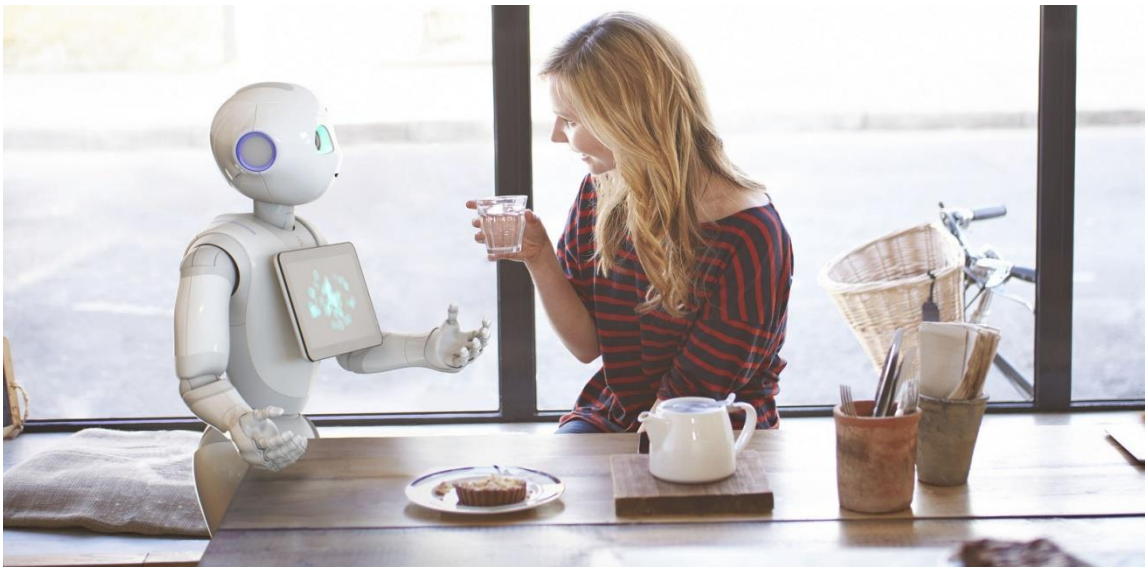

Figure 7 Representation of a Pepper Unit Interacting with A Human("Softbank Robotics", n.d.a)

Pepper is a robotic toy produced by Softbank Robotics, which is also the manufacturer of Nao, another social robot previously examined. Pepper also resembles a human figure with a humanoid body, head, and arms like Nao. Unlike Nao, Pepper does not have humanoid legs. Instead, it uses a wheel motor system to move around. Another physical and functional difference of Pepper compared to Nao is the small LED screen it has on its chest. This screen provides visual imagery and

feedback in communication. This screen also is the key instrument which is a sign of the main differences between Nao and Pepper. Pepper is more focused on human interaction and communication compared to Nao.

The designers of Pepper prefer to use the term “day-to-day companion” instead of being a simple robot to underline its exceptional communication and interaction skills ("Softbank Robotics", n.d.a). Pepper is the first robotic companion/toy which can perceive human emotions, behave accordingly and use basic yet proper communication techniques to sustain appropriate interaction with humans. The screen on Pepper's chest plays a central role in this interaction process by enabling visual feedback to the other side of the communication. Pepper also uses movement (mostly by using arms) and audible reactions for interacting with humans. Pepper has a complex voice recognition technology which helps it to identify a human's emotional state and mood ("Softbank Robotics", n.d.b).

Pepper has been used for both commercial purposes and at homes in Japan. It has been used for more than 140 Softbank Mobile Store to greet and help the customers. Pepper also helps clients in some Nescafe shops. Pepper has not been commercially available to customers, but the producer company is offering units in limited quantities to developers.

3.4.1.3 Jibo

Figure 8 Jibo Examining a Woman Who Prepares a Meal ("Jibo", 2016)

Jibo is another social robotic companion/toy which is designed to interact with human beings in mind ("Jibo", 2016).Compared to the two previous examples, Jibo carries serious differences in terms of physical appearance and functionality. Contrary to the two previous examples, Jibo does not show any traits of humanoid form factor. Jibo consists of the main body and a half spherical head unit. The head unit carries a led screen on the front which is used for the main tool of communication for Jibo. The head unit can rotate, however, body unit is stationary. Jibo cannot move in the environment, unlike many other robotic toys / companions. It has to be carried where you would like to interact with it.

Jibo comes with some abilities which cause him to be considered under the scope of social robots. Jibo is equipped with a camera; so it can see what's around, take photos and record videos. Jibo can hear and identify sounds with an integrated microphone. Jibo makes use of basic but efficient audible communication with built-in speakers. Jibo uses a basic sequence of commands to learn some primary tasks.

As it can be seen from the information above, form factor and a different set of functions put Jibo in a different place compared to other humanoid social robots. Jibo acts like a developed personal assistant who can help you in some of the daily tasks; e.g. showing you recipes while trying to cook almond cookies. It can also act as a security cam and notify you what is happening at your home while you are away.

3.2.1.4 Tapia

Figure 9 A Person Holding Tapia ("MJI Robotics", n.d.a)

Tapia is another example of tabletop social robots like Jibo. Tapia is shaped like a large egg with two eyes attached. Unlike Jibo the main body of Tapia consists of a single piece, instead of two separate parts. The body roughly weights 2.5 kilograms and is stationary. This means that it is not possible to see even the limited movement capabilities of Jibo in Tapia ("MJI Robotics", n.d.a.).

Tapia has an LCD screen attached on its body, which provides most of the communication feedback. The screen acts as Tapia's face in default mode, to be more precise two eyes are used for changing moods according to the emotional state of the communication. The screen has touch screen capabilities. The user can interact with Tapia by audible commands or just by interacting with the touch screen.

Tapia serves for some main purposes. Designers of Tapia underline some of them in a more noticeable ways compared to the others. First, one of these features is it being a life support unit. If Tapia is placed next to a baby, old or sick person, it can stream

video to the user with its built-in camera. Tapia can also call medical authorities and family members in case of need by using audible comments. Also, Tapia's camera helps it act as a security and surveillance device for homes. Tapia can read the daily news, play music or video to the user.

Producer company MJI Inc. started an Indiegogo campaign and an early adopter and developer version of Tapia can be acquired for 580 USD dollars ("Indiegogo", 2016).

3.2.1.5 Rokid

Figure 10 A Woman Interacting with Rokid ("Rokid", n.d.a)

Rokid is another example of tabletop social robots and one of the most sophisticated of them in many different ways. It consists of two stationary pieces attached to each other. The cylindrical base unit supports elliptical head unit. Designers of Rokid claim that one of the most noticeable differences of Rokid compared to the competition is the home automation focus ("Rokid", n.d.a). Rokid is designed to be the "soul" of a home. It can understand its user's commands, identify their habits and memorize them to use later whenever necessary.

Rokid is designed to help its user to control basic functions of the home like heating, ventilation, and security, in future revisions by using simple voice commands. For now, it records and streams video with its integrated camera. It is possible to tell Rokid about the music one likes or one's mood, and it will play it for its user.

Head unit includes special 3D protection system inside which helps the user to play videos within the elliptical body of it. Technically it is not a hologram, yet the visual effect carries noticeable resemblance.

In terms of physical appearance, mobility and functionality Rokid carries small resemblances in common with humanoid robot companions. It also does not provide enough feedback to sustain proper communication with a human, yet it still has considerably strong interaction capabilities with human beings by understanding commands and acting accordingly. Rokid is not available for sale at the moment.

3.2.1.6 MIP

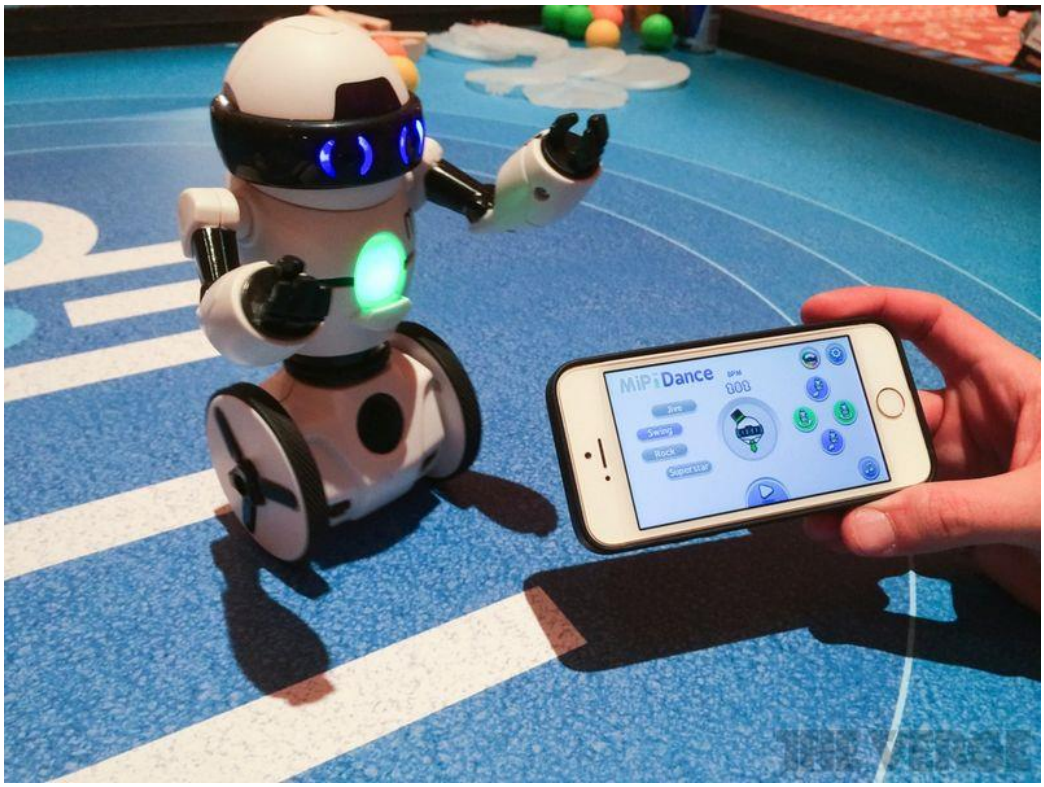

Figure 11 Two MIP Units in Different Colors ("WowWee", n.d.a)

MIP is a robotic toy produced by WowWee. So far the robotic units examined in this paper are robot companions which have the function of being robotic toys with many other functionalities. However, MIP is the first example of being a pure robotic toy with a limited set of functions and zero programmability ("WowWee", n.d.a).

As mentioned above MIP is a basic robotic toy, so what it can do is defined by its limitations of being a toy. MIP can be controlled to move wirelessly via smartphone apps and carry lightweight objects. MIP can detect basic gestures like swipe, touch, claps and show pre-determined reactions to them. MIP can also identify sounds and react to them. MIP can be acquired through online stores or toy stores for the price tag of 79 USD dollars.

3.2.1.7 Chip

Figure 12A Child Playing with Chip ("WowWee", n.d.b)

Chip is another robotic toy from WowWee, the company which produces MIP robotic toy as well ("WowWee", n.d.b). Chip carries a significant difference

compared to other robots examined previous parts of this research: Chip is a robotic pet, a robotic puppy.

The developer company claims that Chip is always ready to play and interact with the human beings just like a real puppy. Chip contains a particular set of technologies like infrared and gyroscope to help it perceive the environment around it and move in the most efficient way. Chip can try to interact and play with people, who are in the same environment. It also can be controlled with smartphone like MIP.

Chip has integrated voice recognition technology which helps recognize it owner's voice and react to it. Chip also has a touch sensor, which basically means it can feel when someone touches it. It is possible to interact with Chip by touching and petting it, just like a real dog.

3.2.1.8 Paro

Figure 13An Injured Child Interacting with Paro in Hospital

("Paro Robots US Inc.", 2014)

Paro is a robotic toy seal which is designed to serve a special purpose. Paro is a neuropathic robot toy which aims to bring animal therapy to hospitals without any side effects ("Paro Robots US Inc.", 2014). The first version of Paro was released in 2003. The developer company, AIST, claims that interacting with Paro reduces stress for both patients and their caregivers. The developer also claims that interacting with Paro improves the social traits of patients and helps them to relax.

To sustain an interaction Paro comes equipped with five different types of sensors: motion, light, temperature, audition and posture. With the help of those sensors Paro can recognize being petted. Paro can acknowledge and identify the difference between gentle and aggressive physical actions towards it and react accordingly. Paro likes being stroked and petted. When the user does that, Paro shows its happiness by changing its facial expression, making baby seal noise and moving its body and tail.

The user can give Paro a name and Paro can learn it. It can also learn what the user approves or does not approve. If Paro does something the user does not approve and the user hits it lightly after that, Paro can learn it and does not repeat that behavior later. Paro can do the same thing for positive behaviors and learn to repeat them with its owner's approval.

3.4.2 Possibility of Building Robotic Toys

This section focuses on the some significant examples of build your own robotic toys in the market. These examples are designed as kits with building blocks and allowing to be controlled via Bluetooth connection. They allow their users to create their customized personal robotic toy experiences. Some of them these examples require some technical knowledge on programming and electronics.

3.2.2.1 TIO

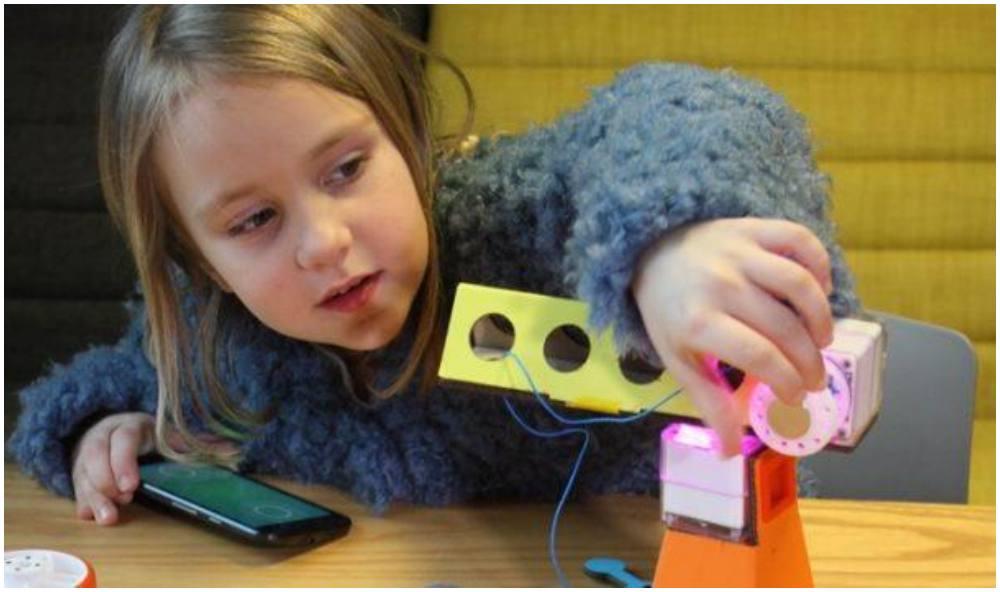

Figure 14 A Child Building Her Own Tio Robot Toy ("The James Dyson Foundation", 2016)

Tio Toys ("The James Dyson Foundation", 2016) is a make your own robot kit based on the concept of building blocks. The idea is based on bringing a main building block and other pieces together for building your personal robot or vehicle. Main building block contains a motor which can be controlled via Bluetooth connection. Main building blocks have led lights and a small battery that can be charged when it is needed. The building blocks can be built in various colors and allows creating unique designs. The kit consists of four main units: main building blocks, extra accessories, mount units and the software to control the robot. Mount units are used to connect main building block to other material or to another building block. While creating the robot, the player can use various materials of choice: plastic, Lego, old toy pieces and even paper cuts; the possibilities seems endless. User can design a various of different devices: robot, truck, a race car, a plane and lots more. As soon as the physical build is finished, the user can control her/his own creation by using a Smartphone. As of now, software support for remote control is limited to iOS devices. Tio Toys offers children an attractive opportunity of endless cycle of discovery: build their own robots from the scratch, control, demolish and rebuild.

3.2.2.2 MODI

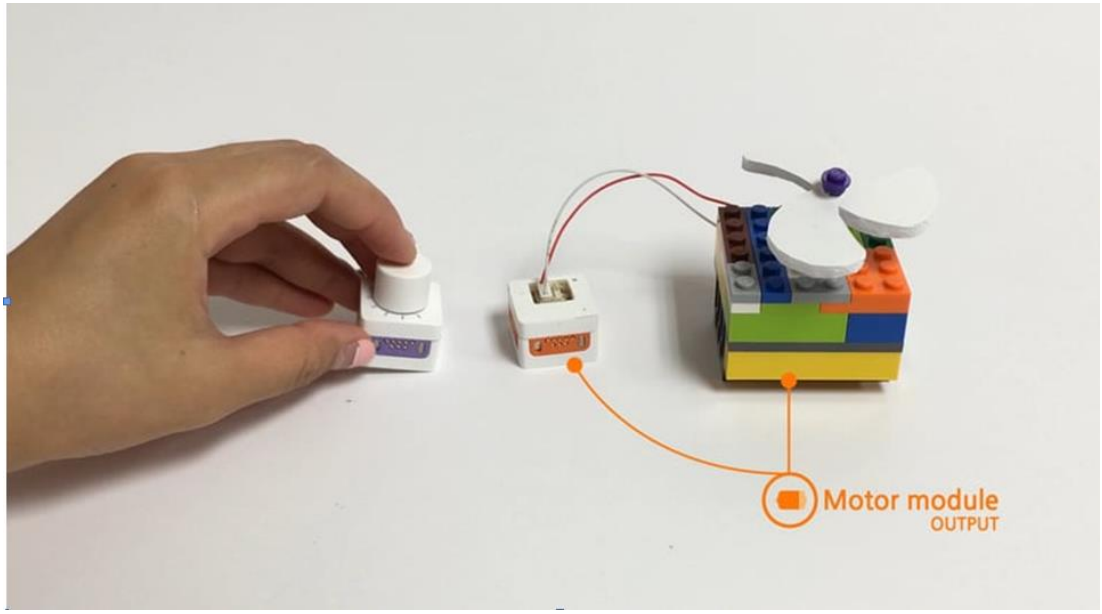

Figure 15 A Player is Trying Her / His Own Modi Design ("LuxRobo", 2016)

Modi is a do-it-yourself (DIY) robot kit. The product is advertised as: “Create anything you want with robotics of things” ("LuxRobo", 2016). Modi offers a very flexible and detailed approach to robots. Modi comes with building blocks, which might look similar to Tio. However, there is a main difference between two which is their target user. Tio Toys offers a simple and easy to learn approach for children for their first robotic toy experience, yet Modi aims to reach for users which have a higher average age (at least 8 years old). Modi offers a software based interface which can be programmed by users. Programming offers a very diverse selection of robot functions and millions of combinations for user to control the robot. However programming is not the only solution to control Modi robots, users can also use their Smartphone to control. What can be built, how it functions and how it can be controlled is almost limited with imagination and the time which is spared for building. Modi offers the ultimate building your own robot experience for older children and adults.

3.2.2.3 STEMI HEXAPOD

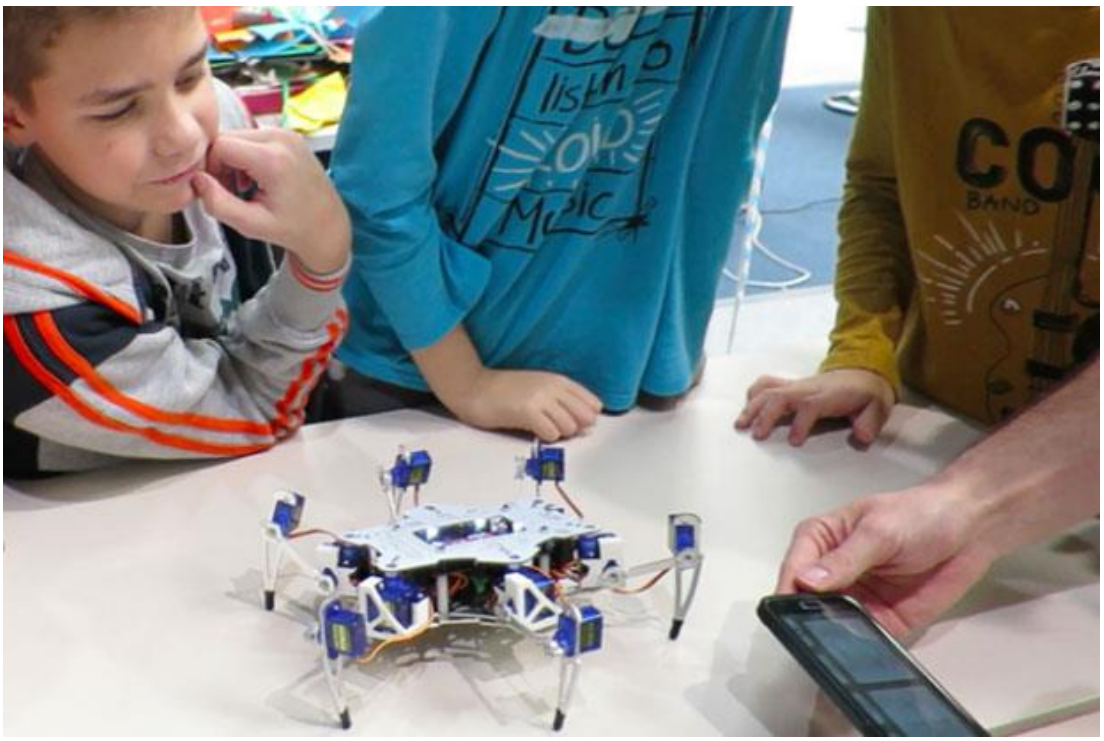

Figure 16 Children Interacting with Stemi Hexapod ("Stemi", 2016)

Stemi Hexapod is one of the most sophisticated build your own robot solutions ("Stemi", 2016). Contrary to the previous examples examined in this section, Stemi Hexapod does not offer the option of creating what you want. Instead, it offers you to build a hexapod which can make sophisticated and complex tasks of its own. A hexapod is a term which is used for six legged insects, in robotics it is used for naming robots which use six different legs to move; in other words it is a robotic spider which can be controlled with a Smartphone. The kit comes with necessary electronic pieces to build a personal robotic spider. To build and program Stemi Hexapod, a certain level of programming, electronic and mathematics knowledge is required. However, if the user does not meet the basic level of requirements, the kit offers education material to teach the user about the topics. As soon as a robotic spider is built and programmed it properly, it can be controlled with a Smartphone through an app to achieve these functions: walking in different modes and speed,

changing height, making complicated movements and even performing some dance gestures.

CHAPTER 4

RESEARCH DESIGN

This chapter includes a study conducted with children. The children were selected from the two age groups reviewed in Chapter 2. For the study, children were asked to play with a robotic toy, Ixi, by using play cards. The main aim was to observe and analyze their interaction with this robotic toy together with its play elements and children's motivation for interaction. The details of the method, the research's major elements, process, findings and the results are explained in the following sections.

The study was conducted for the Research Project course with ID5502 code in TU Delft in the fall semester of 2015-2016, under the supervision of Asst. Prof Mathieu Gielen. The research questions for the study were:

- What levels of social bond between a child and robot can be observed?
- To what extent does extraversion of a child influence his/her social bond with a robot with emotional expressions in one play session?
- What are the differences in terms of social bonding of children in different age groups?

Similarly, the literature research conducted for this previous research were on the effects of physical appearance of robots on interaction (Disalvo et al., 2002), the effects of extraversion on human-robot interaction (Toegel & Barsoux, 2012; Syrdal et al., 2007; Andrsi et al., 2015), child-robot interaction (Belpaeme et al., 2012; Druin and Hendler, 2000; Tanaka et al., 2007) and social bond (Baek et al., 2014). The findings of the quantitative analysis were presented as a report for the course (Dönmez, 2016). However, this quantitative analysis was not related to understanding the motivations of children in interacting with the robotic toy, and their emotional responses. Therefore, a secondary analysis for this thesis was conducted on the same data, this time with a more qualitative approach, in order to

reveal the dimensions of the child-robotic toy interaction and the physical features that are involved. Likewise, a new literature research was conducted on human-robot interaction, child-robot interaction, child development and robotic toys, and used for the thesis corresponding to its aim.

4.1 Ixi

4.1.1 Background of Ixi

A robotic toy, as mentioned earlier, is a robot designed for children to spend their leisure time with playful activities (Fernaeus et al., 2010). For the purpose of this study, the robotic toy that is named Ixi-play was used.

Ixi-Play, abbreviated as Ixi, was designed by the WittyWorx company as a companion for children and offers different games and functions (Dirkx & Van de Aalst 2014). WittyWorx is a Dutch design and development company which has started in 2011. Their robotic toy, Ixi offers games that can be played with cards and building blocks. It is also designed to offer dancing activity. Their aim while designing this robotic toy was to eliminate the need for a parent or a supervisor while offering engaging activities for children.

For this study, a prototype version of Ixi-play with two game options is used. Both of these games can be played using special game cards provided together with Ixi. The toy's most significant feature is it's emotional expressions on its eyes. It can also move, vibrate to support its expressions. The details of its features are described in the following section.

4.1.2 Physical Features

Ixi-play is a an owl-like robotic toy. It has three main components: the head, body and the base (Figure 17). The head part consists of two display eyes, microphone at the sides, a camera on the forehead, an antenna at the top left of the head and a touch sensor placed beneath the top of the head. The camera on the forehead functions as recognizing the cards. The display eyes offer different animated expressions. The body part is made of silicone rubber for allowing Ixi to move and vibrate. It also has

two attached wings next to the body. The base part below the body enables connection through Bluetooth to an android device and has a power on/off switch.

Figure 17 Components of Ixi (Dirkx & Van de Aalst 2014)

Figure 18 Three examples of Ixi's eyes animations, from right to left; happy, scared, angry (Dirkx & Van de Aalst 2014)

4.1.3 Software

In order to operate Ixi-play, an application is required working on an android device. The games are selected and operated through this application.

4.1.4 Cards

This protoype can be interacted using game cards. There are two sets of game cards for two different games. Each card has markers on them for Ixi to recognize and react upon.

Card Set 1

The first set of game cards consists of emotion cards, animal cards and "yes" & "no" cards. These cards are thin; they are made from plastic wrapped paper at the size of 6x12 cm, and are designed to be used vertically (Figure 19).

Figure 19 Emotion Cards (Dirkx & Van de Aalst 2014)

Figure 20 Emotion game cards during a session

Game Set 2

The second set of game cards consists of different animal figures. They are thick, and the figures are printed on foam board. Their size is approximately 12x15 cm, and are used horizontally (Figure 21). The figures in this second game cards can be detachable, a feature that is designed for another game, however the prototype did not support this game.

Figure 21 Animal sounds game cards during the session

4.1.5 Games

The prototype offered two functioning games that are played with the above described sets of cards.

Game 1: Emotion Cards Game

This game's dynamic works as showing a card and getting a response. As soon as the game is started using the android device, Ixi-play starts to move up and down, makes a bouncing sound and a heart animation appears on the eyes. The participant can start the game using the provided cards or s/he can pet Ixi's head. The flow chart in Figure 20 explains the different actions and responses of Ixi for each option. The participant can show the cards as many times as they want.

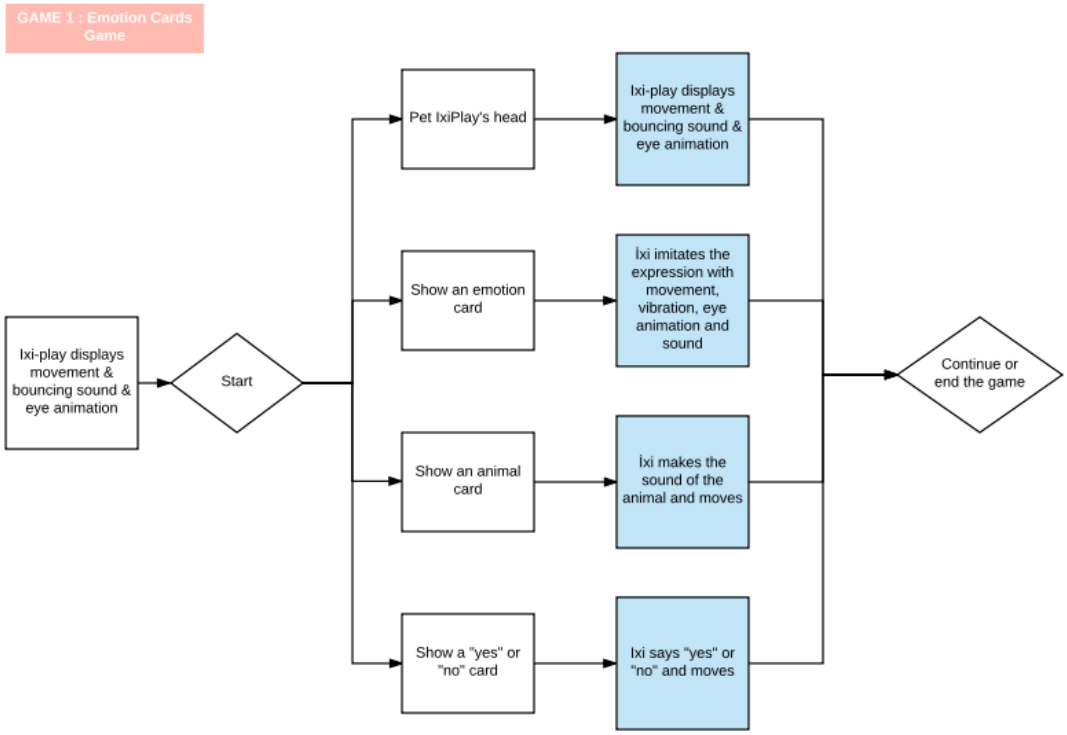

Figure 22 Flow chart showing the game activities for the Emotion Cards Game

Game 2: Animal Sounds Game

In this game, Ixi-play imitates an animal's natural sound and the child is expected to find the related animal and show it's card to Ixi-play. The game starts with a monkey sound and goes with bear, duck, etc., the order is always the same. The options about the game is illustrated in the flow chart in Figure 21. When the participant shows the right card, Ixi-play responds by talking in Dutch saying "yes, very good" or if the incorrect card is shown it says "no" in Dutch.

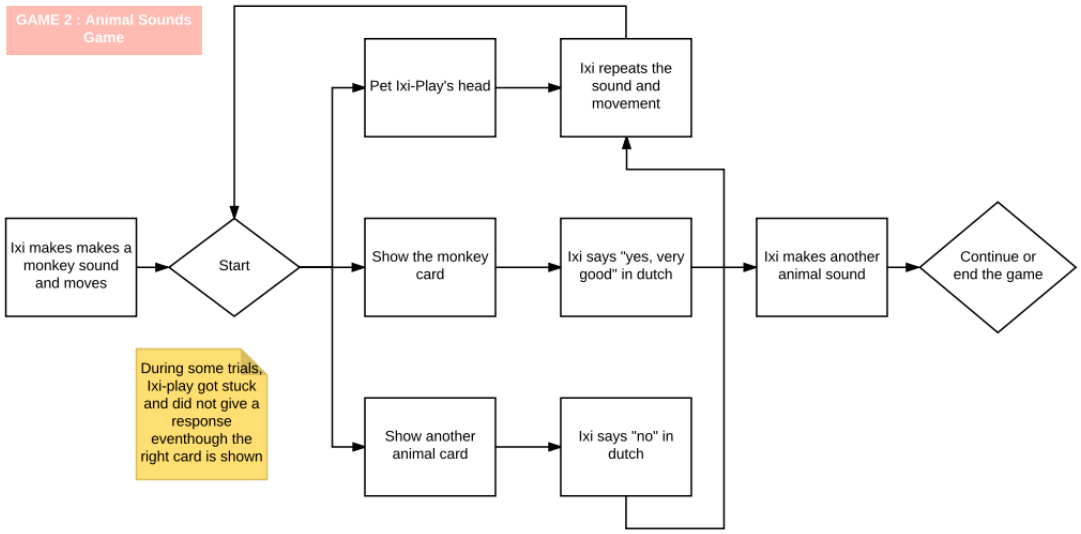

Figure 23 Flow chart showing the game activities for the Animal Sounds Game

4.2 Aim of the research

The study aims to provide insights through observations of participants, to understand their interaction with the robotic toy and its dimensions, and their motivations for interaction. The main aim is to define differences in interaction and provide suggestions for future developments and innovations in the field of child-robot interaction.

4.3 Method: Passive Participant observation

Participant observation is a qualitative analysis method, which can be defined as observing the participants of the research, their activities, tasks, interactions, recording their process and analyzing the data gathered from these sessions (Musante & DeWalt, 2010; Schwartz & Schwartz, 1955). This method is especially used in research on social interactions and activities of people. Passive participant observation is a type of observation in which the role of the observer is limited during the sessions (DeWalt et al., 1998). This happens when the researcher is present to observe and intervene only if it is necessary.

Implementing participant observation to children interaction studies can be a challenge. Especially, considering the 4-5 year-olds and their limited duration to

focus on tasks. But on the other hand, children are less afraid of making mistakes, being wrong, they can be more expressive and daring compared to the adults.

Participant observation method was implemented for the study with the participants to have a clear understanding of what is actually happening and why during the interaction. It was expected from participant observation sessions to gain insights on both child's verbal and gestural interactions with a the robotic toy. Before starting the sessions, the researcher was involved to explain the games and introduce Ixi to the participant. During the play session, the researcher was passive unless there was a necessity for her to communicate with the participant. This was planned to provide the participants a space for them to create an engagement with the robotic toy.

4.4 Research Questions

The study aimed to answer the following questions;

- What are the features that motivate children to interact with this robotic toy?
- What are the problematic and successful features involved in the interaction between the child and this robotic toy?
- How do the tangible and intangible features of the robotic toy impact the child - robotic toy interaction?
- What are the differences and similarities of 4-5-year-olds and 8-9-year-olds in interaction?

4.5 Expected Outcomes

While organizing the sessions, there were different expectations from the two age groups. The reason behind this was mainly their social and behavioral differences as stated in the literature review. It was expected that the group of 4-5 year-old participants to be more engaged and creative while interacting with Ixi-play. Also, their broad imagination could end up with unexpected results. On the other hand, the group of 8-9 year-old participants were expected to have relatively more improved motor skills, which could allow them to manipulate the cards and the robotic toy easily. Since the robotic toy's game options are limited and fairly simple, the 8-9

year-olds were expected to be less engaged in interaction when compared to the 4-5 year-olds.

4.6 Participants

The study was conducted with 14 children from the International School Delft. Contact with this school was done by the project supervisor Asst. Prof. Mathieu Gielen. The education language is English and the children studying in this school are from diverse national backgrounds. Children who had enough English skills to express themselves clearly were selected as participants.

Two children participated to the pilot study and twelve children participated to the actual study. Before carrying out the participant observation sessions, the necessary permissions were granted both from the school and the parents of the children (Appendix A). In order to make the participant comfortable with the researcher being present, the researcher spent one day visiting and getting to know the pupils during their school time. This was necessary so that participants would not feel insecure or shy to talk to, or ask anything from the researcher. The sessions took four days in total and were distributed into four weeks. The participants were six children between the ages of 4 and 5, and eight children between the ages of 8 and 9 years old. Table 1 shows the information of the children.

Table 1 Information on the age group and gender of the participants

4-5 Year-olds 		8-9 Year-olds 	
Female	Male	Female	Male
1	4 (1 study participant)	4 (1 pilot study participant)	4

4.6 Research Set-up

The observation sessions were conducted in a spare activity room at the International School Delft. The sessions were conducted with each participant alone playing with

Ixi, and researcher was there for assistance. The environment aimed to be cozy and comfortable for the child to play by placing a cushion for sitting and a low table in front of the cushion (Figure 22, Figure 23). Ixi was placed on the low table ready to start the first game with the Emotion Cards Game. As illustrated in the figure, the researcher sat behind the participant with a one meter distance, a distance which is neither too close to distract, nor too far for assistance.

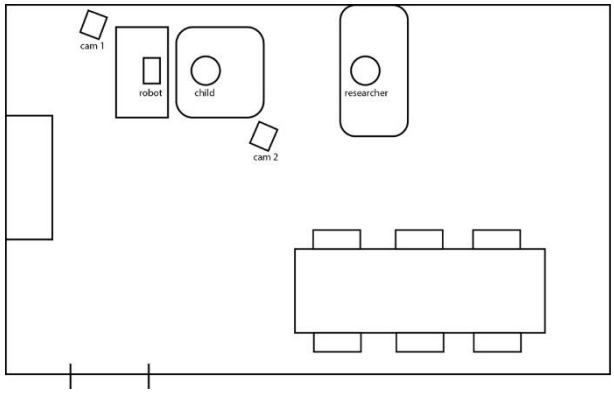

Figure 24 Bird eye's view on the participant observation session room

Figure 25 The research set-up from the researcher's view

4.7 Data Collection Method

During the participant observation sessions, the researcher was present and took notes while the participant was interacting with Ixi-play. The sessions were also video recorded. For each participant, there were two cameras with tripods available for audio-video recording. One camera was positioned to record the participant's gestures and expressions, and recorded the child's interaction and expressions. The other camera was positioned towards the robotic toy to capture the physical interaction and toy's reactions during the sessions, and recorded Ixi-play's reactions during the sessions. These data were used for qualitative analysis after all the sessions are finished with the participants.

4.8 Research Planning

The sessions were planned to be done in four weeks excluding the pilot test. Before the test sessions, the researcher spent one day to get to know the participants and made sure they feel comfortable in her presence during the research. On the first week, a pilot test was conducted. Sessions started with the researcher setting up the room and equipment for recording and make sure that Ixi is on, ready to start the game before the child was invited to the room. During the sessions, the researcher started and switched between the games using an android tablet. Each participant was invited individually to the activity room, where they were asked to sit down on the cushion and were introduced to Ixi. The researcher explained how to play with Ixi and told them they could touch only Ixi's head part, not the body, since the prototype was fragile. The explanation was as short as possible to let them discover themselves how to interact and play with Ixi. They were finally told that they could tell the researcher sitting behind, to end the game whenever they felt bored.

4.9 Pilot Study

Before the actual participant observation sessions, it was necessary to test the setup and the procedure in order to carry out the study efficiently. The pilot study was performed on the same day with two participants separately. The pilot study showed that the procedure went well, and it was possible to gather useful data. Therefore, the

main observation sessions were conducted using the same procedure. The data gathered from these participants were also used in the analysis .

4.9.1 Participants of the Pilot Study

One participant from each age group was selected to participate in the pilot study. The child from the 4-5 year-old age group was male, whereas the child from the 8-9 year-old age group was female. The pilot study was conducted with each child individually.

4.9.2 Main Notes from the Pilot Study

Overall, the observation sessions went smoothly without any significant issues. The robotic toy got stuck in both sessions. At those moments, the researcher restarted the robot, while doing so she distracted the participant's attention by asking questions about the game cards. During the sessions, it was important to state the instructions clearly to the participants about the games and Ixi-play. Even though it had been prompted several times, participants continued to touch the body part which was fragile and could be easily damaged. Also, it was important to explain the game play mechanics and rules before starting to play them. These issues led to distractions during the sessions, as the participants tried to communicate with the researcher several times. Also, the researcher needed to tell the participants she was busy and that they should play with Ixi-Play alone.

As the figures in this second game cards were detachable, which was a feature designed for another game, the participants got distracted with detaching and attaching the pieces. Therefore, it was found necessary to fix the figures in position for the main study.

4.10 The Study

The study was carried out one day per week, four weeks in total. Before each session, Ixi-play and cameras were set to be ready before the participant was invited the room. The participants were seated and given instructions before each game.

4.10.1 Content Analysis of the Data

The data collected involved a total of 185 minutes and 20 seconds of recording. Each session with a child was saved individually in a total of 28 video files obtained from the two cameras. For the first set of analysis conducted in TUDelft, the data was analysed to find indications of social bond, and an extraversion assessment of the children was made (Dönmez, 2016).

The data was found to be a rich source for studying the interaction of the participants with the robotic toy in terms of motivations and interaction types. Therefore, it was decided to carry out a second set of analysis on the same data in METU, this time with both a quantitative and a qualitative approach. In order to define categories for the qualitative approach, recordings were reviewed for a content analysis (Downe-Wamboldt, 1992), in order to indentify the interaction patterns, features involved and the emotions expressed in return. As a result of the initial review, the estimated patterns of behavior for all the sessions in general were listed as follows: facial expressions, looking at the robot, looking at the researcher, looking at the cards, looking away, verbal communication with the researcher, verbal communication with Ixi, physical contact with the cards, and physical contact with Ixi. These behaviors of the participants were gathered under the general three main categories of *physical interaction with Ixi and cards*, *facial expressions* and *communication*.

Table 2 Defined Categories

Main categories	**Subcategories**	**Examples**
Facial expressions and looking directions	Facial expression	smile, grimace, frown,
	Looking at the robot	Staring at Ixi
	Looking at the researcher	Looking for advice
	Looking at the cards	Browsing through cards
	Looking away	Looking at the camera
Communication	Verbal communication with the researcher	Asking for help
	Verbal communication with Ixi-play	To ask for a response
Physical Interaction	Physical contact with the cards	Throwing the cards
	Physical contact with Ixi-play	Petting Ixi's head

This formed an initial template for the second review of the visual data. These behavior patterns were noted down on excel sheets as codes, and then the recordings were reviewed once again, this time marking on excel sheets whether the behavior occurred, the details and how it occurred. The behavior patterns were filled in for every ten second of the session. For each game a different color code is given. As seen in Figure 19, the first game, Emotion Cards Game, the background of the excel sheet was colored in yellow. The interval between two games marked as dark blue, and the Animal Sound Game session was colored in green.

This analysis provided a second set of data in which it was possible to describe the various ways in which these behavior patterns occurred. These behaviors were then reviewed and categorized to be able to describe what they are, when they occur, the reasons and motivations behind them and how they relate to the interaction taking place between the child and the robot.

	facial expression	looking at the robot	looking at the researcher	looking at the cards
00:010 - 00:20				
00:20 - 00:30	excited / happy / curious	looking at the robot		
00:30 - 00:40		looking at the robot		
00:40 - 00:50	laughing			looking at the cards
00:50 - 00:60	excited / happy / curious	looking at ixi's eyes	looking at the researcher for sharing	he looks at the card he is holding before showing to ixi
01:00 - 01:10	involved interested			
01:10 - 01:20	smiling excited			
01:20 - 01:30	smiling excited			
01:30 - 01:40	proud excited		looks at the researcher for calling	he views the card closely after ixi's reaction he shows the same card again
01:40 - 01:50	smiling excited			

Figure 26 First page of excel sheet from Participant 2

looking away	verbal communication with the researcher	verbal communication with Ixi	physical contact with the cards	physical contact with Ixi	
					00:010 - 00:20
	asks what happens if he touches the tummy			touches the head	00:20 - 00:30
					00:30 - 00:40
			takes the cards with one hand without looking holds it upside down to ixi then turns and looks at it		00:40 - 00:50
	he shares his excitement (ixi's movement)			watches ixi's movement	00:50 - 00:60
	he expresses that he is interested		he takes two cards accidently and removes one		01:00 - 01:10
			he rotates the card with two hands and holds to ixi he shakes and gets the card		01:10 - 01:20
	he shares the response of ixi with the researcher	he calls ixi and asks for a response	he drops the card on the floor takes another one with one hand and rotates		01:20 - 01:30
	he wants to show ixi's reaction		he views the card closely after ixi's reaction he	he stares ixi's eyes	01:30 - 01:40
he looks away		he commands ixi to do the action			01:40 - 01:50

Figure 27 Continuing page of excel sheet from Participant 2

Figure 26 and Figure 27 are parts of the excel sheet filled in for participant 2. As shown in the example, each action, and their details were noted. These two examples show the behavioral patterns during the first game, Emotion Cards Game.

Under the category of "facial expression", the emotions expressed verbally and by gestures are noted down. As seen in the example excel sheet, Participant 2 expressed excitement, happiness and curiosity when he first encounters with Ixi between the period of 00:20 - 00.30. This assessment is made by observing the type and nature of his gestures and verbal expressions. During the sessions, the participants ended their visual contact with Ixi or focused more on Ixi. These patterns were recorded on the category of "looking at the robot". Some participants were staring at Ixi's eyes and at some moments they lost their visual contact and got distracted. They looked at the researcher for different reasons. For example, in this example sheet, participant looked at the researcher for sharing his experience or calling for help. These moments were noted down under the category of "looking at the researcher".

looking away			while holding one card from top he browse the others	he touches ixi to encourage to play the game	09:20 - 09:30
	researcher gives a hint he turns his body towards the researcher for inquiry and approval		he holds the card with one hand covers one of the barcodes	he hits ixi's head with one hand while the other is holding the card	09:30 - 09:40
	shows and asks questions about the cards		takes two cards shows one to the researcher talks about them and takes another card		09:40 - 09:50
	complains to the researcher	asks for a response	shows card with two hands from above. Looks at the card's back stares to other cards	cannot see ixi	09:50 - 010:00
	asks questions		he holds with one hand without showing to ixi	he holds the hand (hinders ixi's movement). Stares it's eyes holds the head with one hand	010:00 - 10:10
		he commands ixi before showing the card	holds the card with one hand leans it to ixi's eyes holds not straight	stares at ixi's eyes	10:10 - 10:20
	he asks if the school can have ixi for an opening ceromony				10:20 - 10:30
			he shows the card with one hand cannot get a response switches to another one	ixi is repeating the same sound and movement	10:30 - 10:40
			he shows all the cards in one by one with one hand puts away with his other hand		10:40 - 10:50
			he shows all the cards in one by one with one hand puts away with his other		10:50 - 11:00
	researcher gives a hint				11:00 - 11:10
	he positions himself towards the researcher and complains and asks questions				11:10 - 11:20

Figure 28 Excel sheet during the second game

At some periods of the sessions, participants were observed to spend considerable amount of time focusing on the cards. These behavior patterns were noted down under the title of "looking at the cards". "Looking away" is another category defined as participant losing visual contact with all mediums of interaction. Under the category of "verbal communication with the researcher", the reasons for verbal communication between the researcher and the participant are noted down. As shown in Figure 27, the participant uses verbal communication for expressing his interest or sharing his excitement. The category of "verbal communication with Ixi" is another pattern observed during the sessions. Some participants tried to directly command or inquire to Ixi during the sessions. "Physical contact with the cards" is one of the main categories in the excel sheet. Under this column, the ways of handling the cards and the interaction is noted down. Figure 28 shows some examples under this category. Participant holds the card upside down, shakes it, drops it accidently, etc. The last category is "physical contact with Ixi". Under this, the motivations for physical

contact and the ways of interacting are noted down. The full sizes of the excel sheet can be found in Appendix B.

4.10.2 Data Summary

The excel sheets prepared for each participant is used to constitute findings for each participant. These findings were created using the excel sheets and reviewing the videos when it was necessary. The findings were explained in chronological order during the participant observation session. It starts with the first game, the interval between two games, and ends with the second game. After the chorological order of what happened and the important moment during the session, the tables were created to illustrate for each game expressing the successful and problematic features of the game, cards and Ixi.

4.10.3 Participants between the ages 4 and 5 years

4.10.1.1 Participant 1 (M)

Age: 4 years.

Duration of session: 9 min. 10 seconds.

Game 1 with Participant 1

Participant 1 was one of the pilot participants. The participant starts to interact by staring at Ixi and touching its head with one finger. Before showing any card to Ixi, he hits and squeezes the body, wings and head part of Ixi with a confused expression. He starts to browse through the cards and looks at them while hitting Ixi with the other hand. After that, Ixi makes the starting sound, the participant looks at the researcher for sharing. He starts to hit and squeeze Ixi to hear and see the reaction from Ixi. After that the researcher explains him to use the cards and he starts to show the cards. He prefers to touch Ixi's head part every time before showing any card. This period continues for a while and whenever he gets a reaction from Ixi, he looks at the researcher for sharing. After a few trials, Ixi starts to repeat the starting sound and movement and does not react to the cards. At this, the participant gets annoyed and wants to end the game.

This game session takes 4 minutes and 20 seconds. The interval between two games takes 1 minute and 10 seconds. During this period, Ixi is restarted, the participant looks uninterested and expresses that he is unwilling to play.

Game 2 with Participant 1

The game starts with Ixi making the monkey animal sound. While Ixi is repeating the animal sound, the participant browses through the cards. To encourage to play, the researcher gives a hint and the participant finds and shows the right card to the researcher instead of to Ixi. He positions himself towards the researcher and asks for confirmation before showing cards to Ixi and he looks confused. He tries showing a few cards to Ixi but Ixi repeats the monkey animal sound. During this period he looks at the researcher for confirmation and inquiry for several times and finally expresses that he wants to end the game. This game period takes 3 minutes and 40 seconds.

Table 3 Successful and problematic features of Game 1 for Participant 1

Game 1 (4’ 20")
Successful Features
Ixi Participant 1 physically interacted with Ixi several times during this game. **Game** The starting sound and movement excited the participant.
Problematic features
Ixi Since the prototype was fragile, the participant was warned not to touch the body part. **Cards** Participant 12 did not associate the cards and Ixi (no connection). There was no guidance for the participant to know that the cards are for showing to Ixi. **Game** The game did not evoke any interest in the participant.

Table 4 Successful and problematic features of Game 2 for Participant 1

Game 2 (3' 40")
Problematic features
Ixi Repetitive animal sound annoyed the participant. **Cards** He dropped the card, he spent time to assemble the middle part of a card, preferred to show and got a confirmation from the researcher. **Game** He did not get any response from Ixi, the game did not take his attention, it rather annoyed him.

Table 5 The types of interaction observed for Participant 1

Physical interaction with IXI and cards	**Details**
Staring into Ixi's eyes.	
Touching Ixi's head.	
Pushing and squeezing the body, arms, head.	
Hitting Ixi's head.	
Shaking card to take Ixi's attention.	
Assembling the second game card.	
Showing the card to the researcher.	
Facial expressions and Looking direction	
Looks excited, laughing, surprised at the beginning.	Opening eyes, looking at the researcher
Gets bored, is impatient.	
Confused, annoyed.	Brings his eyebrows closer, pursing his lips
he looks at the researcher for sharing	
Looking at the researcher when given explanation	
he looks at the researcher for her directions	
Looking at the cards	
Mimicking Ixi	When shows the sad card
Communication	
To ask for another game.	
To ask for confirmation.	
To end the game.	"I am finished."

4.10.2 Participant 2 (M)

Age: 5 years.

Duration of session: 17 min. 10 seconds.

Game 1 with Participant 2

At the beginning of the game, the participant is excited, happy and curious to start. His first physical interaction is touching Ixi's head. The Participant takes one random card without looking and holds upside down and shows to Ixi, then he checks the card and holds correctly. At the same time, the participant is excited and happy to watch Ixi's movement and listens to its sound. He starts playing the game by holding the cards at Ixi's face. He struggles for a while to get a response from Ixi, which causes feeling confused. During that, he communicates with the researcher for sharing, confirmation, complaining and asking for help. After the struggle, he manages to get a reaction from Ixi, and he expresses surprise, laughing and imitating Ixi's response to the card.

Throughout the game, the participant gets annoyed and complains several times because Ixi did not give any response. At those times, the participant complains verbally, expresses anger, frustration, annoyance, boredom which is caused by repetitive sound and movement. He also positions himself closer to Ixi's eyes and stares at them several times and hits Ixi's head. In the end, he asks to play a game that he likes using the cards.

After that request, the researcher proposes to switch to the second game and the participant accepts. The first game ends at 8 minutes and 30 seconds.

There is a gap between two games when the researcher explains the second game to the participant. During the interval, the participant is interested and excited. This period takes approximately 50 seconds.

Game 2 with Participant 2

At the beginning, the participant seems interested but confused about how to play the game. While viewing the game cards, he touches Ixi to start playing. As the participant asks questions about the game while Ixi is making animal sounds, researcher gives more information about the game instructions. After some trial with showing cards to Ixi, the participant does not get a response. He holds the cards with two hands. During the trials, he stares at Ixi's eyes and verbally expresses his frustration, and he becomes uninterested in the game. He positions his body towards the researcher and tries to communicate to express his reluctance. The researcher tries to encourage the participant to interact with Ixi and stays neutral. He shows all the cards to Ixi without getting any response and expressing his frustration, he asks to play another game. The researcher suggests switching back to the first game and the participant agrees to it.

This period takes approximately 5 minutes. There are 20 seconds of break time for collecting the cards and starting the game.

Game 1 again with Participant 2

Table 6 Successful and problematic features of Game 1 for Participant 2

Game 1 (8’ 30" + 2' 20")
Successful Features
Ixi Ixi's movement and sound evoked interest and excitement. The participant was excited to watch Ixi and touch its head. **Cards** Enables holding with one hand. He names the cards as "behave cards". He creates a game to play with Ixi acts as if ixi was picking cards (remember me game) **Game** The game is easy to understand, it evokes curiosity and excitement. The participant makes eye contact with Ixi several times.
Problematic features
Ixi It takes a long time for Ixi to recognize the shown card. The participant expected a direct (not involving any cards) communication or guidance

Table 6. continued

from Ixi several times. When this did not happen, the participant directed his attention towards the researcher. **Cards** The participant had difficulty with positioning the cards. He accidentally took too many cards at a time (since they are so thin), he dropped the card. He had difficulty in finding the right distance and angle to hold the card. When the card was positioned upside down Ixi did not respond it. He got physically tired sometimes and placed his elbows on the table. **Game** The participant was disappointed to see only animal and sound cards. He expected more variety and diversity. He wanted to play another game using the same cards. Participant got bored and lost interest in a short time.

After switching back to the first game, the participant does not seem to be excited and interested. He complains about the cards being limited. He shows the cards to Ixi too fast and does not get a response, and he complains and expresses his annoyance. During these trials, he touches Ixi's face, eyes, and arms. This period continues for a minute, the participant expresses his disappointment and boredom. After that, he commands Ixi to play a game he likes and gives half of the cards to Ixi and collects half for himself. While doing so, Ixi continues moving and making a sound, which annoys the participant. After a while, the participant expresses his annoyance and ends the game. This game period takes approximately 2 minutes and 20 seconds.

Table 7 Successful and problematic features of Game 2 for Participant 2

Game 2 (5')
Successful Features
Cards The participant was able to take and position the card better since they are thicker and bigger in size.
Problematic features
Ixi Ixi did not respond to the participant's physical or verbal interaction that caused loss of interest. **Sound** At some point, Ixi got stuck, repetitively made the same animal sound without giving a negative or an affirmative response to the cards and it annoyed the participant. **Cards** It was hard for the participant to hold the cards with one hand, he usually preferred to hold them with two hands. While holding it, it covered the face of Ixi entirely, and the participant was not able to see Ixi's face. **Game** Difficult to understand, explanation + hints are required to understand the game.

Table 7 continued

The game seems to be not attractive to the participant. He was not able to make any successful trial during this game. Ixi looking like an animal and making other animal sounds, confused the participant.

Table 8 The types of interaction observed for Participant 2

Physical interaction with IXI and cards	**Details**
Contact, in order to initiate interaction.	
He splits cards into two groups and places one group in front of Ixi for playing.	
Shows the card from side, upside down, rotates it, holds from above, with one hand and two hands.	
Leans his hand to the table.	
Stares into Ixi's eyes, touches its head to start the game, touches eyes and arms.	
Contact, in order to initiate interaction, and to feel	
Facial expressions and Looking Directions	
excited, happy, expressed by smiling, laughing,	
curious	
confused, not interested	"Why don't he give any answers?"
annoyed, angry, disappointed, bored	Making "haa?" sound and turning towards the researcher , complains, hits cushions angrily.
he looks at the card he is holding before showing to ixi	
looking at the researcher for sharing	
looking at ixi's eyes	
looks at the researcher for calling	
Looking away	While complaining, holding a card and not getting a response.
Looking at the held card	
he looks at the researcher for approval and sharing	
Looking outside	
Communication	
For sharing excitement with the researcher	"Look what happens!" Laughing.
For inquiring how to get response	"Ha? Why is not doing it?"
For complaining about Ixi	"You have to wait very long." "Seriously? That's annoying" when Ixi makes sound repetitively.
To command ixi	"Behave like a dog! Good doggy!" "Come on you robot, why are you not saying anything?"
To chat	"Did he also annoying by the other kids?" "It's a behaving monkey bird."
To show the card to the researcher	"Ok, he has to behave like a dog."
To ask a question	"Do you wanna have something to drink? Yes? Why don't he give any answer?"

4.10.4 Participant 3 (F)

Age: 5 years.

Duration of session: 14 min. 20 seconds.

Game 1 with Participant 3

The participant is curious, happy and excited to start to play with Ixi. The researcher shows the participant how to pet Ixi and the participant tries by herself. After that she starts to pick from closed cards and shows them one by one to Ixi's eyes. At her first trial she receives a response from Ixi and she expresses excitement by smiling. At her second trial, the participant does not get a response from Ixi and directly inquires to the researcher. Then she releases that she needs to wait while holding the card to get a response from Ixi. This is also expressed by the participant as though Ixi's eyes cannot see good, therefore it requires sometime. She continues to play and gets response from every card she has shown. When she shows the "yes" and "no" cards, she gets excited because these cards provide the possibility of another communication medium (instead of making a sound or moving the body, it talks). When she is done with all the cards, she communicates to the researcher and gets ready to start the second game. The break time between two games takes approximately 20 seconds.

Game 2 with Participant 3

The participant starts the game by showing the cards in a row just like the previous game. The sound that Ixi makes seem to not give any clue to the participant. She looks confused while showing the cards because Ixi continuously makes the animal sound. After a few trials, the participant asks the researcher. The researcher gives a hint and explains the game briefly. The participant grabs the correct card and shows to Ixi however, Ixi does not give an affirmative or negative respond to the card. The participant tries showing the monkey card in different distances and angles and this period takes approximately 3 minutes. At the end, she loses interest and starts to look

away. The researcher gets involved and tries to show the card to Ixi however, Ixi is stuck. The participant expresses that she wants to play another game and collects the cards to end the game. She agrees to play the previous game again.

Game 1 again with Participant 3

She starts to play the game by picking the first card and showing it to Ixi. After showing that, she mixes all the cards to change their row. She picks the "yes" and "no" cards that excited her before. She continuous showing cards and gets responses from Ixi during this time, she sometimes imitates Ixi's response as moving her body or making the same facial expression. Once while holding and waiting, she squeezes the card and it drops to the floor. After showing all the cards, she expresses that the playtime was "okay" and ends the game.

Table 9 Successful and problematic features of Game 1 for Participant 3

Game 1 (5’ 10" + 3' 50")
Successful Features
Ixi Ixi excites the participant and she was welcomed to pet Ixi's head. It's big head is suitable for touching and petting. Facial expression movement and talking sound made the participant excited during the game. She showed the card to Ixi's eyes without the need of any explanation. **Cards** Easy to hold with one hand, Ixi reacted on the cards, she placed the used cards to another place. During her second play session, the participant mixed the cards and showed them without viewing them beforehand to evoke excitement and curiosity for herself. **Game** The game is simple and easy to understand without any need of detailed explanation. The session progressed smoothly, the participant was able to get response from almost every card she showed. She got involved by imitating Ixi's facial expression and movement.
Problematic features
Ixi When she did not get a reaction from Ixi, the participant directly wanted to communicate with the researcher and got confused. She had to wait around 2-3 seconds to get a response from Ixi. She was unsure about the distance and angle for holding the card. **Cards** Participant got tired from time to time while holding the card so she leaned her elbow to the table. Once she squeezed the card and dropped it to the floor. **Game** The game got monotonous and boring (she can guess what will happen next). The participant finished the game in a very short time.

Table 10 Successful and problematic features of Game 2 for Participant 3

Game 2 (12’ 30’’)
Successful Features
Cards Participant 4 was able to hold the cards with one hand easily
Problematic features
Sound When Ixi gave a negative response, the participant thought it was affirmative and got confused. At the second animal sound, Ixi got stuck and repeated the same sound even when the correct card was shown. **Cards** Participant 4 placed all the cards on her lap instead of the table because they were too thick and big. She only looked at 3-4 cards, she was not interested in them. While holding, she got tired, switched hands, leaned her elbow to the table. **Game** Participant 4 thought the game was the same with the previous one and started showing the cards in a row. She did not understand Ixi was making an animal sound. After the explanation, she showed the right card and tried to get a reaction from Ixi for around 3 minutes, but Ixi was stuck and continued to make the same animal sound. After that she lost her interest and ended the game.

Table 11 The types of interaction observed for Participant 3

Physical interaction with IXI and cards	**Details**
Petting head to reduce for waiting to get a response.	
Imitating Ixi's facial expression and bodily movement.	
Facial expressions and Looking Direction	
Excited happy smiling.	
Imitating Ixi's facial expression	Angry face, surprised face, happy face.
Disappointed, sad.	Eyebrows coming together, lips are down and pursing the lips.
Looking away.	
Looks at the card when gets a reaction	
Looking at the cards when confused	
Looking at the wall while holding the card and waiting	
Looking at the pile of cards	
Looking at children passing by	

Table 11 continued

Communication	Details
To ask how to get a response	
She asks about the sound (she does not understand that it's an animal sound)	
To comment	"When I did this one, then he could talk." when she shows the "no" card.
To complain and share disappointment	"He can't see good."
To finish the game	
To replay the first game	
To express that the experience was "okay".	"It was okay."
To express confusion	"He did nothing." "I am sure this is the right one" (when showing the monkey animal card).

4.10.7 Participant 4 (M)

Age: 4 years.

Duration of session: 4 min. 30 seconds.

Game 1 with Participant 4

At the beginning the participant looks excited and curious. The participant starts the game by taking cards and showing to Ixi. Ixi gives a response (a dog card) which excites the participant and make him smile. The participant does not take another card but rather prefers to show the same card to Ixi. While showing the card, Ixi repeats the reaction and the participant pets Ixi's head. He continues staring at Ixi while it moves and gets distracted by the noises from outside. He tells the researcher to end the game and agrees to move on to the second game. This period takes 1 minute and 40 seconds.

The interval between the two games takes 20 seconds. During this phase, the participant keeps a neutral facial expression, chats with the researcher and listens to her while looking through the cards.

Game 2 with Participant 4

The participant starts the game by taking one card, holds it with two hands and shows it to Ixi while it is making the monkey animal sound. He takes another card and shows it to Ixi, but he loses his interest, starts to look around and chat with the researcher. The researcher explains what he needs to do to play the game. After that, the participant starts to look for the right card from the pile of cards. While doing that he looks uninterested in playing. He takes one card, shows it to Ixi and touches Ixi's head. Ixi does not give a reaction, and continues to make the monkey sound. The participant spends some time browsing through the cards, looks confused, sad and annoyed. He tries touching Ixi with one finger and after that he positions himself towards the researcher and starts chatting. He expresses he wants to end the game. This session takes approximately 2 minutes and 30 seconds.

Table 12 Successful and problematic features of Game 1 for Participant 4

Game 1 (1’ 40")
Successful Features
Ixi Ixi's facial expression, movement **Sound** animal sound (he only tried the dog card). **Cards** He tried to show only one card but enjoyed the reaction by Ixi. He showed the same card three times and received reaction. **Game** The game is simple and easy to understand, little or no explanation was sufficient.
Problematic features
Ixi The game did not evoke enough curiosity from the participant. **Cards** He did not want to explore other cards, and was only stuck with one card. **Game** He liked the reaction but again it was not enough to evoke more curiosity.

Table 13 Successful and problematic features of Game 2 for Participant 4

Game 2 (2’ 30’’)
Successful Features
Cards Participant spent time browsing through the cards.
Problematic features
Ixi Ixi did not give any guidance about the game, participant got confused and did not get any reaction from Ixi. **Sound** Participant did not understand the animal from the sound. **Cards** He placed all the cards on his lap and spend most of his time looking at them. **Game** he wanted to interact with the researcher and the cards rather than Ixi. He got bored and confused fast.

Table 14 The types of interaction observed for Participant 4

Physical interaction with IXI and cards	**Details**
Contacts Ixi's head with one finger to get a reaction.	
Puts all the cards on his lap and browse.	
Holds the card with one and two hands .	
Facial expressions and Looking Directions	
Curious, interested excited at the beginning.	Opening eyes, focused on Ixi, bites his lips.
Annoyed.	Knitting his eyebrows.
Uninterested.	Looks around, starts to chat.
Confused,	
sad,	Purses hips, eyes are looking down.
looks away hears some noises	Gets distracted by the noises outside.
he holds all the cards in his lap and looks at them	
looks away and starts to chat with the researcher	
looks at the researcher to complain	
looks outside and starts to chat with the researcher	
Communication	
For chatting.	"Have you seen my mommy?"
For ending the game.	
To talk about the cards.	"This and that is the same." (showing the bird card and Ixi)
To get an explanation.	

4.10.11 Participant 5 (M)

Age: 5 years.

Duration of session: 14 min. 40 seconds.

Game 1 with Participant 5

The participant begins the game by taking one card and showing it to Ixi. At the same time, Ixi's starting sound and movement makes the participant think that it was a reaction, which makes him excited and surprised. He views the card and shows again to Ixi while Ixi repeats the starting sound and movement. While waiting for a reaction from Ixi, he expresses his eagerness and asks for a reaction from Ixi. He does not get a reaction for after a few trials and inquiries from the researcher. The researcher gives a hint and the participant finally gets a reaction from Ixi. He expresses his excitement, happiness and laughs. After that, he continues playing with other cards and gets reactions from Ixi. During this period, he once imitates one of Ixi's reactions. He still talks to the researcher for sharing and commenting on Ixi's reactions. He tries different cards and gets reaction from Ixi. Lastly, he is interested in playing with the "no" card and tries showing it to Ixi. However he waits and does not get any reaction from Ixi and decides to switch to the next game. This first game session takes 4 minutes and 20 seconds. The interval between two games takes 20 seconds.

Game 2 with Participant 5

When Ixi starts to make the monkey animal sound, the participant's first reaction is to responds verbally to Ixi saying "It's not a monkey!" and laughs. He places all the cards on his right side and starts to browse through them. While browsing he positions himself towards the cards. He finds and shows the monkey animal card, and Ixi gives a confirming response. After this, he searches for a card to show to Ixi, however Ixi makes another animal sound, which confuses him. He decides to take all the cards and places them on his lap and starts browsing. While browsing, he asks for confirmation from the researcher that he needs to find the animal card and wants to

chat with the researcher. After this, he tries to show different cards and gets several negative responses from Ixi. During this period, he verbally expresses his annoyance and confusion by saying "what animal is this?!" or "Is it lion or tiger?" and turns to the researcher for asking for help and looking annoyed and bored. He also tries to physically interact with Ixi by hitting it with the cards, touching and hitting Ixi's head with one finger. After a few more trials, he shows the right card and gets an affirmative response. To hear another animal sound, he hits Ixi's body part with the card he is holding. After this, Ixi makes another animal sound and the participant finds and shows the right card and gets a confirming reaction. To hear the next animal sound, he touches Ixi's body, head, eyes and wings and starts to hit the head part. Finally he asks to the researcher how to hear the next animal sound and the researcher explains how to touch/rub Ixi's head. Participant continues playing for a while, when he does not get any response he tries to hit Ixi or clap and wave his hands or starts to complain to the researcher. During this time, Ixi gets stuck and the researcher restarts it. After a while he gets annoyed and bored and expresses it verbally and asks to end the game. This session takes approximately 10 minutes.

Table 15 Successful and problematic features of Game 1 for Participant 5

Game 1 (4’ 20")
Successful Features
Ixi The participant tried directly to communicate with Ixi in order to get a reaction. He tried to communicate verbally. He stared at the animation on Ixi's eyes. He imitated one of Ixi's reactions. **Sound** Ixi talking was interesting for the participant "yes" "no" cards **Cards** He liked and made comments on the "no" card. **Game** Getting a reaction was very exciting for Participant 11.
Problematic features
Ixi Participant 11 assumed the starting sound and movement to be a reaction. **Cards** The participant held the cards upside down.

Table 16 Successful and problematic features of Game 2 for Participant 5

Game 2 (10')
Successful Features
Ixi He guessed the animal correctly when Ixi made the animal sound for the first time and directly showed the right card without any explanation. **Sound** He understood the animal from the sound. **Cards** Cards were easy to hold and show with one hand. **Game** Game was easy to understand for the participant, he enjoyed this game more than the other.
Problematic features **Ixi** Ixi's delayed responses when a right card was shown, was late to make a new animal sound, and this made participant annoyed. Ixi got stuck and was restarted once during the game. **Cards** The participant placed the cards on his right and positioned himself towards them, then looked at them all on his lap but they were too thick and many. The participant spent time and effort to browse through the cards.

Table 17 The types of interaction observed for Participant 5

Physical interaction with IXI and cards	**Details**
Stares into Ixi's eyes.	
Touches with one finger to head, body, eyes, antenna, wings to hear a sound.	
Hits the body parts with a card.	
Hits Ixi's head.	
Waves hands, claps to take Ixi's attention.	
Cover its eyes.	
Hits Ixi with cards to take attention.	
Facial expressions and Looking Direction	
Looks excited, laughs, is surprised at the beginning.	Raising eye brows, opening mouth, staring into Ixi's eyes with a smile.
Gets bored, is impatient.	Does not wait while showing a card, looks around the room.
Confused, annoyed.	Knits his eyebrows and grumbles.
Not interested.	
Surprised.	
looks at the researcher when confused	Asking "what is it suppose to do?"
looks at the researcher for sharing	
looking down while holding the card for awhile	
Looking at people outside	
Looking at the pile of cards	He turns his back to Ixi.

Table 17 continued

Communication	
To ask for another game.	
To ask for confirmation.	"So it's like he knows those animals"
To encourage Ixi to play.	"Come on, what is the next one?"
To chat.	
To inquire.	
To complain.	
To end the game.	

4.10.14 Participant 6 (M)

Age: 4 years.

Duration of session: 9 minutes.

Game 1 with Participant 6

The participant starts by taking and viewing the cards, while the researcher introduces Ixi to him. He touches Ixi's head and antenna with one finger but looks shy. He asks what he needs to do to the researcher and shows a card to the researcher. Ixi makes the starting sound, which makes the participant excited and he looks at the researcher for sharing. He takes one card and while showing the card he touches Ixi's head and gets a reaction and looks at the researcher for sharing. He continues playing by showing cards to Ixi. Whenever he gets a reaction from Ixi, he looks at the researcher and shares his excitement. He likes the "yes" and "no" cards and tries showing them several times. He tries to shows them at the same time and hides "yes" card behind "no" card while showing.

At the end, while he is holding and waiting for a reaction he starts to look away and says he is bored and wants to play the next game. This period takes 5 minutes and 40 seconds. The interval period between two games took 30 seconds. During this period, the new game starts and the participant is given the cards for the second game.

Game 2 with Participant 6

Participant 14 takes a card and shows it to Ixi after Ixi makes the monkey animal sound. Ixi gives a negative response and the participant inquires from the researcher. The researcher gives an explanation and the participant start to browse through the cards. He shows a card upside down and to get a response, he hits Ixi's head with finger and with the card. He says "it's difficult" and asks for help. The researcher advises the participant to touch Ixi's head to hear the animal sound again. After a while he shows the right animal card and gets a confirming response from Ixi. He hears the next animal sound and expresses that he does not know the animal and feels bored after a few trials. While showing a card he looks away and gets a negative response from Ixi. After that he expresses that he is bored and wants to end the game. This game session takes 2 minutes and 50 seconds.

Table 18 Successful and problematic features of Game 1 for Participant 6

Game 1 (5’ 40")
Successful Features
Ixi The participant got reactions to card he showed without much delay. **Sound** He liked it a lot when Ixi said "yes" and "no". **Cards** He liked the "yes", "no" cards and showed them more than once and tried to show them at the same time to see what Ixi would do. **Game** He liked Ixi's reactions.
Problematic features
Ixi The participant was shy and unwilling to touch Ixi at the beginning of the game. **Cards** The participant did not understand the relationship between the cards and Ixi. **Game** The game got monotonous.

Table 19 Successful and problematic features of Game 2 for Participant 6

Game 2 (2' 50")
Successful Features
Ixi Ixi gave negative and affirmative responses to the cards.
Problematic features
Ixi The participant did not understand whether the responses were negative or positive. Sound It was not possible to identify the animal sound. Game The participant found the game "difficult".

Table 20 The types of interaction observed for Participant 6

Physical interaction with IXI and cards	**Details**
Touching Ixi's head with two fingers.	
Rubbing the head to hear the animal sound.	
Moving closer to Ixi and staring into its eyes.	
Moving the card back and forth while holding and waiting.	
Moving the card up and down, right and left.	
Bending the card while holding.	
Shaking the card to take Ixi's attention.	
Facial expressions and Looking Direction	
Shy, confused.	Index finger on his mouth, looking around and to the researcher.
Smiling, happy, laughing.	
Surprised, excited.	Opening eyes after a reaction.
Curious.	Opens eyes wide, open mouth, holding cards looking at Ixi.
Bored.	The eyes are halfway open, nearly closed, lips are down, looking around the room and floor, leaning his elbows to the table.
Looking at the researcher for sharing	
Looks away while showing a card	Looking at people passing by.
Communication	
To inquire about what to do.	"Is this working?"
For sharing.	
To express that the game is difficult / to complain.	"It is difficult."
To chat.	
To end the game.	

4.10.4 Participants between the ages 8 and 9 years

4.10.4.1 Participant 7 (F)

Age: 9 years.

Duration of session: 12 min.

Game 1 with Participant 7

This participant is one of the pilot participants. At the beginning of the game, the participant looks interested and listens to the researcher carefully and starts by looking at the cards. She starts to interact with Ixi by holding one card towards it while doing so, touching Ixi's head with her other hand. To get a reaction, she tries asking the researcher, squeezing Ixi's body, wings, body and face. The researcher explains how to hold the card to get a reaction from Ixi. She takes the cards and shows them to Ixi in a row, however she does not wait long enough for Ixi to recognize and react to the cards. She seems to be bored after three minutes of trying and finally gets a reaction from Ixi. She looks surprised and starts laughing while staring at Ixi's eyes. After this, she tries several cards, and while holding a card and waiting for a reaction from Ixi, she looks away. She gets no reaction on some of her attempts. She finishes trying all the cards and positions herself towards the researcher to imply that she is done. This game period takes 4 minutes and 40 seconds.

After that, the participant is asked to switch to the next game, and she chats with the researcher while the researcher starts the new game. This interval period between two games takes 1 minute and 20 seconds.

Game 2 with Participant 7

At the beginning of the game Participant 10 is distracted by the cards that can be assembled and disassembled. After assembling a card, she shows it to Ixi and Ixi makes the monkey animal sound. The participant takes this as a reaction to her action so she laughs and looks at the researcher for sharing. She positions herself closer to Ixi and shows another card. This time Ixi gives a negative response, the participant again looks at the researcher for sharing, smiling and laughing. The researcher

notices that the participant is confused and gives her a hint. She tries showing the right card, but Ixi does not give a reaction but continuously repeats the monkey animal sound and the participant considers this as a reaction. She verbally expresses that the sound is fun but she does not understand why Ixi is making the sound. She is laughing but at the same time confused and expresses her confusion to the researcher verbally. After some trials with different cards, she gets negative response, and tries touching Ixi's body and head. She also inquires the researcher several times and finally wants to end the game without getting any affirmative response from Ixi. This game session takes approximately 6 minutes.

Table 21 Successful and problematic features of Game 1 for Participant 7

Game 1 (4’ 40")
Successful Features
Ixi Ixi evoked curiosity when first encountered with. Ixi surprised the participant and made her laugh when it gave a reaction. **Cards** Cards were easy to hold with one hand.
Problematic features
Ixi Movement caused mixed feelings for the participant (smiling, confused). Ixi did not give guidance to the participant about the game and how to interact. **Sound** Ixi repeated the starting sound causing mixed feeling (smiling and confused). **Cards** Participant held the card low because she wanted to lean her elbow to the table. It was difficult to hold in the same position for a long while. **Game** Participant 10 did not get involved in the game.

Table 22 Successful and problematic features of Game 2 for Participant 7

Game 2 (6’)
Successful Features
Ixi Ixi's animal sounds made the participant laugh.
Problematic features **Ixi** Participant took the repetitive animal sound as a reaction to her showing a card.

Table 22. continued

Ixi did not give confirming reaction even though the right card was shown. **Sound** Only sound feedback was not enough for the participant to understand the animal. **Cards** The cards were disassembling which distracted the participant several times. **Game** The game was confusing.

Table 23 The types of interaction observed for Participant 7

Physical interaction with IXI and cards	**Details**
Touching Ixi with one hand while holding a card towards Ixi with the other hand to make it react on the card.	
Squeezing Ixi's body, arms, eyes, head to take its attention.	
Holds a card with two hands, one hand.	
Holds the card too low, leaning her elbow to the table.	
Disassembling and assembling the second game cards.	
Shaking the card to take Ixi's attention.	
Facial expressions and Looking Directions	
Interested, smiling, excited at the beginning.	
Confused, bored when she does not know what to do and does not get any reaction.	Draws a sigh.
Smiling, interested, laughing,	
excited, shocked, surprised when got a reaction.	Opening and mouth eyes wide.
Bored	Rolling eyes, pursing lips.
Looking away	
Looking at the researcher	
Communication	
To inquire.	
To asks questions about Ixi and the cards.	
To share excitement.	
To express confusion.	
To chat.	

4.10.4.2 Participant 8 (F)

Age: 8 years.

Duration of session: 16 min. 30 seconds.

Game 1 with Participant 8

The first encounter with Ixi evokes excitement, which is expressed with smiling. The participant first interacts with Ixi by squeezing its head with one hand. She holds a card with one hand correctly at her first trial. The participant examines the cards by holding them and looking at them. All the same, the participant does not know what to do with them and seeks help from the researcher by looking at her and directing questions.

The participant starts playing with the game, by holding the cards to the face of Ixi. At first, she holds the card too close, without enough duration or too far and she does not get a response from Ixi. And when she does not get a response, she squeezes Ixi's eyes, head, antenna, and arms.

When achieving to gain a response from Ixi, the participant expresses surprise, by laughing and smiling.

In her subsequent trials, she is not able to get a response from Ixi. Therefore, she displays annoyance by frowning and bodily approaches towards Ixi to hold the card closer. To get a response she tries to move the card away from Ixi, brings it closer, rotates the card while Ixi's head rotates. During these attempts, she sometimes holds it with two hands, and she leans her elbow towards the table box.

This interaction continues throughout the session, as Participant 1 tries to gain a response from Ixi at various times. During this interaction, she checks Ixi by approaching, looking at the face, looking at the eyes. Also, the participant checks the cards occasionally, to see what image is displayed. She tries to adjust the way she holds the card towards Ixi by changing the position and angle of the cards.

After finishing all the cards, the first game ends at 4 minutes and 20 seconds.

This is followed by an interval between two games. The researcher changes the cards and explains the second game briefly. During this, Participant 8 displays excitement by smiling and is looking for the researcher to listen. This interval takes approximately 50 seconds.

Game 2 with Participant 8

Participant 8 looks at the cards and Ixi, seems fairly interested. But as she seems not to understand what the game requires, she seems confused and in thoughts. She spreads all the cards on the floor to see every animal character.

IXI is making animal sounds, and the participant has difficulties in recognizing what the sound is. As she now understands that she has to show the relevant card to IXI, she seems to have gained proper interest once again.

Finding the correct card, she shows it to IXI with one hand and leaning her elbow to the box, but is not able to get an affirmative response. IXI continues to make the sound and does not recognize the card. Participant 8 is frustrated; she verbally expresses that it is the right card then turns to the researcher and expresses again. She then tries to modify the ways in which she holds the card; she checks the card to look at the image. Not being able to succeed, she also checks the other cards in order to make sure she is holding the correct one. She holds the card with one hand sometimes from one side, from top (that causes one of the barcode areas to be closed) and sometimes leans her elbow to the box. In the following minutes, Participant 8 is frustrated, annoyed, confused and finally bored. She also expresses her complaint about Ixi's repetitive annoying sound and movement. She occasionally looks at the researcher for confirmation or help. The researcher responses and gives a hint.

Finally receiving a response from Ixi after 90 seconds, she displays happiness and excitement. She is also surprised from unexpectedly receiving an affirmative response from IXI.

This is followed by the second animal sound. Participant 8 is taken by surprise and checks the cards. The trials she makes lead again to frustration and annoyance. She also repetitively expresses her annoyance by Ixi's sound. The trials continue but around 13 minutes; she loses her interest. She looks away from the cards and IXI; she stares to other parts of the room. She finally looks at the researcher in order to ask for ending the game.

Table 24 Successful and problematic features of Game 1 for Participant 8

Game 1 (Duration: 4’ 20")
Successful features
Ixi Ixi's facial expression, movement, and various sounds impressed the participant during this game. **Cards** They are easy to look and hold with one hand. **Game** The game is simple and easy to understand, a short explanation was sufficient.
Problematic features
Ixi Ixi does not give a clue about where to touch from to the children. It's touch sensory response was not discovered by the participant. It takes a long time for Ixi to recognize the shown card. It does not provide a clue on how far or close the cards should be held. While waiting for Ixi's response, participant's hand got tired and she needed to lean her elbow to the table box. **Cards** They bend when held tight. **Game** Characters on the cards are limited and after showing a few, participant masters the game. At some point, curiosity drops and the gameplay gets quick and monotonous.

Table 25 Successful and problematic features of Game 2 for Participant 8

Game 2 (Duration: 11’ 20’’)
Successful features
Ixi Ixi's sound and movement took attention. **Sound** It reminded the animal sound frequently. Sound took the participant's attention. **Cards** Since the cards are bigger compared to the previous game's cards, it is easier to position them towards Ixi's eyes **Game** Hearing a new animal sound after showing the previous actually was more exciting and fun than hearing Ixi's affirmative sound.
Problematic features

Table 25. continued

Ixi Repetitive sound and movement annoyed the participant. Also, Ixi did not give an affirmative or negative response in many situations, which was confusing and frustrating for the participant. The game does not allow the participant to be spontaneous and make choices. **Sound** It is difficult to see which sound belongs to which animal, there is only an audio information. Directly starts making an animal sound repetitively, which caused confusion and annoyance. **Cards** Cards are too big and thick. While holding the card, the participant sometimes covered the barcode area that is designed for the sole purpose of being recognized by Ixi. It was physically hard to hold all of them at the same time. They were too many to put on the table, so the child preferred to lay them all on the floor. She positioned herself towards the cards and spent a lot of time interacting with them. She spends more time looking at the researcher and the cards than Ixi. **Game** Hard to understand, explanation + hints are required to understand the game. Neither the positive nor negative response excited the participant.

Table 26 The types of interaction observed for Participant 8

Physical interaction with Ixi and cards	**Details**
Contact, in order to initiate interaction, to feel the vibration and movement.	
Squeezing and pressing head, arm, antenna, eyes.	
Rotates the card, puts it on the floor and table.	
Holds the card from above, below and from side.	
Throws the card to the floor.	
Facial expressions and looking directions	
Confused	Asks "how does this even work?" touches randomly, makes a sound "hıı?"
Surprised, excited.	Opening eyes wide, lifting eyebrows.
Annoyed when she does not get a response.	
bored, frustrated, and angry, sad	Draws a sigh, makes a sound "hee??!!", throws a card on the floor, purses her lips.
Looking at the researcher while asking	
Looking at the researcher	
Looking outside, to walls	
Looking at the held card	
Staring absently	

Table 26. continued

Communication	
For sharing excitement with the researcher	
For inquiring how to get response	
To inform the researcher that she is done	
To get approval from the researcher about the card	"It's a monkey right? But I showed it to" (then shows the card)
To complain	"It does not recognize the animal."
To get hint or direction	
For complaining about Ixi's sound and movement	"It's only making the sound."
Asks confirmation from Ixi	

4.10.4.3 Participant 9 (F)

Age: 9 years.

Duration of session: 16 min. 30 seconds.

Game 1 with Participant 9

The participant is curious yet also shy when she first encounters Ixi. Her contact is a physical interaction by touching Ixi's arm and head. She starts the game by taking cards one by one without viewing them and showing to Ixi. While holding them, she stares into Ixi's eyes. During the play time, when the participant gets a response from Ixi, she gets excited and expresses it with smiling. Throughout the game she is able to get various responses. However, sometimes it takes a while for Ixi to respond. At those moments, the participant gets confused and annoyed. During the session, the participant positions her body closer to Ixi and stares into Ixi's eyes while waiting for a response. She verbally communicates to the researcher for inquiry and sharing excitement. The game session ends when the participant finishes showing all the cards. Overall this game play took approximately, 3 minutes and 20 seconds.

After the first game ends, the participant gets ready for the second game and takes the new cards and a brief explanation from the researcher. This period takes approximately 30 seconds.

Game 2 with Participant 9

When the participant is ready to start, she seems confused and not confident. She starts playing the game as if it is the same with the previous one. She grabs one card and shows it to Ixi and gains a negative response. However, the participant's expression of not showing any concern, shows that she does not understand that it is a negative response.

Table 27 Successful and problematic features of Game 1 for Participant 9

Game 1 (3’ 20")
Successful Features
Ixi Ixi evoked curiosity and welcomes the participant to play. Ixi's facial expression, movement excited the participant. The participant did not look at the card before showing to Ixi in this phase, participant got more excited and surprised by Ixi's expressions. **Sound** Various sounds impressed the participant during this game. **Cards** Easy to hold with one hand, the participant could take two cards at a time. She separates the used cards and not used ones during the game. **Game** The game is simple and easy to understand. The session went smoothly, the participant was able to get response from almost every card that she showed.
Problematic features
Participant 9 did not know how to hold the card (distance, angle etc.) and asks for guidance. Participant 9 wanted to share her excitement and she communicated with the researcher. **Cards** Participant 9 got tired while holding the card so she leaned her elbow to the table. **Game** The game got monotonous and boring. The participant finished the game in a very short time.

As in the previous game she takes one card and shows it to Ixi. Ixi gives a negative response to that card but the participant continues showing cards in a row and her facial expression shows that she is confused and not confident. After three trials, the participant shows the right animal card to Ixi and gets an affirmative response. The

participant expresses happiness by smiling. After this, Ixi does not make another animal sound so the participant seeks help from the researcher; as advised by the researcher, the participant touches Ixi's head. After that Ixi makes another animal sound and the participant continues the game. She tries to find the right animal card but fails to get an affirmative response from Ixi. At those trials she expresses frustration, annoyance, and anger. She spends most of the time by browsing through the cards without having any proper interaction with Ixi. After struggling approximately for 4 minutes and 50 seconds, the participant communicates with the researcher for inquiry, confirmation and complaint. The game ends because Ixi is stuck.

Table 28 Successful and problematic features of Game 2 for Participant 9

Game 2 (12’ 30’’)
Successful Features
Ixi The participant was able to gain response (both negative and affirmative) from Ixi several times .
Problematic features
Ixi At the second animal sound, Ixi got stuck and repeated the same sound even thought the correct card was shown. **Sound** When Ixi gave a negative response, the participant thought it to be affirmative and got confused. Animal sound was not easy to understand for the participant. **Cards** During the game the participant wanted to categorize the cards into two groups however, since the cards occupied too much space and were hard to hold (too thick) the participant spent too much time to put them in different places and organize them. Hard to hold them with one hand and tiring, participant leaned her elbow to the table. Cards distracted the participant's attention. **Game** The participant thought the game was the same as the previous one. She could not guess the animal for a long time. She spent too much time browsing, the interaction with Ixi was interrupted for several minutes.

Table 29 The types of interaction observed for Participant 9

Physical interaction with Ixi and cards	**Details**
Contact, in order to initiate interaction,	
Petting head and arm for starting	
Staring eyes for a response Positioning self closer to hear and see the response	
Touching head to hear the sound	
Facial expressions and Looking Directions	
Confused, not confident, clueless, reluctant	She frowns, positions herself away from Ixi, opens mouth, asks "what I do?" Places her index finger next to her mouth and sneers.
Surprised, excited, happy, smiling, laughing	
Mimicking Ixi's expression	
Annoyed, angry, frustrated, bored	Pursing her mouth, showing teeth, frowning, grumbling.
Looking at the wall	While Ixi is giving a reaction or waiting for a reaction.
Looks at the researcher for help	
Communication	
To inquire about how to hold the cards	
For sharing excitement	
Expressing excitement	"Wow!"
Asks about how to play the game	
For asking help	"what I do?"
To share frustration	
Asks for a hint from the researcher on the game	
Expresses her confusion	
Asks for confirmation	"Is that a lion?"
To chat	

4.10.4.4 Participant 10 (M)

Age: 8 years old

Duration of session: 11 min. 10 seconds.

Game 1 with Participant 10

Participant looks excited and interested. At the beginning before the researcher tells how to play the game, the participant takes one card, turns his body towards the researcher and shares his thoughts about the card. Then the participant is told to show the card to Ixi. While showing, Ixi continuously makes the starting sound. He tries to show it but does not know how far he should hold it so he tries different distances and angles and positioning up or down. Since Ixi only makes the starting sound, the participant thinks that this is the reaction he should be getting from Ixi but when he is successful with his attempt, he gets an animal sound in response, which excites him expressed by laughing and sharing with the researcher. During his trials, while waiting for a response he talks to encourage Ixi to respond ("come on" etc.). During the game period, sometimes he does not get a response so he gets disappointed and switches to another card without waiting or trying more. Whenever he gets a response, he shares his excitement with the researcher. He is interested in some cards (emotions) then the animal cards. After trying every card without response, the participant states that he is done with the game.

After that, playing another game is proposed to the participant and he accepts that offer. The first game play time took roughly, 5 minutes and 50 seconds. The switching time between two games took 10 seconds.

Game 2 with Participant 10

Participant positions himself in a comfortable way and places all the cards on his lap. He starts showing cards in a row and gets a negative response but he thinks this means he did something right. He does not understand Ixi is making an animal sound he thinks he is continuously laughing. After two trials, he asks why is Ixi is laughing. The researcher explains that it is an animal sound and he needs to show the right card

to Ixi. He positions himself towards the cards and the researcher starts searching for the right card. That period takes approximately 35 seconds and then the participant tries a card and shows it to Ixi. It takes a while to get a response from Ixi so the participant waits while showing the card and talks to encourage Ixi. He gets a negative response but thinks it is positive and shares with the researcher. The researcher explains that it means "no". He starts viewing the cards and searching again without looking at Ixi. Ixi continuously makes the monkey sound. He finally finds the right card and shows it to Ixi. While waiting for Ixi to process, he looks closer, tries to see both the card and Ixi's eyes at the same time. After the response, he positions himself towards the cards and the researcher for sharing. Ixi makes another animal sound. Participant shows a card and gets a negative response. After that, the participant wants to hear the animal sound but Ixi does not repeat it. He inquires the researcher and the researcher suggests the participant to touch Ixi's head. The participant tries to touch the with finger and to the eyes (as if it is a touch screen). The researcher suggests him to place his hand palm and wait longer. Ixi makes the animal sound again. He finds the right card however, Ixi does not give a positive or negative response but continuous to make the animal sound. Participant expresses frustration and annoyance verbally. Finally he gets an affirmative response. He plays one more round and then expresses his frustration for waiting and wants to end the game. This game period takes approximately 5 minutes and 10 seconds.

Table 30 Successful and problematic features of Game 1 for Participant 10

Game 1 (5' 50")
Successful Features
Ixi Ixi's sound and movement raises excitement and interest . **Sound** Repeating the same sound and then suddenly getting reaction excited and made the participant laugh. **Cards** emotion cards drew participant's attention. At the beginning of the game, the cards were placed closed, participant drew cards in a row and viewed them then showed them. Game The game is easy to play, but Ixi got stuck several times, the participant got bored at those times and switched to another card. The most interesting feature of the game was Ixi's emotional expression.

Table 30 continued

Problematic features
Ixi It took a long time for Ixi to process, also Ixi was not able to see the cards at some points. The participant did not know how to hold the card. The participant inquired several times and shared his thoughts with the researcher. **Sound** Ixi's sound started to annoy the participant and he thought that is the reaction from Ixi to the card. **Cards** The participant could not figure out how to hold, at what distance, for how long and where from exactly. He held the "no" card upside down thinking that that was the correct way. He squeezed the card too much and bent it. Animal cards were not as interesting as emotion cards to the participant. **Game** Waiting and trying to get response was frustrating and boring. At the end the participant was a bit disappointed.

Table 31 Successful and problematic features of Game 2 for Participant 10

Game 2 (5' 10')
Successful Features
Ixi Ixi was responsive at this game. It gave negative and affirmative responses to guide the participant. **Cards** During the game the participant looked comfortable holding all the cards on his lap. **Game** The game was challenging.
Problematic features
Ixi Ixi did not respond to the participant's physical or verbal interaction, which caused loss of interest. At some point, Ixi got stuck, repetitively made the same animal sound without giving a negative or an affirmative response to the cards. The participant did not know where to touch, he thought he needed to touch the eyes since they looked like screen. **Sound** Only sound feedback was weak and hard to understand. The "no" reaction was in Dutch, so the participant did not understand it. **Cards** It was hard for the participant to hold the cards with one hand, he usually preferred to hold them with two hands. While holding it, it covered the face of Ixi entirely, and the participant was not able to see Ixi's face. The participant took a lot of time searching for the card and the main interest were the cards. **Game** Participant got bored and frustrated, the game was not interesting for him. It needed explanation; it misguided and confused the participant.

Table 32 The types of interaction observed for Participant 10

Physical interaction with IXI and cards	**Details**
Touching Ixi in order to re hear the sound .	
Shows the card upside down, rotates it, holds from above, with one hand from far distance .	
Leans his hand to the table.	
Shakes the card while holding for drawing attention of Ixi.	While shaking he says "hello."
Touches Ixi's head to feel the vibration.	
Holds all the cards and browses.	
Facial expressions and Looking Directions	
In the beginning, excited, interested, curious.	
surprised	He raises eyebrows, makes "huh" sound and boggles.
While waiting for a response annoyed, frustrated, bored, disappointed.	He places his head on his hand and says "why are you not sad, please be sad" while showing the sad card. He makes "pfff" sound, purses his lips.
When he gets a response excited, happy, laughing.	
Confused about the second game.	
Looks at the researcher for sharing excitement	Looks at the researcher while laughing.
Looks at the cards while browsing	
Looks at the researcher when she gives an explanation	
Communication	
For sharing excitement with the researcher.	Imitates the expression to show the researcher.
For encouraging Ixi to respond	"hello", "hey!" "Boooo!" , "come on!", "look at this card, look."
to comment on reactions.	
For complaining about Ixi.	
To chat .	"Is this your robot?" " who built this robot, oh it's nice"
To show the card to the researcher.	
To ask a question.	
To express frustration.	"Can you not see it, this is a duck, and the duck make quack, quack!"

4.10.4.5 Participant 11 (F)

Age: 8 years.

Duration of session: 15 min. 30 seconds.

Game 1 with Participant 11

The participant looks confused and shy at the beginning. After the researcher's explanation, she looks at the cards and tries touching Ixi for several times. She touches, the head, eyes and wings. After another explanation from the researcher, she understands that she needs to show the cards to Ixi. She starts doing so and gets response immediately. She continues showing the cards in a row and gets response from Ixi. This continues for 3 minutes and 50 seconds. During the playtime, she expresses a neutral facial expression; but only when she shows the happy card, she also smiles and laughs. When she is done with all the cards, she informs the researcher and they switch to the next game. This part of the sessions takes overall 6 minutes and 30 seconds.

Then it is followed by a quick pause of switching the game and the cards. Participant 11 asks to start the game by touching Ixi's head. This interval takes 20 seconds.

Game 2 with Participant 11

The participant immediately starts playing by showing the cards to Ixi while Ixi is making the monkey sound. When a card is shown by the participant, Ixi gives a negative response but the participant does not understand the response and continues showing cards in a row. After trying for two minutes, she asks for help. The researcher explains what she needs to do and the response from Ixi. While the participant is trying other cards, the researcher explains the game and tells her to show the monkey card to Ixi. The participant finally understands, shows the monkey card and gets a positive response. Till this point, she looks confused and not interested. After that, she keeps her neutral expression but looks interested. Ixi play

makes the second animal sound, she starts to search for the right card. Before showing any card, she touches Ixi's head even though it was only necessary for rehearing the sound when Ixi is silent. She searches and shows some cards to Ixi and gets negative response from some of her trials. After a while, Ixi's continuous sound seems to cause annoyance for the participant and the researcher realizes that Ixi got stuck. At this point, the researcher tries to fix Ixi, and still keep the participant's attention on the game. So she asks the participant to find some cards for her, while trying to restart Ixi. However, Ixi does not restart so they have to end the game. This sessions overall takes 8 minutes and 40 seconds.

Table 33 Successful and problematic features of Game 1 for Participant 11

Game 1 (6’ 30")
Successful Features
Ixi Ixi was quick to give response to the shown cards. Especially, the happy and sad faces draw the participant's attention. She showed the sad card twice. **Cards** They are easy to look and hold with one hand. Understandable expressions. **Game** After an explanation, the game went smoothly.
Problematic features
Ixi At the beginning, Ixi usually makes a movement and sound but did not do it this time. Participant expected to see a "start" expression from Ixi. She tried pushing and touching Ixi several times. **Cards** Participant cannot see the card from behind.

Table 34 Successful and problematic features of Game 2 for Participant 11

Game 2 (8’ 40’’)
Successful Features
Ixi Ixi gave negative or positive responses and they were fast. **Cards** Easy to hold. **Game** After understanding the game, it became interesting for the participant.
Problematic features
Ixi Repetitive sound and movement annoyed participant. It was difficult to find the right card. **Sound** Participant 6 did not understand the negative response probably because it was in Dutch.

Table 34. continued

She did not understand the animal from the sound. **Cards** Cards were large to fit on the table. It was hard to browse through all of them, it took so much attention and time. **Game** Took time to explain the game. Did not understand the animal sound & negative response.

Table 35 The types of interaction observed for Participant 11

Physical interaction with IXI and cards	**Details**
Touching with one finger to head, eyes, body. Pulling the wings, rubbing the head.	
Leans her hand to the table while showing a card.	
Holds the card from side.	
Browses the cards on the table.	
Facial expressions and Looking Directions	
Confused, clueless, shy at the beginning.	She reluctantly touches Ixi, Her lips are down, stares at Ixi.
During the session mostly neutral.	
Sad, Annoyed by the repetitive animal sound.	She drops her head on her hand and lips are down browsing through the cards without looking at Ixi. She raises her hand open (with annoyance) when asking "what is she saying?" points Ixi.
Smiling and laughing at the happy card.	
Looking away while touching to Ixi	
Looking at the cards	
Looking at the researcher	
Looking at the camera	
Communication	
To express confusion.	"What is she saying?"
To ask for help.	
To inform the researcher that she is done.	
To chat.	
To get a hint or directive.	

4.10.4.6 Participant 12 (F)

Age: 8 years.

Duration of session: 12 min. 20 seconds.

Game 1 with Participant 12

At the beginning of the session, participant looks curious and watches movement and listens the sound. She starts to play by taking cards and showing to Ixi. While doing that she commands Ixi saying "be that". To get a reaction, she brings the card closer shakes it and then puts it away without getting any response takes another card. The researcher tells the participant how to hold the card and tells her to wait while showing the card. She still does not get a reaction from Ixi and starts to complain. After a few trials, she finally gets a reaction from Ixi. Every time she shows a card, she commands Ixi by saying the card's name "be love", "be dog" etc.. While showing and waiting for a reaction, she touches Ixi's head eyes and talks about the card she is showing. After trying every card, she touches the body and tells she is done with the game. This game period takes 8 minutes and 10 seconds.

During the interval participant receives the next game cards. This period takes 20 seconds.

Game 2 with Participant 12

When the participant hears the animal sound, she directly says "It's a monkey!". She does not understand that she needs to find and show the monkey card, instead she starts to browse through the cards and shows a card she prefers to Ixi . While showing the card, she shakes the card and commands saying "come on!" with an annoyed expression. After a while, the researcher gives a hint to the participant and she looks for the monkey animal card. She finds and shows the monkey animal card however Ixi does not give any response. At that time, the researcher comes and finds out Ixi is stuck and restarts it. The participant tries showing the monkey card again, says "come on" and pets Ixi's head to get a response. However, it does not work. She

complains and wants to end the game. This game period takes 3 minutes and 50 seconds.

Table 36 Successful and problematic features of Game 1 for Participant 12

Game 1 (8’ 10")
Successful Features
Ixi The participant was curious and excited by the cards and the reactions She preferred to verbally communicate with Ixi. **Sound** She commanded Ixi "to be" instead of "make ... sound". **Cards** While showing a card to Ixi, she described the emotions. **Game** Game was fun, exciting. She looked interested in the game.
Problematic features
Ixi Ixi was not giving reactions for a while. **Cards** She did not know how to hold the card, researcher explained how to hold the cards and she needed to wait.

Table 37 Successful and problematic features of Game 2 for Participant 12

Game 2 (3’ 50’’)
Successful Features
Sound She directly understood the sound was a monkey sound.
Problematic features Ixi Ixi does not give any response to the cards. **Sound** Ixi repeated the monkey animal sound which annoyed, confused the participant **Cards** Cards are too big to put all of them on the table and browse. Game The participant understood the monkey sound however, she did not know what to do. Game needed guidance.

Table 38 The types of interaction observed for Participant 12

Physical interaction with IXI and cards	**Details**
Hits Ixi's eyes with a card.	
Touches Ixi's head with one finger.	
Touches the body part after a reaction.	
Pets Ixi's head.	
Gets her body closer to Ixi and stares into Ixi's eyes.	
Facial expressions and Looking Directions	
Happy, laughing, Excited, interested.	Smiling, opening eyes, raising eyebrows.
Mimicking the card	While showing the "angry" card.
Surprised	When gets a reaction she stops a second opens her mouth and says "that's a good boy".
Annoyed, distracted	Looking around the room, draws a sigh and complains "why aren't you working!"
Look around the room	
Communication	
To comment on cards and sounds	"It's a monkey!" "ok so you're a happy person" (when ixi does not react on the "angry" card).
To encourage Ixi to react	"What is this?" "Be a dog woof, woof!" "come on, bark!"
To complain	"It's not doing anything."

4.10.4.7 Participant 13 (M)

Age: 8 years.

Duration of session: 13 min. 10 seconds.

Game 1 with Participant 13

When the participant first encounters Ixi, he stares at it and asks questions with curiosity. While the researcher gives an explanation on Ixi and the game, he tries to physically interact with Ixi by touching its head with one finger several times and playing his hand on Ixi's head. He starts the game by picking a card and showing to Ixi without looking at it. At his first trial, he holds the card horizontally which is incorrect. While showing the card, he stares at Ixi and places his hand on Ixi's head

to encourage to start the game and also feel its movement. He looks confused and asks the researcher for help. After a small explanation, he holds the card vertically, and stares at Ixi. While waiting for a response, Ixi continuously tilts its head to sides, Participants takes that action as a reaction to him showing the card and gets excited. So he tries moving the card to Ixi's back, expecting it to turn its head. Then he tries to hold the card in every angle possible, rotates, upside down, sideways, etc. While showing the card he places his hand on Ixi's head to feel the movement. He again thinks Ixi is rotating its head to follow the card's movement and wants to share it with the researcher. He gets bored and starts to chat with the researcher. He picks a card holds it upside down towards Ixi, checks the card and repositions it and shows to Ixi. While showing it, he touches Ixi's head and finally gets a response from Ixi and after that he says he is done playing this game. After that, the participant hands over the first game cards and gets the new cards and the game is ready to start. The interval between the two games takes 20 seconds.

Game 2 with Participant 13

The participant's first interaction with Ixi is touching its head to start the game while Ixi starts making the monkey animal sound. He takes one card and holds it upside down while his hand is on Ixi's head. While holding the card towards Ixi, it repeats the monkey animal sound and the participant considers this as a response and starts laughing and smiling. He takes another card, again upside down and Ixi repeats the animal sound. After that the participant looks confused and asks the researcher about the sound, the researcher explains the game. He starts browsing through the cards. He takes another card and shows towards Ixi and while holding it, he places his hand on Ixi's head but he looks still confused. The researcher gives him another hint to find the monkey animal card. He spends time to find the right card, shows it and places his hand on Ixi's head and finally gets a confirming response from Ixi. After the response, he expresses smiling and surprised gesture that he shares with the researcher. He continues playing the game. During the next animal sound, he shows false cards and gets negative response from Ixi. When he shows the right animal card, Ixi does not give any response, so the participant complains to the researcher

and verbally insists that it's the right card. After a few trials, he starts to feel bored and expresses it by looking absently then tells he is done playing. This game session takes 7 minutes and 20 seconds.

Table 39 Successful and problematic features of Game 1 for Participant 13

Game 1 (5’ 30")
Successful Features
Ixi Ixi's movement and sound evoked curiosity. Especially during the game, Ixi's head movement excited the participant, he liked to touch Ixi's head. **Sound** He got very excited when Ixi was talking when "yes" or "no" cards were shown. **Cards** Cards were easy to manipulate, he tried every angle and direction to show the cards **Game** When participant liked one card, he preferred to show it several times and got the reaction several times.
Problematic features
Ixi Ixi did not recognize the card when it was held horizontal, or upside down. **Cards** Participant held the card upside down several times without noticing. It was problematic in both games. **Game** Overall the game did not excite the participant so much, only some certain cards and its reactions did.

Table 40 Successful and problematic features of Game 2 for Participant 13

Game 2 (7’ 20’’)
Successful Features
Ixi Participant got surprised and excited when he got a reaction. **Game** The game was challenging.
Problematic features
Ixi Ixi did not give any reaction to the right card during the second animal sound which made participant annoyed and caused him to end the game. **Sound** Ixi's repetitive sound confused the participant as if it was a reaction to the shown card. **Cards** Participant 9 held the cards upside down several times. Browsing through cards took too much time because of the size of the cards. He did not understand the animal on a card. **Game** it was difficult to understand the animal sound.

Table 41 The types of interaction observed for Participant 13

Physical interaction with IXI and cards	**Details**
Tapping Ixi with one finger several times to start the game or take attention.	
Playing his palm on Ixi's head while holding a card.	
Touching the head, eyes, body, antenna.	
Petting the head.	
Holding the cards upside down, sideways, rotating, holding behind Ixi's head.	
Turning cards towards himself several times to check if it is upside down.	
Facial expressions and Looking Directions	
Surprised, excited at the beginning.	"Wow, what is that?", "wow he is talking"
Confused .	Scratching his head and staring absently.
Excited, happy, smiling or shocked when he gets a reaction.	
Frustrated, annoyed at the end of the second game.	"But this sound is not that!" He drops his shoulders and stares at other things.
looks at the researcher for inquiry	
looks at the card he is holding	
looks away while waiting	Looks at the wall.
Looking away	Staring absently.
Communication	
To inquire.	
To chat	"Is this a robot?" " It's not a robot, it's a bird"
To share excitement.	
To tell he is done playing.	
For confirmation.	Showing a card and saying "is this a monkey?"
To complain.	

4.10.4.8 Participant 14 (M)

Age: 9 years.

Duration of session: 18 min. 50 seconds.

Game 1 with Participant 14

The participant starts by touching Ixi's head with two fingers. He takes a card and shows it to Ixi without viewing the card beforehand and gets a reaction. This makes the participant laugh and he looks at the researcher for sharing this moment. He continues showing cards and getting reactions from Ixi. While showing a card, he once shows it upside down, moves to towards Ixi and far, moves to the right and left. He smiles after each reaction and ends the game when he finishes playing with all the cards. This game session takes 4 minutes.

During the pause time between two games, the participant gets the second game cards and asks what he should do during the next game. This period takes approximately 30 seconds.

Game 2 with Participant 14

In order to hear the animal sound, the researcher asks the participant to touch Ixi's head. He gently pets and rubs Ixi's head. Ixi makes the monkey animal sound. When the participant hears the animal sound he tells the researcher that the card he is holding is not that animal. He expects Ixi to make the animal sound on the card he is holding. He continues to hold the same card and gets a negative response, which confuses again and he inquires from the researcher. He does not understand that the response was negative and the researcher explains this to the participant. After a while, he finds and shows the monkey animal card and while showing the card he touches Ixi's head with one finger. After one repetitive sound, Ixi gives a confirming response to the card. He continues with the next animal sound and before showing any card, he rubs Ixi's head for taking attention. He plays and continues to guess the right animals. While waiting for a response from Ixi, he holds the cards with different angles, holds vertically and horizontally, shakes them and moves back and

forth. When Ixi does not make any animal sound, the participant inquires to the researcher and as advised, tries touching Ixi's head. He ends the game, when he does not get any response from Ixi for more than 30 seconds, which causes him to feel bored.

Table 42 Successful and problematic features of Game 1 for Participant 14

Game 1 (4’ 20")
Successful Features
Ixi He defined Ixi as "It's pretty cool". **Cards** Cards were easy to hold from sides and above. **Game** Game was easy to understand and follow for the participant.
Problematic features
Cards Participant 13 tried showing the cards before viewing them however, when he did that he realized that he showed some cards upside down and after that checked the cards before showing to Ixi. He bent a card while showing it to Ixi. **Game** The game was monotonous once the participant understood what to do.

Table 43 Successful and problematic features of Game 2 for Participant 14

Game 2 (14' 10")
Successful Features
Ixi Ixi did not get stuck and gave both negative and positive responses during the playtime. **Game** Participant 14 was interested in playing the game for a long time, it evoked curiosity and interest.
Problematic features
Ixi Participant 14 did not understand the negative response from Ixi. to get a response from Ixi takes too much time, finally the participant got bored and ended the game. **Sound** Ixi's repetitive animal sound annoyed the participant. **Cards** Participant 14 placed the cards on the table and had difficulty in reaching them and browsing. **Game** Game responses and the delay in hearing the next animal sound confused the participant.

Table 44 The types of interaction observed for Participant 14

Physical interaction with IXI and cards	**Details**
Touching Ixi's head with two fingers.	
Rubbing the head to hear the animal sound.	
Moving closer to Ixi and staring into its eyes.	
Moving the card back and forth while holding and waiting.	
Moving the card up and down, right and left.	
Bending the card while holding.	
Shaking the card to take Ixi's attention.	
Facial expressions	
Laughing and smiling at the beginning.	
Neutral.	
Smiling after each reaction from Ixi.	
Not interested.	
Confused.	Open mouth looking at the researcher.
Annoyed.	He opens his eyes and makes his lips like "hıh".
Bored.	Looking at other objects, camera, wall.
looks at the card after showing	
looks at the researcher for sharing	
Looking at the cards	Spending too much time browsing them.
Looking outside when people are passing by	
Looking away	While thinking about the animal sound.
looking away	While waiting for ixi to make a new animal sound.
looking at the cards	
looking away	While thinking about the animal sound.
Communication	
To end the game.	
To inquire	"What is that mean?" when Ixi says "no" in Dutch.
For confirmation.	

4.11 Review of the Findings

After these analyses, all the data gathered from each participant categorized under the different age group under new sheets. For each age group, the data obtained from each participant's session, game 1 and game 2's successful and problematic features are written down. After that, the similar features are gathered together in order to identify patterns in the interaction. Similarly, same categorization applied to the

physical interaction, communication and facial expressions of the participants. Under these categories also, participant's actions and motivations clustered to point out the patterns during the play sessions. These sheets were used for categorizing the findings under certain titles for each group. These sheets can be found in appendix B. The statements on these excel sheets were then clustered and the titles were evaluated again. Some of the titles of the statements were changed in order to express the qualities of the features better.

CHAPTER 5

FINDINGS OF THE STUDY

The study was conducted with aiming to obtain a deeper understanding on children's interaction with a robotic toy and the interaction's dimensions through observation. These observations were expected to provide information on children's motivations for interaction. The conclusions were presented in the similar order with the findings. The overall successful and problematic features of the two games for each age group and interactions observed during the sessions are presented below.

5.1 Findings for participants between the ages 4 and 5 years

5.2.1 Game 1 - Emotion Cards Game

5.2.1.1 Successful Features

Welcoming - Exciting - Engaging: During the first game Ixi's starting sound and movement was found welcoming and exciting by the participants in general. The emotional expressions on Ixi's eyes excited the participants. The participants made eye contact with Ixi several times and engaged in playing. Reactions and the starting sound was stimulating. Some of the participants were so engaged that they unwittingly imitated Ixi's movements and gestures. One participant even tried talking to Ixi, to encourage it to react.

Inviting to Touch*:* Participants touched Ixi several times. Ixi's big head is suitable for touching and petting.

Talking: When the "yes" and "no" cards were shown by the participants, Ixi's reaction, as if it was talking, excited the participant more than emotional expressions and animal sounds. This was expressed from one participant as "Wow he is talking!"

***Game - Easy to Understand and Play**:* The game is simple and easy to understand, little or no explanation was sufficient. One of the participants directly started showing cards to Ixi without waiting for any explanation. The session progressed smoothly, the participants were able to get response from almost every card she showed.

Cards - Easy to Hold and Manipulate: The game cards, were observed to be easy to hold with one hand during the sessions. Participants tried separating the used cards from the others.

Offering Creativity: One participant wanted to play another game which he called "remember me" using the cards. He preferred to play with only that card and tried showing it three times. Some of them tried showing cards without looking at them beforehand which was an additional excitement to the game.

Responsive: Overall Ixi was quick to respond to the cards shown. The participants got reactions to card he showed without much delay.

Social Bonding: Animal-inspired, owl-like design of Ixi, and it being responsive, have helped children to consider it as a social creature with which they can interact, talk and even play games. During one of the play sessions, the participant tried to play a card game and even threatened Ixi to prevent it from drinking water. Consuming water is something only living beings do and playing card games is a social game only human beings can play. Thus it is safe to assume that Ixi offers a possibility of social bonding with children.

5.2.1.2 Problematic Features:

Fragile Prototype: As stated before, the prototype was fragile and offered limited physical interaction. The participants wanted to touch and play with the body parts, however it was not possible. This also seemed to cause one participant to feel shy to touch Ixi.

Lack of Guidance - No communication: The participants at this age group expected guidance about how to show the cards, and how long they should wait while showing

it. They were unsure about the distance and angle for holding the card. When nothing happened while holding a card, they complained and communicated directly with the researcher. Furthermore, it was observed that three participants did not make a connection between the cards and Ixi. They did not associate the cards with Ixi's reaction.

Repetitive Starting Sound, Movement & Animation: The starting sound and movement were repetitive, when Ixi did not recognize any cards. This led to a misunderstanding as if it was a reaction to the card shown to Ixi.

Graphic Design of the Cards: Some participants showed the cards upside down without realizing because the back side of the card did not have an image of the card. While holding a card they were unable to see what they were showing to Ixi.

Structure of the Cards: The cards were easy to hold. However, since the cards are so thin, two participants from this age group squeezed and dropped the cards on the floor.

Lack of variety in the Cards: The limited number of cards, only emotion cards, yes-no and animal cards were disappointing. One of the children was stuck with one card and did not want to explore the others.

Monotonous Game: After understanding the game dynamics, the play time got monotonous and boring for the participants. Some stopped playing the game after a very short period when they understood how to play.

5.2.2 Game 2 - Animal Sounds Game

5.2.2.1 Succesful Features

Responsive: One of the main concerns during this game, was the possibility that Ixi stalled during the sessions. During some of the play sessions, Ixi was responsive and did not stall. These were considered as successful features.

Challenging: During the game, hearing a new animal sound after guessing the previous one, excited the participants. The game was observed to be "challenging".

It took more effort to play the game compared to the first game, so for some participants it was more interesting.

Cards - Easy to Hold and Manipulate: The cards were bigger and thicker compared to those in the previous game, they were easier to hold.

5.2.2.2 Problematic Features

Getting Stalled - Repetition: As stated before, during this game, sometimes, Ixi got stuck and did not respond or repeated the same animal sound. Even though the right card was shown, sometimes Ixi repeated the same animal sound without confirmation or gave a negative response. These situations confused and frustrated the participants. During the game, Ixi repeated the same animal sound together with up and down movements to remind the participant of the animal. However, after a while, it became annoying and frustrating for some participants especially when Ixi did not give a response to the card shown.

Lack of Guidance: Another problem during this game was that participants was not guided to touch Ixi's head. When for one participant wanted to touch Ixi to hear the animal sound, one participant preferred to touch the eyes as if they were touch screen.

Unidentifiable Animal Sounds: The animal sounds were the only information provided for the participants. There was no eye animation to support the feedback. As a result, participants did not realize it was an animal sound or even if they realized it was an animal, they were unable to identify the animal. One of them guessed the animal right, but did not know what to do.

Responses Being In Dutch Only: There were problematic features in terms of Ixi's sound. Ixi gave positive and negative responses only in Dutch. Even though the stress on the tone was a clue on being either positive or negative, participants did not understand their meaning and asked the researcher. Also a negative response was understood as a positive reaction from one participant.

Game - Difficult to Understand and Play: One of the main issues with the game was its being hard to understand without explanation. Participants expected the game dynamics to be similar to the previous one. During the sessions, it required several hints and explanations for participants to understand the game which caused a loss of interest.

Game - Not Spontaneous: The game was not spontaneous, the animal sounds were played in a certain sequence. The first game allowed participants to choose and try the cards they wanted. After the spontaneity of the previous game, this game was hard to understand and keep pace with .The participants had to play the game in the way Ixi led, which caused confusion.

5.2.3. Interactions observed for participants between the ages of 4 and 5

5.2.3.1 Physical Interaction

To Get a Reaction: The participants touched Ixi for three main reasons. Firstly, to get a reaction or response from Ixi during the play session. To get a reaction or response from Ixi, the participants tried various ways of physically interacting with Ixi. They tried hitting, touching with one or two fingers, rubbing and petting Ixi's head. Some of them tried touching the body, eyes, Ixi's antenna or wings to get a reaction. Some of them were harsh on Ixi as they pushed and squeezed the body, arms and head. At those moments, the participants were warned by the researcher in order not to break the prototype.

To Silence Ixi: Participants also touched Ixi when it repetitively moved and annoyed the participants. They wanted to silence Ixi and draw its attention to the shown card. To do so, they did similar things they did to get a reaction, placing their palm, hitting Ixi etc.

To Feel the Reaction: To contact or feel the reaction obtained from Ixi, participants approached Ixi and placed their hands on Ixi's head.

To Draw Attention without Touching Ixi: To get Ixi's attention and get a response, participants also tried other things without touching Ixi. They shook the cards, waved

their hands or clapped hands towards Ixi. One of them tried covering and opening Ixi's eyes using a card.

Holding and Manipulating Cards: During the sessions, participants tried to hold the cards in various angles and ways. When they got tired with one hand, they put their elbows on the table, switched hands or held the card with two hands. Also, to get a response, they tried to move the card back and forth, up and down and right and left. When holding and waiting sometimes they bent the cards. The pilot study participant spent time assembling and disassembling the second game cards since they were detachable. While browsing through the card during the second game, one participant preferred to place all the cards on his lap and browse from there.

Personifying for Interaction: One of the interesting and creative ways to play with Ixi was to try to play a game that a participant already knew. He divided the cards into two and put one half in front of Ixi and took other half for himself and tried to play a game he called "remember me". This can also be an indication for social bonding. Participant felt connected to Ixi and wanted to share one of his favorite games with Ixi.

5.2.3.2 Facial Expressions and Looking Directions

Expressions of Positive Emotions: At the beginning of the session, participants were curious, excited and happy to play. When they got a reaction, they expressed happiness by laughing, smiling. They were surprised when they got an unexpected reaction expressed by raising eyebrows and opening mouth or expressing this verbally.

Confusion: Participants were observed to be confused when they did not understand how to play with Ixi. At the beginning of the session, some of them were also shy to touch Ixi. They looked confused, expressed by opening the mouth, looking at the researcher, making "he?" sound or saying that they were confused. This also happened when they did not get a response from Ixi or when Ixi repeated the same animal sound constantly.

Expressions of Negative Emotions: During the sessions, when participants did not get a reaction from Ixi, they expressed disappointment, annoyance, sadness. These moments were followed by loss of interest in playing.

Loss of Interest: Some of the participants lost interest and got bored in playing with Ixi, when they did not get excited by the reactions or did not get any response from Ixi. After that, they usually talked with the researcher to end the game.

Mimicking Ixi: Two participants in this age group unwittingly imitated Ixi's emotional expression and movement when they showed an emotion card.

Looking at Ixi: When they got a reaction, participants in general, they got closer, opened their eyes and stared at Ixi for a while to watch the eye animation and movement.

Looking at the Researcher: The participants looked at the researcher when they needed assistance, confirmation and when they wanted to share their thoughts and feelings. They looked at the researcher when they felt confused and asked questions about the game. They also looked for approval of the cards or the way to touch Ixi. During the session, when Ixi gave a reaction, the participants wanted to share their excitement and show what was happening to the researcher. When they felt angry or annoyed, they looked at the researcher and complained about Ixi and the games.

Looking at the Cards: Participants looked at the card they were holding to check whether they were holding it correctly. During the second game, considerable amount of time was spent by looking and browsing through the cards while Ixi was repeating the animal sound.

Looking Away: When participants felt confused, bored or when they were holding a card and waiting for a reaction from Ixi, they got distracted. They looked outside from the window, looked around the room, looked at the corridor when they heard their friend's noises.

5.2.3.3 Communication

To Share Feelings and Opinions: During the sessions, participants preferred to verbally communicate with the researcher for sharing their experience. They usually communicated with the researcher to share their excitement, or to complain and express annoyance about Ixi and the game. They also communicated to evaluate the game such as "difficult".

For Confirmation: Two of the participants in this age group, asked the researcher for confirmation. They asked for confirmation of the right card and holding position of the cards. One of them showed the card to the researcher for confirmation instead of showing it to Ixi.

To End the Game or Play the Next Game: Participants were told that they can tell the researcher whenever they felt bored. They communicated with the researcher when they no longer wanted to play a game or when they wanted to try another game.

To Communicate with Ixi: Two participants from this age group tried verbally communicating with Ixi when waiting for a response. They used sentences to encourage Ixi to give a reaction to the shown card.

To Chat with the Researcher: When participants were bored or during the interval between the two games, they talked with the researcher about random things, also about Ixi and cards.

To Inquire: When participants were confused, they inquired the researcher. They asked how to get a response, or how to play the game. One of the participants asked about the animal sound during the second game.

5.3 Findings for Participants between the Ages 8 and 9 Years

5.3.1 Game 1 - Emotion Cards Game

5.3.1.1 Successful Features

Welcoming - Exciting - Engaging: The first encounter with Ixi, watching its movement, sound and eye animation, evoked curiosity and excitement. The animations on the eyes impressed and engaged the participants.

Easy to Understand and Play: The game was easy to understand. There was no need to explain the game. The sessions mostly went smoothly with all the participants, the emotional expressions and talking sound impressed the participants more than animal sounds. The emotions were easy to understand for the participants.

Talking: Especially, the reaction to "yes" and "no" cards surprised the participants and it drew interest. This was because they felt like Ixi was talking to them.

Cards - Easy to Hold and Manipulate : The cards were easy to hold with one or two hands. They tried holding with one hand, took two cards at the same time, held from side and above. They tried different angles when showing to Ixi.

Offering Creativity: Two of the participants in this age group, showed the cards towards Ixi without looking at them beforehand to make this experience more exciting.

5.3.1.2 Problematic Features

Lack of Guidance: The most common problem during the sessions was that there was no guidance for interaction. The participants did not know how to hold, how far to hold the cards from, and Ixi did not respond when the cards were held upside down or sideways. Furthermore, the children did not know how to physically interact with Ixi without an explanation.

Delay in Response: To get a reaction from Ixi took time; while waiting for a reaction participants got bored, some gave up and put the card away and tried showing another one. Some leaned on the table and held the card below Ixi's eye level.

Repetitive Starting Sound, Movement & Animation: During some sessions, Ixi continuously made the starting sound and movement. Participants did not understand the reason, another participant mistook it as a reaction to the card shown.

Graphic Design of the Cards: The participants tried showing the cards to Ixi without looking at them beforehand. However, sometimes the cards were held upside down and Ixi did not recognize them. After realizing this problem participants started to check the card before showing it. There is no possibility to see the card from behind, to see both the visual on the card and Ixi's eyes, participants had to lean and hold the card at an angle. One of the participants mistook the writing on the "no" card as "on" and insisted on showing it to Ixi upside down.

Structure of the Cards: It was observed that the cards were too thin; three participants bent them easily while holding them.

Monotonous Game: After a few trials, participants mastered the game, which caused the game to become monotonous and boring for them. Participants finished the game in a very short time.

5.3.2 Game 2 - Animal Sounds Game

5.3.2.1 Successful Features

Challenging: For this age group, the game was challenging in a positive way. Participants were curious and excited to play the game. For one participant, it was exciting to hear the next animal sound after the confirming sound from Ixi.

Responsive: During the sessions with the game group, Ixi being responsive with both negative and confirming responses, helped participants to be engaged in the sessions.

5.3.2.2 Problematic Features

Getting Stalled - Repetition: During this game Ixi sometimes stalled and did not give any reaction to the card shown. Furthermore, it sometimes stalled with the same animal sound and up and down movement, which caused annoyance and confusion for the participants.

Not Spontaneous: The game was following a certain sequence with animal sounds. As this was the dynamics of this game, it did not allow participants to be spontaneous and to choose. This was one of the problematic features of the game.

Game - Difficult to Understand and Play: The game needed a proper explanation and several hints for participants to understand. After hearing the animal sound, participants did not know what to do, the game needed guidance.

Lack of Guidance: There was also no guidance about where to touch. Participants tried touching Ixi's screen-like eyes.

Unidentifiable Animal Sounds: The animal sound was hard to understand. It was difficult for participants to understand which sound belonged to which animal.

Responses Being in Dutch Only: Three of the participants did not understand the response since they were in Dutch, they asked the researcher. After hearing the repetitive animal sound while showing a card, when Ixi suddenly responded, it was considered as a positive response from the participants without knowing whether it was actually positive or negative.

Responses Being Dull: The responses participants got after showing the right card was disappointing, participants did not get excited when they heard the confirming sound from Ixi.

Difficulties in Holding and Manipulating the Cards: There were some problematic features with the game cards. Even though they were easier to position towards Ixi's eyes compared to the previous game, their size and thickness caused difficulties for browsing through, placing, organizing and holding them. Participants preferred to hold them with two hands, placed them on their lap or next to them. These situations caused participants to spend considerable amount of time and effort for looking at, browsing through and organizing the cards, which caused distraction from the game itself.

5.3.3. Interactions observed for participants between the ages of 8 and 9

5.3.3.1 Physical Interaction

To Get a Reaction: Participants touched Ixi in various ways to get a reaction. They squeezed and pressed Ixi's body, arms, eyes and head, petted the head while holding a card with their other hand. Some of them tried touching and tapping several times on Ixi' head with two or one finger to get a reaction from Ixi.

To Silence Ixi: Participants wanted to silence Ixi when it made repetitive actions. They placed and hold their hands while or before showing a card.

To Feel the Reaction: Some of the participants tried touching Ixi for another reason, to initiate interaction, to feel the vibration and movement that comes together with the reaction. Participants touched the body part, placed their palms on Ixi's head while holding a card towards Ixi.

Holding and Manipulating Cards: During both games, participants tried to hold and manipulate the game cards. To get a reaction from Ixi, they rotated, moved them back and forth, up and down, right and left. They tried holding from a side or hold with one hand from above. They turned the cards towards themselves several times to check if it is upside down. One of them tried holding the card to behind Ixi's head to see if it's head will rotate to see the card. They tried browsing the cards on the table, on the floor and on their lap.

Leaning on the Table: While holding a card and waiting for a reaction from Ixi, participants got tired and leaned their elbows on the table. While doing that they usually held the cards lower than Ixi's eye level.

5.3.3.2 Facial Expressions and Looking Directions:

Expressions of Positive Emotions: Participants were expressing positive emotions when they first saw Ixi and started playing. They also expressed positive emotions when they got a reaction. These expressions were smiling, being interested in, laughing, being excited, shocked and surprised when they got a reaction.

Confusion: Participants looked confused, clueless, shy and reluctant when they did not know what to do or did not get any reaction from Ixi. This situation happened at the beginning of the session and usually on the second game.

Negative Expressions: Participants looked frustrated, angry and annoyed at some moments. Participants expressed these emotions when they did not get any reaction from Ixi and while Ixi was stalled and making an animal sound repetitively during the second game.

Loss of Interest: When participants did not get any reaction from Ixi or when Ixi is stalled, they got bored, uninterested in playing and started looking at other things.

Neutral Expression: One of the participants did not looked interest during the session and had a neutral facial expression most of the time.

Mimicking Ixi: Two participants in this age group, mimicked Ixi and the emotion on the card.

Looking at Ixi: During the sessions, participants were looking at Ixi's eyes to watch any reaction from Ixi. Some moved closer and stared into Ixi's eyes when there was an animation.

Looking at the Researcher: Participants in this age group looked at the researcher when they wanted assistance. They also looked at the researcher to share their excitement about Ixi's reactions.

Looking away: Participants looked away while holding a card and waiting for a reaction. This was related to the delay in reaction from Ixi. One of them looked away when touching Ixi. When they lost interest in playing, they looked at people passing by, looked at the walls and camera, around the room or even stared absently.

5.3.3.3 Communication

To Inquire: Participants consulted the researcher several times during the sessions. They inquired about what to do and how to get a response or reaction. In return the researcher gave hints and directives to the participants.

For Confirmation: Participants communicated with the researcher for confirmation about how to hold a card during the first game. They asked for confirmation about the animal card during the second game.

To Share Feelings and Opinions: Participants wanted to express their emotions and opinions about Ixi during the sessions. They expressed their excitement, confusion, frustration and complains towards the researcher. They also talked about their opinions on Ixi, cards and sounds.

To Chat with the Researcher: They wanted to chat about Ixi and random things while playing and during the interval period.

To Communicate with Ixi: Some participants directly talked towards Ixi. They did that to encourage Ixi to react or respond to them. (e.g. "What is this?" while showing a card) ("be a dog woof, woof!" "come on, bark!")

To End the Game or Play the Next Game: The participants informed the researcher when they were done playing.

5.4 Differences of the play behavior and interaction types observed between 4-5 and 8-9 age groups

The conclusions for each age group showed that there are some differences in terms of play behaviors and interaction types for this two age group. Findings for these two age groups had some similarities but also some significant differences well as.

5.4.1 Play durations for each age group:

Play durations for both age group are calculated and listed in Table.45 and Table.46

Table 45 Duration of games for participants in the age group of 4-5 years

	GAME 1	**GAME 2**
P1	4' 20" (260")	3' 40" (220)
P2	8' 30" + 2' 20" (650")	5' (300")
P3	5' 10" + 3' 50" (540")	12' 30" (750")
P4	1' 40" (100")	2' 30" (150")
P5	4' 20" (260")	10' (600")
P6	5' 40" (340")	2' 50" (170")
Total number of seconds	2150"	2190"
Average per participant	5' 58" (358")	6'5" (365")

Table 46 Duration of games for participants in the age group of 8-9 years

	GAME 1	GAME 2
P7	4' 40" (280")	6' (360")
P8	4' 20" (260")	11' 20" (680")
P9	3' 20" (200")	12' 30" (750")
P10	5' 50" (350")	5' 10" (310")
P11	6' 30" (390")	8' 40" (520")
P12	8' 10" (490")	3' 50" (230")
P13	5' 30" (330")	7' 20" (440")
P14	4' 20" (260")	14' 10" (850")
Total number of seconds	2560"	4140"
Average per participant	5' 20" (320")	8' 37" (517")

Game 1: There is only a difference of 38 seconds in the average play duration per participant for Game 1 for participants in the age group of 4-5 years (5'58") and 8-9 years (5'20"). It can be said that both age groups enjoyed playing the first game and the time they spent for playing the game is close.

Participant 2 and Participant 3, in 4-5 year age group, after playing the second game, wanted to switch to the first game and played it again. They enjoyed the first game more and it was easier for them to understand and play.

The participants in the 4-5 year age group tried personifying the same game. One of them tried to divide the cards into two and invited Ixi to play the game he wanted.

It was observed in both age groups to mimic Ixi's emotional and movement expression during the first game. Participants were engaged during this game.

Game 2: However, there was a significant difference between the average play duration for Game 2 for the two age groups. In average, participants in the 8-9 year age group, even though there were considerable amount of problematic features, found this game more challenging and engaging and wanted to curiously play as much as it goes. On the other hand, participants in the 4-5 years old age group had problems in adapting to and understanding the second game. It was difficult for them to understand the animal sound and find the card for the correct animal. Furthermore, compared to the first game, Ixi's response to the cards took longer. This might have caused the younger age group to be bored, the older age group might have been more patient in waiting for a response from Ixi. During the second game, the younger age group needed more assistance from the researcher compared to the older age group. They asked more for approval of the right card and even preferred to show the card to the researcher to get a confirmation about the card before showing it to Ixi.

5.4.2 Physical Interaction

When the physical interaction with Ixi is considered, the reasons are similar however, the way both groups preferred to interact are slightly different. The younger age group was observed to be harsher on Ixi and the participants were more diverse in the way they touched Ixi. Furthermore, they preferred to express their emotions more with physical movements, such as throwing the cards.

5.4.3 Facial Expression and Looking Directions

In both age groups, mimicking of Ixi's emotional expressions were observed during the game. While participants in the older age group mimicked the expressions, a participant in the younger age group also mimicked Ixi's movement.

The younger age group was more prone to express loss of interest compared to the older age group. They got distracted more easily and started looking at other things when there was delay in response or when Ixi stalled.

5.4.4 Communication

During the sessions, the 4-5 years age group needed more assistance and tried to communicate with the researcher more compared to the 8-9 year-olds. They needed more confirmation and also wanted show what was happening with Ixi to the researcher. Some of them talked about things which were imaginary, such as one participant threatening Ixi ("I will not give you water."). On the other hand, participants in the 8-9 year age group tried to communicate more about their opinions, the way Ixi works and made general comments.

CHAPTER 6

CONCLUSION

To investigate children's motivations to interact with a robotic toy, a field study was conducted by observing children in a play session. The children were selected from two different age groups. Their behavioral and social skills were expected to bring some differences and similarities to the research.

In this chapter, the research questions that were presented in the first chapter are evaluated. In the light of the results of the study, suggestions are made for a robotic toy providing an engaging interaction.

6.1 Revisiting the Research Questions

The developmental, behavioral and play capabilities of children at the age of 4-5 and 8-9 year-olds

In Chapter 2, the child development of 4-5 year-olds an 8-9 year-olds are reviewed. The child development is investigated under the main categories of *Social & Emotional Capabilities, Language & Communication Capabilities, Cognitive Capabilities* and *Movement& Physical Capabilities*. In order to have a deeper level of understand the effects of these main categories, their impact on a child's play behaviors are described, after each category. Some of the important behavioral and play capabilities can be described as follows.

4-5 year-olds can understand others' emotions to show condolence for others however, their language skills and expressions are not good enough to express their feelings well. A 4 year-old sometimes cannot control her/his emotions so they might be impulsive when they get angry. On the other hand, a 5 years old can be better at controlling him/herself while expressing emotions and can express them better with words.

They tend to use physical gestures. As a child gets older, their play behavior becomes more cooperative. However, these ages are considered as transition era in play since children start to change their play behavior from solitary to cooperative play. Children at these ages can still prefer to play alone but they are able to share or take turns while playing. At the end of 5 years, a child becomes more cooperative and can prefer to play with others. Since this age group cannot verbally express their emotions enough, they can prefer to express themselves using sociodramatic play. They can show their emotions through singing, drawing, bodily gestures and fictional imaginary stories. They can also use dolls or stuffed animals to assign emotions or to support their sociodramatic play activates. They are also able to play with toys with large buttons and large puzzles.

8-9 year-olds are in the age period before the puberty era. Children at these ages know proper social behaviors and behave accordingly. They can show empathy for others. They have a very long attention span. They give importance to relationships and build complex and strong friendships. Their language skills are highly improved. Especially 9 year-olds can use sophisticated ways to express different feelings. They can use different ways to express themselves and use alternative communication and self-expression methods: writing basic and short stories, making more complex drawings, learning an instrument. They have knowledge of basic functionalities of digital devices like computer and mobile phones.

The current robotic toys' features used for motivating interaction

In Chapter 3, some popular examples of robotic toys were reviewed. Some of the trends among robots was to have animalistic or humanoid physical traits. Such tendencies are understandable considering our perception of living beings, with which we can build social bonds. In real life cases, we are used to interacting with people and animals. To have certain physical and behavioral similarities with people and animals, those two categories are used to motivate people for interacting and social bonding with robots. Paro, Chip and Ixi are three examples that have been mentioned previously in different parts of the thesis. The three have common traits of being in an animalistic physical body shape and attributes.

Paro is a seal-like robotic toy which moves its body and head, responds to touch, reacts to physical interaction and moves towards to audible reception. It has been mentioned in Section 3.1 that a research shows old people interacting with Paro, petting it like a cat, giving it names and even kissing it. Paro's reaction towards physical affection and responsive nature for audio input can be considered as important motivational factors for further interaction.

Nao can be considered as the prime example of robots which have humanoid physical features. Nao has been designed for being a social companion toy for children. As mentioned it has humanoid body parts like arms, legs and a face, which it uses actively to reflect emotions. By using body posture and gestures, it transmits different types of emotions like happiness, sadness and pride (Belpaeme et al., 2012). It can dance and mimic some physical motions of the people it interacts with. Those physical features and emotional responsiveness are considered as the stimulus of interaction for children.

Tapia is a different kind of a social robot with neither humanoid nor animalistic features. Tapia is a large egg shaped robot with a big screen which resembles a face. Even though it does not look like anything we have encountered and interacted with in real life, it shows emotional reactions via its touch screen and audible responses. Player can also interact it via audio commands or touch screen input. The user can also hold and hug Tapia and it responds towards that way. In Tapia's case, the main driving force for interaction is emotional expressions conveyed through its screen, audible feedback, motion sensor response and gyro.

There are also some "build your own robotic toy" kits in the market which are found to be interesting to mention. They offer the opportunity of creating a personal robotic toy. For example, Tio is a robotic toy kit consisting of building blocks and some connecting parts which can be controlled via Bluetooth. This robotic toy kit offers its users to be creative and build their customized robots. Even though, this category can be offering limited social interaction, the idea of creating a personal device and programming its actions can be engaging and motivate children to interact with it.

The tangible (and intangible) features of robots that impact the child's interaction with a robotic toy

In this study, Ixi a robotic toy with an owl-like body and its game cards are used for investigating the interaction. Ixi offers two game options that can be played using these game cards. Also, the robotic toy's head part enables interaction with its touch sensor. The participants could touch the head part to initiate interaction and get a reaction from Ixi during the first game. The reaction from Ixi included an audio feedback, eye animation with heart shape and up and down movements. In the second game, it allowed participant to hear the animal sound and watch Ixi's up and down movement again. To do so, the participants needed to touch Ixi's head for a short while. However, during the sessions, it was observed that participants were not able to naturally find this function out. They needed to be told about this. After they were informed, they tried touching Ixi's head in several different ways. Using one finger, two fingers, touching the antenna on Ixi's head, rubbing the head, petting the head, even using a card to touch the head. When they got a reaction or animal sound after this action, the participants were observed to touch Ixi's head constantly before showing any card to Ixi. It was considered as an action to take Ixi's attention to play the game. The body part and Ixi's wings did not contain any sensors. It had a flexible body allowing it to move up and down and right and left. Ixi used during the sessions was a fragile prototype. The material of the body part was tearable and the wings were detachable. For this end, participants were warned not to touch the body part while playing. However, still the 4-5 year-olds tried to touch and squeeze the body part and lift the wings.

The cards were a medium to facilitate interaction between the participants and Ixi. The two sets of game cards had different graphical designs and structures. Game 1's cards consisted of mostly emotion cards, some animal cards and "yes" and "no" cards. The image on the cards were only on one side. They were made of thin paper and designed to be held vertically. During the sessions, participants browsed and selected the cards on the table. They held the cards with two fingers or with full palm, from above, from sides. Some accidently held the card upside down. Some

squeezed the cards while holding and dropped them on the floor. During the sessions, participants used the cards to play with Ixi. To get a reaction, they tried holding it towards Ixi's eyes. They tried different angles, distances and heights while holding the cards. Other than this intention, they also used cards to take Ixi's attention, for example, waving the cards, and hitting Ixi with the cards.

The second game cards were thicker and almost twice the size of the first cards. They contained animal figures printed on foam boards. Same as the previous cards, the animal figures were only printed on one side. The animal images on the cards were actually detachable during the pilot test studies. During those sessions, participants tried detaching and reassembling the cards. After those sessions, the detachable parts were fixed to the cards. Since the cards were thick and large, it was not easy to browse through them on the table. Participants preferred to place them on their lap or to their side. They spent time to browse, view, separate and position them towards Ixi.

Other than these physical features, there were some intangible factors that affected interaction. The two games, sound, eye animation and vibration feedback provided by Ixi are the tangible features that can be mentioned. Both games offered interaction through their game cards. During the first game, participants were able to get a reaction from Ixi using cards and also by touching Ixi's head. Second game did not offer a reaction by touching but offered the repetition of the animal sound when Ixi's head is touched by the participants.

During the play sessions, participants touched Ixi to feel the vibration while Ixi is making an emotional expression. This can be considered as an engaging invitation to touch to Ixi. Also, when Ixi had an eye animation and audio feedback, participants came closer to Ixi and stared into its eyes. During the second game, the repetitive movement and sound caused participants to be confused and made them uninterested in playing over time. These can be mentioned as the intangible factors effecting the interaction during the sessions.

The types of interaction occurring during play between a child and a robotic toy

Three different categories of interactions were noted during the sessions. They were categorized as *the physical interaction, facial expressions and looking directions,* and *verbal communication*. While playing, participants physically interacted with Ixi and the cards. They touched Ixi to get a response, to shut its repetitive movement and sound and to feel the movement and vibration together with the response. Other than touching to Ixi, the cards were the only medium to communicate with Ixi.

Participants showed the cards to Ixi to get a reaction. They also used cards to draw Ixi's attention or to shut the repetitive movement and sound. To do so, they hit Ixi with cards or waived them towards Ixi.

Facial expressions and looking directions are the signs of engagement with Ixi. Participants expressed emotions towards Ixi's actions and at some moments mimicked Ixi's expressions. When they were engaged in playing, some of them got closer to Ixi and stared into its eyes. On the other hand, when they did not get any response or when Ixi got stall, participants looked at different things around the room.

Participants tried verbally communicating with Ixi and the researcher. The researcher was asked to help several times when Ixi got stall or became repetitive. They also shared their opinions on Ixi, the games and the cards. Participants also talked towards Ixi to encourage it to respond to them. Some of them tried explaining the card they were holding, some made the animal sound that Ixi is supposed to make and some even tried to threaten Ixi.

6.2 Suggestions for Developing Robotic Toys for Children - Robotic Toys that Motivate for Interaction

The study with the robotic toy Ixi showed some significant successful and problematic features occurring during the interaction. Interaction types occurred during the sessions also is a guidance on improving engaging interactions and

motivating children. The suggestions listed below are made in the light of this information.

6.2.1 Considering the Age Differences

It is suggested to consider differences in ages while designing a robotic toy for children. As mentioned previously, even one year of difference in child development can have a great impact on a child's behavior patterns, skills and social interactions. In the study, there were some differences and similarities of the two age groups in terms of engagement and interaction. Some of these differences are mentioned below.

6.2.1.1 Attention span

It was observed from the overall play durations of each age group that, 4-5 year-olds' attention span is rather shorter compared to 8-9 year-olds. They had less tolerance for waiting for a reaction and lost interest sooner while playing. While designing a robotic toy and games for children the attention span of each age group should be considered.

6.2.1.2 Fine Motor Skills

4-5 year-olds spent a considerable amount of time trying to position, hold and turn the cards while playing. Sometimes, they dropped the cards because they could not adjust how tight they needed to hold. On the other hand, the 8-9 year-olds were more successful in manipulating the cards. This shows a need for considering fine motor skills of different age groups, and the appropriate sizes of items to be held, while designing cards.

6.2.1.3 More physical interaction for 4-5 year-olds

4-5 year-olds tried to touch Ixi in several ways. They wanted to squeeze and play with Ixi's body part even though they were not allowed to. On the other hand, 8-9 year-olds were more restrained when touching Ixi. A robotic toy designed for 4-5 year-olds, should offer more physical interaction with different body parts.

6.2.2 Card Design

The two card sets had some problematic features. The images were only printed on one side and participants did not know if they were holding the cards correctly. On the other hand, Ixi reacted on the cards only if they were held correctly. It is advised to design the cards which can be processed by Ixi in every angle. This is especially important for 4-5 year-olds, since their fine motor skills do not allow them to be precise while positioning the cards. Another suggestion is to print the images on both sides so that participants can see how they are holding the cards.

6.2.3 Guidance

The lack of guidance was a problematic feature for both age groups. There was a necessity for guiding participants in touching Ixi. Furthermore, the games required guidance instead of repetitive sound and movement. It is suggested to have a short game-like tutorial for participants to get warm towards Ixi and its own features. Instead of the researcher telling where to touch or how to interact, Ixi can guide the game by using features such as the eye animation to lead the children for interaction. Instead of asking the researcher, there should be supportive clues to encourage to continue playing. Otherwise the participants are distracted.

6.2.4 Responsive instead of Repetitive

At first, Ixi's autonomous action of movement, sound and animation were considered as welcoming and interesting by the participants. However, while playing with it, the repetition of these became annoying. Most participants wanted to silence Ixi. They placed their hands on Ixi to shut Ixi and to draw its attention to the shown card. Thus, repetitive actions should be avoided while a player is interacting with the robot. During the second game, there was a necessity to repeat the animal sound when the participant wants. For that, instead of repeating the animal sound in periods, it is suggested that, participant asks Ixi, then Ixi gives a response. This asking does not need to be verbal. It can be by touching Ixi, or by showing a certain card.

6.2.5 Multidimensional Feedback

Animal sounds during the second game were observed to be unidentifiable. The reason behind this was that, there was only an audio feedback from Ixi and up & down movement which made it difficult to visualize the animal by the participants. In some situations, it caused confusion because children did not expect to hear another animal sound from Ixi since it looks like an owl and it is expected to act like an owl. These situations happened in both age groups. The physical appearance of a robotic toy should be compatible with what it does. Also, in order to solve the misleading problem, a suggestion is to find ways to improve the quality of the sound. Also, while designing such a game using sound, there should be a multidimensional feedback to support. For example, visual feedback can be added to audio feedback. In this case, Ixi could have supported the audio sound with eye animation.

6.2.6 Sharing and Playing with Peers

While playing, participants wanted the researcher to be involved and they shared their experiences with Ixi. They asked the researcher to watch Ixi's reactions and also made comments on Ixi. Since 4-5 year-olds are starting to adapt cooperative play, it is suggested to design an interaction for more than one child. It could also be an element of their sociodramatic play mentioned Section 2.1.2.

6.2.7 Spontaneity in Games

The first game offered participants the right to chose the card they wanted. However, during the second game Ixi was in charge of the game dynamics. Ixi made the animal sounds in an order and the participant was expected to adjust to this order. When participants did not like the animal sound or wanted to select another one, it was not possible. This situation frustrated and annoyed the participants. For that reason, it is important to design games allowing spontaneity while playing to engage children.

6.2.8 Using Language

It can be particularly recommended for older age groups to use basic language as a motivational factor for interaction. Ixi used basic words during the first game, which were "yes" and "no". However, they were unexpected and rare, so it excited the

participants to hear and see it from the cards. One participant wanted Ixi to say "yes" and "no" together, or to chose one of them. It would be interesting to use language cards for building sentences together with Ixi.

6.2.9 Verbal communication

It was observed during the play sessions that the verbal reactions from Ixi excited the participants significantly. Furthermore, participants tried talking to Ixi several times for communicating directly. They tried describing situations and used encouraging words.

During the second game, Ixi responded to the right and wrong cards by talking in Dutch. However, even though the stress and tone of the responses were meant to give message on negativity or affirmation, participants did not understand what Ixi was saying because they did not know Dutch. Even though they knew Dutch, the first game was in English ("yes" and "no" cards) and this one was in Dutch. This contradiction again confused the participants.

It is suggested to use verbal communication as a medium of interaction besides touching and the cards, since it excites and engages the users in both age groups. More simple vocabulary such as "yes" and "no" which were used during the first game, can be implemented for motivating children to interact with Ixi.

6.3 Discussions

The research was conducted with children of different age groups to understand their motivations for interacting with a robotic toy. The findings of the study were subjected to both quantitative and qualitative analysis. The difference and similarities in their interaction and engagement with a robotic toy were observed. The results in general showed the differences in age and the importance of guidance, being responsive to users' actions, and multidimensional feedback for both age groups. The findings also showed that emotional expression and verbal communication can be a strong motivation for interaction and engagement.

The literature research on child development before the study brought expectation on seeing significant differences in children's engagement and interaction with the robotic toy. However, the results indeed showed differences but not as much as we have foreseen before the analysis. For example, the types of interactions were similar in most cases, however, difference**s** occurred in the details of the interaction. For example both age groups touched Ixi to get a reaction, but the way they preferred to touch, the mode and the intensity of their physical interaction were different. Similarly, the motivations for verbal communication were similar; however, because of differences in their linguistic capabilities, their ways of expressing were different. It was observed that 4-5 year-olds supported their verbal communication with heavy gestures and strong expressions.

Effect of emotional expression animations: Before the study, it was not foreseen that the simple animated facial expressions would bring this much attention and engagement to the play sessions. Even though it is a simple addition, it helped building a simple superficial social bond between the robot and the participants.

Using props as a medium of interaction: The idea of using props to support the interaction between children and a robot could be promising. However, since in this case, it adds another layer of interaction, it hinders the direct interaction between the child and the robot. The aim of the usage of props and the way they support the interaction could be designed differently, so that it can support interaction instead of causing distraction.

Evaluating the effectiveness of the interaction: In Chapter 3, common metrics used for evaluating human robot interaction has been discussed. In this study, both the characteristics of the interaction and the engagement were evaluated because using one of them would not bring a comprehensive analysis in this case. The reason behind this was the limited sample size and limited duration of sessions. Thus, we tried to benefit from the data as much as possible with a broader perspective. The evaluation method used in this study could be beneficial for similar case studies where there are some limitations in terms of time and sample sizes.

Compatibility between physical appearance and behavior & feedback: In general people make certain assumptions about the capabilities of a robot based on its physical appearance. A robotic toy in the appearance of a bird is expected to act as a bird. When it starts to imitate different animals, it starts to cause confusion. Therefore, it is important to keep the compatibility between the physical appearance, behavior and feedback while designing a robotic toy.

6.4 Limitations of the Study

There are some limitations of the study that need to be discussed. Although the aim of the study was not to arrive at generalizable conclusions, the study was conducted with only 14 children, and this may be limited in certain aspects. These 14 children were from two different age groups. Therefore, the size of each group can be considered as a small sample size. Besides, the study was conducted with a multicultural group and the gender distribution was not equal.

Limited Features of the Robot: The robotic toy used for the study was only a prototype with limited features. Its body was fragile and the participants were not allowed to touch it. Also, it frequently got stalled during the sessions**,** which limited the interaction and duration of play.

Limitations Caused by School Regulations: The study was conducted inside the school with certain regulations. The participants were not able spend too much time for the sessions and they had to attend their class activities. Also, some parents did not allow their children to participate in the study.

Linguistic Difficulties: Children in both ages were not good with grammar. Some of them learned English as second language and some had English as their mother tongue. The linguistic difficulties may cause misunderstanding in their verbal communication with both the researcher and Ixi.

Recommendations for further study may include, repeating such a study with a higher number of students, all with same linguistic abilities. Experimental conditions can be provided in order to assess the effects of play sessions with robotic toys. For

example, the duration of play can be kept longer, or the play sessions can be repeated, and control groups can be involved.

REFERENCES

American Academy of Pediatrics (1993). *Caring for your baby and young child: Birth to age five.* S. P. Shelov (Ed.). NY: Bantam.

Andrist, S., Mutlu, B. & Tapus, A. (2015, April). Look Like Me: Matching Robot Personality via Gaze to Increase Motivation. *In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 3603-3612. ACM.

Baek, C., Choi, J. J., & Kwak, S. S. (2014, October). Can you touch me?: The impact of physical contact of emotional engagement with a robot. *In Proceedings of the second international conference on Human-agent interaction*, 149-152. ACM.

Bar-Cohen, Y. & Breazeal, C. (2003, July). Biologically inspired intelligent robots. In Smart Structures and Materials. *International Society for Optics and Photonics*, 14-20.

Bayley, N. (1955). On the growth of intelligence. *American Psychologist*, *10*(12), 805.

Baxter, P., Belpaeme, T., Canamero, L., Cosi, P., Demiris, Y., Enescu, V., ... & Neerincx, M. (2011, March). Long-term human-robot interaction with young users. In *IEEE/ACM Human-Robot Interaction 2011 Conference (Robots with Children Workshop)*.

Belpaeme, T., Baxter, P., De Greeff, J., Kennedy, J., Read, R., Looije, R., ... & Zelati, M. C. (2013, October). Child-robot interaction: Perspectives and challenges. In *International Conference on Social Robotics*, 452-459. Switzerland: Springer International Publishing.

Belpaeme, T., Baxter, P.E., Read, R., Wood, R., Cuayáhuitl, H., Kiefer, B., ... & Looije, R. (2012). Multimodal child-robot interaction: Building social bonds. *Journal of Human-Robot Interaction, 1*(2), 33-53.

Breazeal, C.L. (2004). *Designing Sociable Robots*. Cambridge, MA: MIT Press.

Brown, B. H., Richards, H. C. & Wilson, C. A. (1996). Pet bonding and pet bereavement among adolescents. *Journal of Counseling & Development*, *74*(5), 505–509.

CDC (2016, March 15). *Middle Childhood (6-8 years of age).* Retrieved May 13, 2016, from http://www.cdc.gov/ncbddd/childdevelopment/positiveparenting/middle.html

Charlesworth, R. (2013). *Understanding Child Development*. Belmont, CA: Cengage Learning.

CYWHS (2016, February 4). *Child development: 6-9 years*. Retrieved May 13, 2016, from http://www.cyh.com/HealthTopics/HealthTopicDetails.aspx?p=114 &np=122&id=1867.

Dautenhahn, K. (1998). The art of designing socially intelligent agents: Science, fiction, and the human in the loop. *Applied Artificial Intelligence,12*(7-8), 573-617.

Dautenhahn, K. & Werry, I. (2012) A quantitative technique for analysing robot-human interactions. In *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*.

DeWalt, K.M., DeWalt, B.R., & Wayland, C.B. (1998). Participant observation. In H.R. Bernard (Ed.), *Handbook of Methods in Cultural Anthropology*, 259-299. Walnut Creek, CA: AltaMira Press.

Dirkx, B. & Van de Aalst, R. (2014). Ixi-Play, a robot buddy for young children. In *Creating the Difference: Proceedings of the Chi Sparks 2014 Conference*, 149-151. The Netherlands: The Hague University of Applied Sciences.

DiSalvo, C. F., Gemperle, F., Forlizzi, J., & Kiesler, S. (2002, June). All robots are not created equal: the design and perception of humanoid robot heads. *In Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques*, 321-326. ACM.

Downe-Wamboldt, B. (1992). *Content analysis: method, applications, and issues. Health care for women international, 13*(3), 313-321.

Dönmez, Y. (2016). Befriending with a non-human: A study on Child - Robot Interaction and the effect of Extraversion (Unpublished report). ID5502 Research Project, Supervisor: Asst. Prof. Mathieu Gielen, TU Delft, The Netherlands.

Druin, A. & Hendler, J. A. (2000). *Robots for kids: exploring new technologies for learning*. Massachusetts: Morgan Kaufmann.

Fernaeus, Y., Håkansson, M., Jacobsson, M. & Ljungblad, S. (2010, June). How do you play with a robotic toy animal?: A long-term study of pleo. In *Proceedings of the 9th international Conference on Interaction Design and Children*, 39-48, Spain: ACM.

Fong, T., Nourbakhsh, I. & Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and Autonomous Systems, 42*(3), 143-166.

Fong, T., Thorpe, C. & Baur, C. (2003). Collaboration, dialogue, human-robot interaction. In *Robotics Research*, 255-266. Germany: Springer Berlin Heidelberg.

Frith, U. & Frith, C. (2001). The biological basis of social interaction. *Current Directions in Psychological Science, 10*(5), 151-155.

Frost, J.L., Wortham, S.C. & Reifel, R.S. (2005). *Play and Child Development (2nd ed.).* Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.

Goetz, J. & Kiesler, S. (2002, April). Cooperation with a robotic assistant. *In CHI'02 Extended Abstracts on Human Factors in Computing Systems,* 578-579. ACM.

Goodrich, M. A. & Schultz, A. C. (2007). *Human-robot interaction: a survey. Foundations and trends in human-computer interaction, 1*(3), 203-275.

Guillet, A., Lenain, R., Thuilot, B. & Martinet, P. (2014). Adaptable robot formation control: adaptive and predictive formation control of autonomous vehicles. *Robotics & Automation Magazine, 21*(1), 28-39. IEEE

Hagan, J.F., Shaw, J.S. & Duncan, P.M. (2008). *Bright Futures: Guidelines for Health Supervision of Infants.* Children, and Adolescents (3rd ed.). USA: America Academy of Pediatrics.

Hirschi, Travis. (1969). *Causes of Delinquency*. Berkeley, CA: University of California Press.

HIV/ AIDS: Definition of key terms Retrieved January 18, 2017, from http://www.who.int/hiv/pub/guidelines/arv2013/intro /keyterms/en/

Hughes, F.P. (2009). *Children, Play, and Development.* Thousand Oaks, CF: Sage Publications, Inc.

Indiegogo (2016, June). *TAPIA: AI Robot Companion Learning Your Lifestyle*. Retrieved January 11, 2017, from https://www.indiegogo.com/projects/tapia-ai-robot-companion-learning-your-lifestyle

Janssen, J. B., van der Wal, C. C., Neerincx, M. A., & Looije, R. (2011, November). Motivating children to learn arithmetic with an adaptive robot game. In *International Conference on Social Robotics*, 153-162. Germany: Springer Berlin Heidelberg.

Jibo (2016). *The social robot for your home.* Retrieved January 10, 2017, from https://www.jibo.com/

Lee, K. (2016, November 30). *Your 8-Year-Old Child: Emotional Development.* Retrieved January 18, 2017, from https://www.verywell.com/8-year-old-child-emotional-development-620706

Leite, I., Martinho, C., Pereira, A. & Paiva, A. (2009). As time goes by: Long-term evaluation of social presence in robotic companions. In *RO-MAN 2009-The 18th*

IEEE International Symposium on Robot and Human Interactive Communication, 669-674.Japan: IEEE.

Ltoday (2010). *The Aurora Project – Robots Helping Autistic Children*. Retrieved January 14, 2017, from http://www.mangomon.com/the-aurora-project-robots-helping-autistic-children/

LuxRobo (2016). *Modi - How It Works*. Retrieved January 14, 2017, from http://www.luxrobo.com/how-it-works/

MJI Robotics (n.d.). *Tapia ／MJI／communication robot*. Retrieved January 11, 2017, from http://mjirobotics.co.jp/en

Musante, K. & DeWalt, B.R. (2010). *Participant Observation: A Guide for Fieldworkers*. Lanhman, MD: Rowman & Littlefield.

UNC Lineberger (2016, March 22). *Social networks as important as exercise and diet across the span of our lives — UNC Lineberger comprehensive cancer center.* Retrieved January 21, 2017, from https://unclineberger.org/news/social-networks

Paro Robots US Inc. (2014). *PARO Therapeutic Robot*. Retrieved December 11, 2016, from http://www.parorobots.com/

Raising Children Network (2016, February 05). *4-5 years: Preschooler development.* Retrieved May 11, 2016, from http://raisingchildren.net.au/articles/child_development_four_to_five_years.html/context/567

Raising Children Network (2016, February 05). *6-8 years: Child development.* Retrieved May 11, 2016, from http://raisingchildren.net.au/articles/child_development_6-8_years.html/context/511

Robins, B., Dautenhahn, K. & Dubowski, J. (2005). Robots as isolators or mediators for children with autism a cautionary tale. In *Proceedings of the AISB 05 Symposium on Robot Companions*, 3-5. UK: AISB.

RobotLAB Inc. (2016) *RobotLAB Store.* Retrieved January 12, 2017, from http://shop.robotslab.com/collections/all

Rokid (n.d.) *Rokid - The Future is Here.* Retrieved January 12, 2017, from https://www.rokid.com/

Ros, R., Nalin, M., Wood, R., Baxter, P., Looije, R. and Demiris, Y. (2011). Child-robot interaction in the wild: advice to the aspiring experimenter. In *Proceedings of the 13th international conference on multimodal interfaces*, 335-342. New York: ACM.

Sabanovic, S., Bennett, C. C., Chang, W. L. & Huber, L. (2013). PARO robot affects diverse interaction modalities in group sensory therapy for older adults with dementia. In *Rehabilitation Robotics (ICORR), IEEE International Conference*, 1-6. United Kingdom: IEEE.

Scholtz, J. (2003, January). Theory and evaluation of human robot interactions. In *System Science. Proceedings of the 36th Annual Hawaii International Conference*, 10. IEEE.

Schwartz, M.S. & Schwartz, C.G. (1955). Problems in participant observation. *American Journal of Sociology, 60*(4), 343-353

Sharman, C., Cross, W. & Vennis, D. (2004). *Observing Children: A Practical Guide.* New York, NY: Bloomsbury Publishing.

Softbank Robotics (2016a). *Who is NAO?* Retrieved January 11, 2017, from https://www.ald.softbankrobotics.com/en/cool-robots/nao

Softbank Robotics (2016b). *Find out more about NAO*. Retrieved January 12, 2017, from https://www.ald.softbankrobotics.com/en/cool-robots/nao/find-out-more-about-nao

Softbank Robotics (n.d.a) *Who is Pepper?* Retrieved January 12, 2017, from https://www.ald.softbankrobotics.com/en/cool-robots/pepper

Softbank Robotics (n.d.b) *Find More About Pepper.* Retrieved January 12, 2017, from https://www.ald.softbankrobotics.com/en/find-out-more-about-pepper

Steinfeld, A., Fong, T., Kaber, D., Lewis, M., Scholtz, J., Schultz, A. & Goodrich, M. (2006, March). Common metrics for human-robot interaction. In *Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-robot interaction*, 33-40. ACM

STEMI (2017). *Meet STEMI Hexapod - Learning by creating.* Retrieved January 15, 2017, from http://www.stemi.education/hexapod/

Syrdal, D. S., Dautenhahn, K., Woods, S. N., Walters, M. L. & Koay, K. L. (2007). Looking Good? Appearance Preferences and Robot Personality Inferences at Zero Acquaintance. *In AAAI Spring Symposium Multidisciplinary Collaboration for Socially Assistive Robotics*, 86-92.

Tanaka, F., Cicourel, A., & Movellan, J. R. (2007). Socialization between toddlers and robots at an early childhood education center. In *Proceedings of the Na tional Academy of Sciences, 104*(46), 17954-17958.

Tanaka, F. & Matsuzoe, S. (2012). Children teach a care-receiving robot to promote their learning: Field experiments in a classroom for vocabulary learning. *Journal of Human-Robot Interaction, 1*(1), 78-95.

The James Dyson Foundation (2016). *Tio – Robotic Building Blocks.* Retrieved January 14, 2017, from http://www.jamesdysonaward.org/projects/tio-robotic-building-blocks/

Thrun, S., Schulte, J. & Rosenberg, C. (2000). Interaction with mobile robots in public places. *IEEE Intelligent Systems*, 7-11.

Toegel, G., & Barsoux, J. L. (2012). How to become a better leader. *MIT Sloan Management Review, 53*(3), 51-60.

Tovrov, D. (2012, November 07). *Robot Seals Help Elderly After Fukushima*. Retrieved January 14, 2017, from http://www.ibtimes.com/robot-seals-help-elderly-after-fukushima-839955.

Toy Association (2016). *Annual U.S. Sales Data.* Retrieved January 12, 2017, from http://www.toyassociation.org/TIA/Industry_Facts/salesdata/IndustryFacts/Sales_Data/Sales_Data.aspx?hkey=6381a73a-ce46-4caf-8bc1-72b99567df1e#.V4f__rh96Uk

Wada, K., Shibata, T., Saito, T., Sakamoto, K. & Tanie, K. (2005). Psychological and social effects of one year robot assisted activity on elderly people at a health service facility for the aged. In *Proceedings of the 2005 IEEE international conference on robotics and automation*, 2785-2790. Japan: IEEE.

Waytz, A., Epley, N. & Cacioppo, J. T. (2010). Social cognition unbound: Insights into anthropomorphism and dehumanization. *Current Directions in Psychological Science, 19*(1), 58-62.

WowWee (n.d.a). *WowWee® - MiP*. Retrieved January 11, 2017, from http://wowwee.com/about

WowWee (n.d.b). *WowWee CHiP: The smart and lovable robot dog.* Retrieved January 12, 2017, from http://wowwee.com/chip

You, Z. J., Shen, C. Y., Chang, C. W., Liu, B. J. & Chen, G. D. (2006, July). A robot as a teaching assistant in an English class. In *Advanced Learning Technologies, 2006. Sixth International Conference on*, 87-91. IEEE.

APPENDIX A

CONSENT FORM & LETTER FOR PARENTS

Delft, 10-09-2015

Dear parents and caretakers,
I would like to inform you about our research project which is in collaboration with International School of Delft and TU Delft Faculty of Industrial Design Engineering.
In this research project, we want to test a robotic toy with children. The aim is to understand their perspective on an interactive robot and investigate how they react on to it. It will be also interesting to see if children see the robotic toy as a living animal or just as a toy. Also, with this collaboration, children will have a chance to play a new type of toy which is not on the market yet.
The study will be conducted inside the international school of Delft. Every child will have some time to play with the robotic toy and I will be present to assist if necessary. There will be also video, audio recording and maybe photo taking during and after the sessions. The reason for that is to collect data about children's opinion and reactions on a robotic toy. These recordings will only be used for analysis and documentation of the research report. In case of publication, the data and outcomes will be anonymous.
Please fill in the consent form to inform us about your approval and return it to the teacher.
If you have any more questions please feel free to contact me or my supervisor Mathieu Gielen (m.a.gielen@tudelft.nl).
Kind Regards,

Yasemin Dönmez
Master's-Degree Student
Industrial Design Engineering, TU DELFT
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Informed consent form, 10-09-2015

Dear parent/caretaker,
After reading the information letter about the research project in collaboration with TU Delft, do you agree to allow your child participating in this project? Please tick the appropriate box, sign the form and return it to your school before end of September.

☐ Yes, I allow my child to participate.
☐ No, I do not allow my child to participate.

Name of parent / caretaker: .....
First name of the child: .....
Signature of parent / caretaker: .....

APPENDIX B

CLUSTERING THE FINDINGS

Participants between the ages 4 and 5 years.

Game 1

SUCCESSFUL FEATURES
Ixi
Physical Interaction
Participant 12 physically interacted with Ixi several times during this game.
It's big head is suitable for touching and petting.
Welcoming- exciting
Ixi's movement evoked excitement.
The participant was excited to watch Ixi and touch its head.
Ixi excites the participant and she was welcomed to pet Ixi's head.
Facial expression movement and talking sound made the participant excited during the game.
Ixi's facial expression, movement, and animal sound (he only tried the dog card) excited him.
Movement excited the participant.
He stared at the animation on Ixi's eyes.
No need for guidance
She showed the card to Ixi's eyes without the need of any explanation.
Communication
The participant tried directly to communicate with Ixi in order to get a reaction.
He tried to communicate verbally.
Imitating
He imitated one of Ixi's reactions.
Quick
The participant got reactions to card he showed without much delay.
Sound
Exciting
Sound evoked interest and excitement.
Animal sound (he only tried the dog card) excited the participant.
The starting sound excited the participant.

Talking
Talking sound made the participant excited during the game.
He liked and made comments on the "no" card.
He liked the "yes", "no" cards and showed them more than once and tried to show them at the same time to see what Ixi would do.
Cards

One Hand
Enables holding with one hand.
Easy to hold with one hand.
Separating
She placed the used cards to another place.
Enabling manipulation
During her second play session, the participant mixed the cards and showed them without viewing them beforehand to evoke excitement and curiosity for herself.
Interesting
He tried to show only one card but enjoyed the reaction by Ixi. He showed the same card three times and received reaction.
He wanted to play another game using the same cards.

Game 1
Easy to Understand
The game is easy to understand.
The game is simple and easy to understand without any need of detailed explanation.

Engaging
It evokes curiosity and excitement.
The participant makes eye contact with Ixi several times.
She got involved by imitating Ixi's facial expression and movement.
Getting a reaction was very exciting for Participant 11.
He liked Ixi's reactions.

Easy to Play
The session progressed smoothly, the participant was able to get response from almost every card she showed.
The game is simple and easy to understand, little or no explanation was sufficient.

PROBLEMATIC FEATURES
Ixi
Fragile Prototype
Since the prototype was fragile, the participant was warned not to touch the body part.
No guidance or communication
The participant expected a direct (not involving any cards) communication or guidance from Ixi several times.
When this did not happen, the participant directed his attention towards the researcher.
When she did not get a reaction from Ixi, the participant directly wanted to communicate with the researcher and got confused.
She was unsure about the distance and angle for holding the card.
Waiting
It takes a long time for Ixi to recognize the shown card.
She had to wait around 2-3 seconds to get a response from Ixi.

No curiosity - welcoming element
The game did not evoke enough curiosity from the participant.
The participant was shy and unwilling to touch Ixi at the beginning of the game.

Sound

Misdirecting
Participant 11 assumed the starting sound and movement to be a reaction.

Cards

No relation or guidance between the cards-Ixi
Participant 12 did not associate the cards and Ixi (no connection).
There was no guidance for the participant to know that the cards are for showing to Ixi.
The participant did not understand the relationship between the cards and Ixi.
No positioning guidance
The participant had difficulty with positioning the cards.
He had difficulty in finding the right distance and angle to hold the card.
When the card was positioned upside down Ixi did not respond it.
The participant held the cards upside down.

Cards being Thin

He accidentally took too many cards at a time (since they are so thin), he dropped the card.
Once she squeezed the card and dropped it to the floor.

Time - effort

He got physically tired sometimes and placed his elbows on the table.
Participant got tired from time to time while holding the card so she leaned her elbow to the table.

Uninteresting - not encouraging

He did not want to explore other cards, and was only stuck with one card.

Game

Not interesting

The game did not evoke any interest in the participant.
Participant got bored and lost interest in a short time.
The game got monotonous and boring (she can guess what will happen next).
He liked the reaction but again it was not enough to evoke more curiosity.

No variety

The participant was disappointed to see only animal and emotion cards and he expected more variety and diversity.

Monotonous

The participant finished the game in a very short time.
The game got monotonous.

Game 2

SUCCESSFUL FEATURES

Ixi

Easy to Understand

He guessed the animal correctly when Ixi made the animal sound for the first time and directly showed the right card without any explanation.

Being Responsive

Ixi gave negative and affirmative responses to the cards.

Cards

Positioning

The participant was able to take and position the card better since they are thicker and bigger in size.

Participant 4 was able to hold the cards with one hand easily.

Cards were easy to hold and show with one hand.

Game

Engaging

Game was easy to understand for the participant, he enjoyed this game more than the other.

PROBLEMATIC FEATURES

Ixi

No response - Got Stuck

Ixi did not respond to the participant's physical or verbal interaction that caused loss of interest.

At some point, Ixi got stuck, repetitively made the same animal sound without giving a negative or an affirmative response to the cards.

At the second animal sound, Ixi got stuck and repeated the same sound even when the correct card was shown.

Ixi got stuck and was restarted once during the game.

After the explanation, she showed the right card and tried to get a reaction from Ixi for around 3 minutes, but Ixi was stuck and continued to make the same animal sound. After that she lost her interest and ended the game.

No guidance

Ixi did not give any guidance about the game, participant got confused and did not get any reaction from Ixi.

Sound

Unclear Audio Responses

When Ixi gave a negative response, the participant thought it was affirmative and got confused.

Animal sound

It was not possible to identify the animal sound.

Participant did not understand the animal so he wanted to interact with the researcher and the cards rather than Ixi.

Responses being Dutch

The participant did not understand whether the sound responses were negative or positive.

She did not understand Ixi was making an animal sound.

Delay in responses

Ixi's delayed responses when a right card was shown, was late to make a new animal sound, and this made participant annoyed.

Cards

Time - Effort

While holding a card, she got tired, switched hands, leaned her elbow to the table.

Size and Thickness

It was hard for the participant to hold the cards with one hand, he usually preferred to hold them with two hands.
While holding it, it covered the face of Ixi entirely, and the participant was not able to see Ixi's face.
Participant 4 placed all the cards on her lap instead of the table because they were too thick and big.

Not interesting

She only looked at 3-4 cards, she was not interested in them.

Time - Distracting

He placed all the cards on his lap and spend most of his time looking at them.
The participant placed the cards on his right and positioned himself towards them, then looked at them all on his lap but they were too thick and many.
The participant spent time and effort to browse through the cards.
Participant spent time browsing through the cards.

Game

Hard to Understand

Difficult to understand, explanation + hints are required to understand the game.
Participant 4 thought the game was the same with the previous one and started showing the cards in a row.
The game seems to be not attractive to the participant.
He got bored and confused fast.

Difficult to Play

The participant found the game "difficult".
He was not able to make any successful trial during this game.

4-5 Age Types of Interaction

Physical interaction with IXI and cards

Watching & engaged
Staring into Ixi's eyes.
Stares into Ixi's eyes,
Stares into Ixi's eyes.
Moving closer to Ixi and staring into its eyes.

To feel

Touching Ixi's head.
Contact in order to feel
To get a reaction
Hits Ixi's head.
Hits the body parts with a card.
Contacts Ixi's head with one finger to get a reaction.
Touches its head to start the game,
Touching Ixi's head with two fingers.
Touches with one finger to head, body, eyes, antenna, wings to hear a sound.
Hitting Ixi's head.
Rubbing the head to hear the animal sound.
Petting head to reduce for waiting to get a response.

Pushing and squeezing the body, arms, head.
touches eyes and arms.
To take attention
Shaking card to take Ixi's attention.
Shaking the card to take Ixi's attention.
Waves hands, claps to take Ixi's attention.
Cover its eyes.
Manipulative
Assembling the second game card.
He splits cards into two groups and places one group in front of Ixi for playing.
Researcher
Showing the card to the researcher.
Imitation
Imitating Ixi's facial expression and bodily movement.
Holding cards
Shows the card from side, upside down, rotates it, holds from above, with one hand and two hands.
Moving the card back and forth while holding and waiting.
Moving the card up and down, right and left.
Bending the card while holding.
Holds the card with one and two hands .
Table
Leans his hand to the table.
Browsing
Puts all the cards on his lap and browse.
Facial expressions
Looks excited, laughing, surprised at the beginning.
Excited happy smiling.
Excited, happy, curious expressed by smiling, laughing,
Surprised.
Curious, interested excited at the beginning.
Looks excited, laughs, is surprised at the beginning.
During the first game, smiling, laughing, excited,
Surprised.
Smiling, happy, laughing.
Surprised, excited.
Curious.
Loss of Interest
Gets bored, is impatient.
Not interested.
Uninterested.
Gets bored, is impatient.
Not interested.
Bored.
Negative
Shy, confused.
Confused,

Confused, sad, annoyed.
Annoyed.
Disappointed, sad.
Confused, annoyed.
confused, not interested
annoyed, angry, disappointed, bored
he looks at the researcher for sharing
Looking at the researcher when given explanation
he looks at the researcher for her directions
Looking at the cards
Mimicking Ixi
When shows the sad card
he looks at the card he is holding before showing to ixi
looking at the researcher for sharing
looking at ixi's eyes
looks at the researcher for calling
Looking away
While complaining, holding a card and not getting a response
Looking at the held card
he looks at the researcher for approval and sharing
Looking outside
looks away hears some noises
he holds all the cards in his lap and looks at them
looks away and starts to chat with the researcher
looks at the researcher to complain
looks outside and starts to chat with the researcher
looks at the researcher when confused
looks at the researcher for sharing
looking down while holding the card for awhile
Looking at people outside
Looking at the pile of cards
Looking at the researcher for sharing
Looks away while showing a card
Imitating Ixi's facial expression and bodily movement.
Looking away.
Neutral facial expression.

Communication
End the game
To ask for another game.
To end the game.
To finish the game
To end the game.
For ending the game
To end the game.
To replay the first game
To ask for another game.

Confirmation
To ask for confirmation.
To ask for confirmation.
With Ixi
To encourage Ixi to play
To encourage Ixi to play.
chat
To chat
To chat
To chat
For chatting.
To chat.
To talk about the cards.
Question
To inquire
To inquire
To ask how to get a response
She asks about the sound (she does not understand that it's an animal sound)
For inquiring how to get response
To ask a question
To get an explanation.
To inquire about what to do.
Share feelings
To complain
To complain
For complaining about Ixi
To complain and share disappointment
To express that the experience was "okay".
To express confusion
For sharing excitement with the researcher
For sharing.
To express that the game is difficult / to complain.
To play with the researcher
To show the card to the researcher

Participants between the ages 8 and 9 years

Game 1

SUCCESSFUL FEATURES
Ixi
Evoking interest
Ixi evoked curiosity when first encountered with.
Ixi surprised the participant and made her laugh when it gave a reaction.

Ixi's facial expression, movement, and various sounds impressed the participant during this game.
Ixi evoked curiosity and welcomes the participant to play.
Ixi's sound and movement take attention.
Ixi's sound and movement raises excitement and interest.
Ixi's movement and sound evoked curiosity.
The participant was curious and excited by the cards and the reactions.
He defined Ixi as "It's pretty cool".
Unexpected Reaction
Repeating the same sound and then suddenly getting reaction excited and made the participant laugh.

Responsive

Ixi was quick to give response to the shown cards.
Emotional Expressions
Especially, the happy and sad faces draw the participant's attention. She showed the sad card twice.

Physical Interaction

Especially during the game, Ixi's head movement excited the participant, he liked to touch Ixi's head.
Communicating Directly with Ixi
She commanded Ixi "to be" instead of "make ... sound".
She preferred to verbally communicate with Ixi.

Sound

Engaging

Ixi's sound raised excitement and interest.
Ixi's animal sounds made the participant laugh.

Talking

He got very excited when Ixi was talking when "yes" or "no" cards are shown.

Cards

Enriching the game
The participant did not look at the card before showing to Ixi in this phase, participant got more excited and surprised by Ixi's expressions.
At the beginning of the game, the cards were placed closed, participant drew cards in a row and viewed them then showed them.

Easy to Manipulate

Cards were easy to hold with one hand.
They are easy to look and hold with one hand.
Easy to hold with one hand, the participant could take two cards at a time.
Cards are easy to hold,
They are easy to look and hold with one hand.
Cards were easy to hold from sides and above.
Cards were easy to manipulate, the participant tried every angle and direction to show the cards.

Categorizing

She separates the used cards and not used ones during the game.
Emotion Cards
Emotion cards drew participant's attention.

Understandable expressions.
Empathy
While showing a card to Ixi, she described the emotions to Ixi.

Game

Easy to Understand

The game is simple and easy to understand, a short explanation was sufficient.
The game is simple and easy to understand.
Game was easy to understand and follow for the participant.

Easy to Play

After an explanation, the game went smoothly.
The session went smoothly, the participant was able to get response from almost every card that she showed.
The game is easy to play.
The most interesting feature of the game was Ixi's emotional expression.
Preferences
When participant liked one card, he preferred to show it several times and got the reaction several times.

Engaging

Game was fun, exciting. She looked interested in the game.

PROBLEMATIC FEATURES

Ixi

No Guidance

Ixi did not give guidance to the participant about the game and how to interact.
Ixi does not give a clue about where to touch from to the children. It's touch sensory response was not discovered by the participant.
It does not provide a clue on how far or close the cards should be held.
Participant 2 did not know how to hold the card (distance, angle etc.) and asks for guidance.
The participant did not know how to hold the card. The participant inquired several times and shared his thoughts with the researcher.
The participant could not figure out how to hold, at what distance, for how long and where from exactly.
Ixi got stuck several times, the participant got bored at those times and switched to another card.
At the beginning, Ixi usually makes a movement and sound but did not do it this time. Participant expected to see a "start" expression from Ixi. She tried pushing and touching Ixi several times.

Got Stuck

Ixi was not giving reactions for a while.

Process time

It takes a long time for Ixi to recognize the shown card.
It took a long time for Ixi to process, also Ixi was not able to see the cards at some points.
While waiting for Ixi's response, participant's hand got tired and she needed to lean her elbow to the table box.

Not engaging enough

Participant 2 wanted to share her excitement and she communicated with the researcher.

Positioning

Ixi did not recognize the card when it was held horizontal, or upside down.

Sound

Ixi repeated the starting sound caused mixed feelings (smiling & confused).

Ixi's sound started to annoy the participant and he thought that is the reaction from Ixi to the card.

Cards

Participant held the card low because she wanted to lean her elbow to the table.

It was difficult to hold in the same position for a long while.

Participant 2 got tired while holding the card so she leaned her elbow to the table.

Bending

They bend when held tight.

He squeezed the card too much and bent it.

He bent a card while showing it to Ixi.

Upside down

He held the "no" card upside down as "on" card thinking that was the correct way.

Participant held the card upside down several times without noticing. It was problematic in both games.

Participant 13 tried showing the cards before viewing them however, when he did that he realized that he showed some cards upside down and after that checked the cards before showing to Ixi.

Animal Cards

Animal cards were not as interesting as emotion cards to the participant.

Design

Participant cannot see the card from behind.

No Guidance

She did not know how to hold the card, researcher explained how to hold the cards and she needed to wait.

Game

Not Engaging

Participant 10 did not get involved in the game.

Monotonous

Characters on the cards are limited and after showing a few, participant masters the game. At some point, curiosity drops and the gameplay gets quick and monotonous.

The game got monotonous and boring. The participant finished the game in a very short time.

Overall the game did not excite the participant so much, only some certain cards and its reactions did.

The game was monotonous once the participant understood what to do.

Waiting for a reaction

Waiting and trying to get response was frustrating and boring. At the end the participant was a bit disappointed.

Game 2

SUCCESSFUL FEATURES

Ixi

Engaging

Hearing a new animal sound after getting a response actually was more exciting and fun than hearing Ixi's affirmative sound.

Participant got surprised and excited when he got a reaction.

Being Responsive

The participant was able to gain response (both negative and affirmative) from Ixi several times .

Ixi was responsive at this game. It gave negative and affirmative responses to guide the participant.

Ixi gave negative or positive responses and they were fast.

Ixi did not get stuck and gave both negative and positive responses during the playtime.

Sound

Understandable

She directly understood the sound was a monkey sound.

Cards

Easy to Hold

During the game the participant looked comfortable holding all the cards on his lap.

Easy to hold.

Game

Engaging

The game was challenging.

The game was challenging.

Participant 13 was interested in playing the game for a long time, it evoked curiosity and interest.

After understanding the game, it became interesting for the participant.

PROBLEMATIC FEATURES

Ixi

Being Stuck - Repetition

Ixi did not give confirming reaction even though the right card was shown.

Ixi did not give an affirmative or negative response in many situations, which was confusing and frustrating for the participant.

Ixi did not give any reaction to the right card during the second animal sound which made participant annoyed and caused him to end the game.

Ixi's repetitive animal sound, to get a response from Ixi takes too much time, finally the participant got bored and ended the game.

Ixi does not give any response to the cards.

Ixi did not respond to the participant's physical or verbal interaction, which caused loss of interest.

Movement annoyed the participant.

Repetitive sound and movement annoyed the participant.

Ixi's repetitive sound confused the participant as if it was a reaction to the shown card.

At some point, Ixi got stuck, repetitively made the same animal sound without giving a negative or an affirmative response to the cards.

Not Spontaneous

The game does not allow the participant to be spontaneous and make choices.

No guidance for touching

The participant did not know where to touch, he thought he needed to touch the eyes since they looked like screen.

Sound

Animal Sound

Only sound feedback was weak and hard to understand.

She did not understand the animal from the sound.

Only sound feedback was not enough for the participant to understand the animal.

Animal sound was not easy to understand for the participant.

It is difficult to understand which sound belongs to which animal, there is only an audio information.

When Ixi gave a negative response, the participant thought it to be affirmative and got confused.

At the second animal sound, Ixi got stuck and repeated the same sound even thought the correct card was shown.

Repetition

Participant took the repetitive animal sound as a reaction to her showing a card.

Repetitive sound annoyed the participant.

Ixi repeated the monkey animal sound which annoyed, confused the participant

Feedback

Participant 6 did not understand the negative response probably because it was in Dutch.

The "no" reaction was in Dutch, so the participant did not understand it.

Participant 13 did not understand the negative response from Ixi.

Cards

Size and thickness

Cards are too big and thick.

It was physically hard to hold all of them at the same time.

They were too thick and big to put on the table, so the child preferred to lay them all on the floor.

Since the cards are bigger compared to the previous game's cards, it is easier to position them towards Ixi's eyes.

Hard to hold them with one hand and tiring, participant leaned her elbow to the table.

Cards were large to fit on the table.

It was hard for the participant to hold the cards with one hand, he usually preferred to hold them with two hands.

While holding it, it covered the face of Ixi entirely, and the participant was not able to see Ixi's face.

Difficult to Browse

During the game the participant wanted to categorize the cards into two groups however, since the cards occupied too much space and were hard to hold (too thick) the participant spent too much time to put them in different places and organize them.

It was difficult for her to find the right card.
Browsing through cards took too much time because of the size of the cards.
Cards are too big to put all of them on the table and browse.
It was hard to browse through all of them, it took so much attention and time.
She spent too much time browsing, the interaction with Ixi was interrupted for several minutes.

Structure

The cards were disassembling which distracted the participant several times.
Design
While holding the card, the participant sometimes covered the barcode area that is designed for the sole purpose of being recognized by Ixi.

Distracting

Cards distracted the participant's attention.
She positioned herself towards the cards and spent a lot of time interacting with them.
She spends more time looking at the researcher and the cards than Ixi.
The participant took a lot of time searching for the card and the main interest were the cards.
Upside down
Participant 9 held the cards upside down several times.

Game

Hard to Understand - No guidance

The game was confusing.
Hard to understand, explanation + hints are required to understand the game.
The participant thought the game was the same as the previous one.
Took so much time to explain the game. Participant 6 did not undersrtand the animal sound and the negative response.
It took several explanations for the participant to understand the game.
It needed explanation, it misguided and confused the participant.
The participant understood the monkey sound however, she did not know what to do.
Game needed guidance.

Repetetive Sound

Directly starts making an animal sound repetitively, which caused confusion and annoyance.
It was difficult to understand the animal sound.

Delay

Game responses and the delay in hearing the next animal sound confused the participant.

Not engaging

Participant got bored and frustrated, the game was not interesting for him.

Sound

Responses being not exciting
Neither the positive nor negative response excited the participant.

Animal Sound

She could not guess the animal for a long time.

Physical interaction with IXI and cards

For a reaction
Touching Ixi with one hand while holding a card towards Ixi with the other hand to make it react on the card.
Squeezing Ixi's body, arms, eyes, head to take its attention.
Holds a card with two hands, one hand.
Squeezing and pressing head, arm, antenna, eyes.
Petting head and arm for starting
Touching head to hear the sound
Touching Ixi in order to re hear the sound .
Touching the head, eyes, body, antenna.
Petting the head.
Touching Ixi's head with two fingers.
Rubbing the head to hear the animal sound.
Touching with one finger to head, eyes, body. Pulling the wings, rubbing the head.
touches ixi's head with one finger
Pets Ixi's head
Tapping Ixi with one finger several times to start the game

To feel
Touches the body part after a reaction
Placing his palm on Ixi's head while holding a card.
Touches Ixi's head to feel the vibration.
Contact, in order to initiate interaction, to feel the vibration and movement.

To take attention without Touching
Shaking the card to take Ixi's attention.
Shakes the card while holding for drawing attention of Ixi.
Hits ixi's eyes with a card
Shaking the card to take Ixi's attention.
Tapping Ixi with one finger several times to take attention.

Cards
Rotates the card, puts it on the floor and table.
Throws the card to the floor.
Holds the card from above, below and from side.
Shows the card upside down, rotates it, holds from above, with one hand from far distance
Holds the card from side.
Browses the cards on the table.
Holding the cards upside down, sideways, rotating, holding behind Ixi's head.
Turning cards towards himself several times to check if it is upside down.
Holds all the cards and browses.
Moving the card back and forth while holding and waiting.
Moving the card up and down, right and left.
Bending the card while holding.

Table

Leans his hand to the table.
Leans her hand to the table while showing a card.
Holds the card too low, leaning her elbow to the table.

Manipulate
Disassembling and assembling the second game cards.
Eyes
Staring eyes for a response
Moving closer to Ixi and staring into its eyes.
Gets her body closer to Ixi and stares into Ixi's eyes
Positioning self closer to hear and see the response.
Facial expressions and Looking Directions
Positive
Interested, smiling, excited at the beginning.
Smiling, interested, laughing, excited, shocked, surprised when got a reaction.
Surprised, excited.
Surprised, excited,
happy, smiling, laughing
Laughing and smiling at the beginning.
Smiling after each reaction from Ixi.
Surprised, excited at the beginning.
Excited, happy, smiling or shocked when he gets a reaction.
Smiling and laughing at the happy card.
Happy, laughing, Excited, interested.
Smiling, opening eyes raising eyebrows.
Surprised

Confused
bored when she does not know what to do and does not get any reaction.
Bored, confused.
Confused, not confident.
Confused, clueless, reluctant
Not interested.
Confused.
Confused, shy at the beginning.
Confused.
Negative
Annoyed when she does not get a response.
Starts to get bored, frustrated, confused and angry.
Annoyed, angry, frustrated, bored
Annoyed.
Bored.
Frustrated, annoyed at the end of the second game.
Annoyed by the repetitive animal sound.
Annoyed, distracted

Mimicking
Ixi's expression.
Mimicking the card.

Neutral.
During the session mostly neutral.
looks at the researcher for inquiry
looks at the card he is holding
looks away while waiting
Looking away
looks at the card after showing
looks at the researcher for sharing
Looking at the cards
Looking outside when people are passing by
Looking away
looking away
looking at the cards
looking away
Looking at the researcher while asking
Looking at the researcher
Looking outside, to walls
Looking at the held card
Staring absently
Looking at the wall
Looks at the researcher for help
Looks at the researcher for sharing excitement
Looks at the cards while browsing
Looks at the researcher when she gives an explanation
Looking away while touching to Ixi
Looking at the cards
Looking at the researcher
Looking at the camera
Look around the room
Communication
Inquiry
To inquire.
To asks questions about Ixi and the cards.
For inquiring how to get response
To inquire about how to hold the cards
For asking help
To inquire.
To get hint or direction
To ask what to do.
Asks about how to play the game
Asks for a hint from the researcher on the game
To ask for help.
To ask about the response.

To get a hint or directive.

Asking for confirmation from The Researcher
To get approval from the researcher about the card
Asks for confirmation from the researcher
Asks confirmation from Ixi
Asks for confirmation
For confirmation.
For confirmation.

Sharing with The Researcher
To share excitement.
To express confusion.
For sharing excitement with the researcher
For sharing excitement
Expressing excitement (wow!)
Expresses her confusion
To share frustration
For complaining about Ixi's sound and movement
To express confusion.
To complain.
To express that he likes it.
To share excitement.
To comment on cards and sounds
To complain
"It's not doing anything."

Chatting
To chat.
To chat.
To chat
To chat about the robot.
To chat.

Ending
To inform the researcher that she is done
To end the game.
To tell he is done playing.
To inform the researcher that she is done.

Talking directly towards Ixi
"It's a monkey!" "ok so you're a happy person." (when Ixi does not react on the "angry" card.)
To encourage Ixi to react
"what is this?"
"be a dog woof, woof!" "come on, bark!"