Connecting through interacting:
Toys that help designers learn from children with autism by playing with them.

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Abstract: Designers need insight into the people they are designing for. When these people are very different from the designer, it can be difficult for him or her to get an understanding of them. Our aim is to develop methods and tools that help designers bridge this gap. In this paper, designers gained understanding for children with autism for their design project by means of direct contact. They used a set of toys we especially developed to support and stimulate designers in interacting with these children. These interactions should result in empathy for children with autism, and thereby products that better fit these children's needs. This paper discusses the role of these toys in structuring the interactions and bringing out learning points.

Key words: empathic design, experiential learning, designs tools, autism

1. Introduction

In the field of empathic design, many researchers have emphasized the need for designers to meet prospective users to obtain empathy for them [3, 5, 7, 8, 13]. Getting closer to the lives and experiences of users increases the likelihood that products and services meet the user's needs [5]. Examples of existing techniques for learning about users through direct contact are observation studies, interviewing, and generative sessions with users [13].

In practise, designers often do not have direct contact with users, because other specialists mediate the contact (e.g., in market studies or usability tests) [14]. Moreover, it might be difficult to interact with some user groups, such as people with mental disorders or cognitive disabilities. For example, many young children with autism cannot talk and are difficult to engage in social interactions, and can react strongly to new events or situations. A designer can feel uncomfortable in this situation, especially when he or she does not have prior experience with these users. Our aim is to develop tools and techniques to bridge this gap.

In this paper, we describe an explorative study, in which designers broadened their empathic horizon for children with autism through direct contact. We arranged encounters between designers and children with autism at schools and homes. Moreover, we designed a set of toys to support designers in interacting with autistic children to gain understanding (see figure 1).

Figure 1. The seven toys (left) and impressions of how the designers used these toys in interacting with children with autism.

2. Empathic design for difficult-to-reach users

With empathy in design it is not the aim of the designer to fully understand the user, but it is an *attempt 'to achieve a greater awareness, an extended imagination and sensitivity to another person's world in a powerful and memorable way'* [3]. Designers need to put more time and effort in this attempt, when users are very different from themselves, such as users with cognitive disabilities.

Designers can get insight into the lives and experiences of these difficult-to-reach user groups in different ways. They can read literature, books, and blogs, watch documentaries and movies, and physically meet the people and their caregivers, or even become a caregiver him or herself [4]. Caregivers, such as relatives, pedagogues, and therapists, deal with these people on a daily basis and can serve as information source for design [e.g., 1, 12]. Along with several other authors [3, 6, 8, 9], we believe direct contact is a valuable source when designing for these user groups, because seeing their situation, condition, and behaviour with your own eyes provides an understanding you cannot retrieve from other information sources. Experiencing their mental disorder or disability is almost impossible, but a glimpse into their context and behaviour might support designers to get a feel for them. The degree of possible understanding is influenced by the individual empathic ability and willingness of the designers [6].

In this paper, the user group was children with a disorder in the spectrum of autism. Most of these children were not able to communicate or speak in language. Autism is an inborn developmental disorder that affects around 91 people in every 10 000. Much variation exists between autistic children, and even with one child the diagnosis can change over time. Affected children may display a range of disabilities at many levels, such as impairment in social relationships, communication, and imagination [10]. Although, the official term is "autism spectrum disorder" (ASD), in this paper, we refer to "children with autism" for short. Current design literature has reported on insights gained from evaluations of proposed prototypes [e.g., 2], but little has been done to include interactions with these users in the fuzzy front end, before prototypes are made. Van Rijn and Stappers reported a design project where a designer involved three children with autism from start to end [12]. Observing children, letting them react on prototypes, and contact with caregivers was valuable to gain understanding for the children. This designer spent many days with the children.

However, in the current project designers had limited time to meet the children. In addition, observing the children and interacting with them can be overwhelming, especially during the first encounters. Therefore, we aimed to explore how designers' first interactions with these children can be structured for maximal learning about their needs and possibilities.

3. The project: Elective RichCollections

The project was offered as an elective course to first year M.Sc. design students, which ensured that their willingness was high. As result, thirteen M.Sc. design students choose to participate in the project. They were teamed up into five teams of two or three students. Their motivations varied from *"a true design challenge"*, *"like to learn more about autism"*, and *"love to design for children"*. From now on, we refer to them as 'designers'.

In total, twelve children with autism from four different schools participated in this project. These children varied in diagnosis, intelligence, and speaking ability. Also, their caregivers, such as parents, pedagogues, and teachers, gave permission and were involved.

The designers had no prior knowledge on autism. They were challenged to gain empathy for children with autism through direct contact (phase 1), and later design a product for these children (phase 2). An overview of the project is shown in figure 2. The three gray horizontal lines represent how we collected data from the designers' reflections about contact with the children: (1) individually in a notebook, (2) with their team on video, and (3) in plenary meetings with all teams together. The yellow line shows the order of these reflection moments combined with the steps in their process.

Figure 2. The yellow line shows the designers' process from left to right. Taken steps are illustrated by the pictures. Reflection moments (individually, team, or plenary) are illustrated by the little square boxes. The second step, interacting, has a yellow stroke to pinpoint our focus.

3.2 Phase 1: Understanding

First, each design team visited a school to get acquainted with the situation, learn about children with autism, and how to interact with them. They were told to only observe the children. Second, they visited the same school again. They were instructed to interact with the children and record this, using the toys described in the next section. In total, each designer played with two to five children. Aim of these interactions was to learn about the children's preferences, dislikes, and needs, from own experience. Next, the teams analyzed the movies. Finally, they presented their insights about autism as starting point for their designing phase.

Designers kept track of their gained insight in three ways: individually, with their team members, and in plenary class meetings. Individually, they wrote insights in a notebook that served as a reflective diary (see figure 3). As team, they told their expectations and first reactions into the camera right before and after each visit as a video diary. Plenary, they discussed their insights in class meetings. These three different ways of reflecting are illustrated as square boxes in figure 2. The yellow line shows how these reflection moments were scheduled in time.

Figure 3. A designer writes in her notebook.

3.2 Phase 2: Designing

Three teams of each three designers used the understanding gained in phase 1 for their design project for children with autism. At start, these designers communicated their insights to three new members who had no prior experience on autism. Together, each team designed a product, built an experiential prototype, and finally evaluated this prototype with children. At the start of the design project, all teams were told they could contact caregivers and children for information and evaluation. In this paper, we focus at the understanding phase of the project, and especially the role of these toys for designers in interacting with and learning about autistic children.

4. Toys to facilitate learning from direct contact between designers and autistic children

The set of toys was to help designers broaden their empathic horizon for children with autism through direct contact. Support in this is helpful in the beginning of a design process, because the first encounters with these children are difficult. For this we aimed to develop tools that facilitate interaction and bring out particular behaviour of the children.

Based on the first author's prior experience in designing for children with autism, the set of toys was designed with the following aims:

- For the designers, tools should give confidence to face the interaction with the children, help to keep the interaction going, and facilitate empathy building.
- For the children, tools should elicit them to approach and interact with the tools, and trigger them to exhibit important behaviour patterns.
- For the caregivers, tools should put them in their expert role, and trigger them to explain to the designers about the behaviour, needs and preferences of the children.

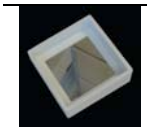
4.1 The toys

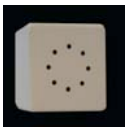
The set of toys, their functionality, aim, and design considerations are given in table 1. The toys came in a bag, accompanied by pictograms of the toys, a video camera, and blank postcards. The pictograms aimed to structure the interaction and facilitate communication between designers and children. The video camera was to record observations and interactions for analysis purpose. The blank postcards were put in the bag to invite designers to inform (absent) caregivers about their encounter and thank them for this. This should open up communication channels for the continuation of the design project.

When interacting with the children, the designer can use the toys in whatever way works, because the situation differs for each encounter. Each team met different children at another location in a different time span and with or without presence of caregivers. For comparison reasons, we encouraged them to use all seven toys.

Important for the children to enjoy the toys are immediate sensory feedback, such as coloured lights and sounds, and enabling repetition [11]. All toys are white, because colour can distract the child from the designed purpose of the toy.

Table.1 The toys with its functionalities, aims, and design considerations

Toy	Function	Aim that the designers experience that the children…	Design considerations
	In the **mirror** a child can look at the reflection.	… don't all have self-awareness. … enjoy the sensory experience of the reflecting mirror.	• Things can be put in or on top of the mirror.
	**Light memory** contains 16 push buttons. Pushing a button gives a colored light. Pushing two buttons of the same color, results in all buttons flashing in that color.	… enjoy the lights. … enjoy direct feedback. … do not always understand the game's rules.	• The buttons are made of pleasurable-to- touch rubber. • The on/off button is a little switch on the back to avoid children to use it.

	**Animal sounds** contains four buttons with an animal picture on a row. When pushing the button, the toy plays the animal sound. One button (belonging to the cricket sound) is hard to push.	… enjoy the animal sounds. … enjoy direct feedback. … ask for their help to push the cricket.	• The linear lay-out of the buttons elicit interaction. • Pictures help the child predicting the sound. • The cricket elicits a child to ask help.
	**Tumble** makes the sound of a sea gull when turned around its axis. Shaking gives a squeaking sound.	… enjoy the sounds. … enjoy direct feedback.	• The holes on top show the game's orientation. • Holes are put in a circular pattern for visual aesthetics.
	**House** contains a roof, a window, a door, a working doorbell and three puppets.	… lack fantasy play. For them the elements often are meaningless objects. … enjoy the vibrating sound.	• Shaped like an archetypical house to elicit storytelling by the designer. • The mechanical bell keeps ringing to reassure the child of its control.
	**Moving lights** contains two sensors and seven red lights. When covering one sensor, the closest light will turn on. When also covering the other, one by one all lights turn on.	… enjoy the red lights. … enjoy direct feedback. … rather play alone.	• The linear lay out of the sensors and lights elicits interaction.
	**Recording sounds** contains a red recording button, a green play button, and a microphone. When holding red button, a sound is recorded. When pushing the green button, sound is played back.	… have difficulties learning the procedure. … do not always recognize their own voice. … enjoy listening back.	• The (difficult) red button elicits the designer to help. • The designer is free in choosing what sounds to record (e.g. child's voice, own voice, making sounds).

5. Evaluation of the toys

The designers used all seven toys in interacting with the children, according to their assignment. Many designers used the toys as means to test the cognitive abilities of the children instead of exploring their needs and preferences at the spot and going along in their play. For example, they researched if the children understood a specific game, and if not, their goal was to help the children to learn how to play with the toy. This seemed to relate to the personal interaction style of the designers. Some were very reactive on the child's behaviour and actively trying to be part of their game. Others took on the observer's role, and tested how the child reacts to the specific toy. Although we advised to interact with one child and one toy at a time, one team left all toys at the table, resulting in chaos. In fact, the moment of changing the toys was an important for the designers. When the child did not want the change, he or she could start to cry. Therefore, the designers tried to prevent this at all times by letting the children decide in the end. In this section, we describe our findings for each toy. After that, we will discuss our general findings.

Mirror

The mirror brought out the lacking self-awareness of the children. Designers of all three teams mentioned the children did not recognize themselves in the mirror. Designers held the mirror in front of the child to explore his self-awareness (see figure 4). Also caregivers explained designers about the lacking self-awareness, while using the mirror. One teacher whispered in a designer's ear: *"He has no self image. He does recognize me (the teacher), but not himself*" (from video). A mirror directly refers to psychological theory that teachers have available. Moreover, the designers experienced the children enjoy the sensory experience of the mirror. *"Almost every child looked into the mirror from real close"* (from plenary meeting). Interestingly, many designers tried making contact by indirectly looking at the children, waving to them, or giving feedback on what they see.

Figure 4. A designer explores whether the child recognizes himself in the mirror.

Light memory

This toy has brought many different insights. Light memory showed designers the children enjoy cause and effect and coloured lights a lot. Many mention that they liked to look into the lights from real close. *"It's something normal children would not do. They really like to stimulate their senses in an extreme way*" (from a designer's notebook). In addition, designers learned about the characters of the children, and their preference for repetition, soft materials, and colours. The toy gave many starting points for interaction, because there were 16 buttons to push. The child could impossibly keep them all for himself. Often the designers were pushed away, but the buttons provided opportunities to explore to what degree they were allowed to join in (see figure 5).

Multiple layers of functionality within this game created misunderstanding between the designers and the children. The designers often tried to explain the children the game's purpose, pushing to identical coloured buttons, while the children enjoyed pushing one button and looking into the light.

The small switch to turn the game on or off, gave nice rewards with less effort. After a switch, the buttons flash in red, green, and blue lights in a row. Amazingly, many children discovered this switch. *"This child really understands how to get the lights with the on/off switch"* (from a designer's notebook). Although switching repetitively was annoying for the designers, this was a valuable lesson about their preference for repetition and being thoughtful in designing rewards.

Figure 5. A designer explores if the child allows her push a button.

Animal sounds

Animal sounds showed that some children enjoy sounds a lot. One child was very sensitive to sounds, and did not like to listen to the animals. Interestingly, almost all children had problems with pushing the button belonging to the cricket sound. Therefore, the children asked the designer for help or grabbed the designer's hand and thereby the designer as instrument to push. The designers experienced they were only needed for that part, because the children did not like them to push the other animals as well (from video). One special moment occurred when the child and the designer developed a sequence. They took turns in pushing the animals. *"At that moment I felt included in his play"* (from a designer's notebook). Also, the animals were a good starting point for verbal communication

Figure 6. A child asks the designer to name the animals he pushes.

between the designer and the child. The boy in figure 6 repetitively asked the designer to name the animal each time he pushed one.

Tumble

The tumble toy did not always give feedback. Only when used with the top facing upwards when tumbling, it makes a sound. The designers expected this toy to be boring, because it cannot do very much. Indeed, the children ignored the toy, when they did not understand how to produce any sound. However, some children really liked it. One boy did the game over and over, and only in one manner. He laughed every time the sound came out. *"He is playing with the toy in a very structured way, following the pattern he knows. He really likes it though"* (from a designer's notebook). And the pedagogue said: *"this is autism"* (from the video). The boy in figure 7 loved to shake the toy near his ear and listen to the sound.

Figure 7. A child listens to the sound of the toy when he shakes the toy next to his ear.

House

The house gave many opportunities for interaction. The house aimed designers to experience the children lack fantasy play. Interestingly, this toy gave designers starting points for interaction, because the house has meaning to the designers. The puppets invited the designer to talk to the children and try storytelling, such as *"hello"* and *"I am mommy"* (from the video). Designers knew what to do with the house, even though the children did not react as they expected. Impossibly, the child could keep the toy to himself, because it contained three puppets that could be freely moved around. This evoked exploration, because the puppets could walk away, slide of the roof, or fall on the ground. One designer hid one puppet for the child, and the child noticed this. *"The child knows there are three puppets. He is constantly counting them"* (from this designer's notebook). The boy in figure 8 used the toy as a box with peek holes. Finally, there was a mechanical doorbell. Almost all children loved to ring that bell continuously. The children enjoyed the vibrating sound, but the designers did not. *"For the children the bell was pleasant, for us it was irritating"* (from a designer's notebook). However, the bell made the house interesting for the children for a longer period of time. Every time the children reached back to the house and rang the doorbell again.

Figure 8. The child lifts the house and looks into it from real close. The designer grabs a puppet.

Moving lights

The two opposite sensors of the toy aimed to force the designer and child to play together. However, often this did not happen. The children could easily reach the two sensors with both hands. The designers were left out to watch, because the children preferred to play alone. Interestingly, sometimes designers were allowed to join in, as shown in figure 9. Each time the designers move their finger, the interaction becomes unpredictable for the children. As a solution, one little girl forced a designer to keep her finger on one sensor, so she could play by herself with the other sensor. This toy clearly expresses to designers the difficulties in interacting with the children, such as turn taking and sharing.

Figure 9. A rare moment on which the child lets the designer occupy a sensor.

Recording sounds

Many designers told this toy was not helpful in interacting with the children, because the operation was too difficult for the children (from plenary meeting). However, some designers reported interesting moments. One child used the toy as a phone to call his daddy. This made the designers curious about its home situation. Accidentally, a boy recorded his own voice. He was surprised and laughed hard about it. His laughing made the whole team laugh. *"It is very nice to see his expression"* (from a designer's notebook). According to these designers, this toy brought them together. Another boy loved to record his own voice and even gave commandos to his dog through the toy. *"He could enjoy himself for hours with this toy according to his mom"* (from a designer's notebook). Probably, other designers were disappointed when children only listened to the buttons' clicks without recording any sounds, such as the boy in figure 10. Finally, the children might dislike the recording changing all the time. They probably prefer repetitively listening to the same sound.

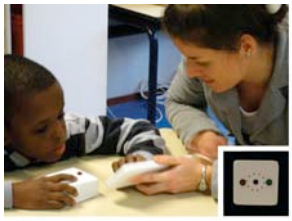


Figure 10. The child pushes the buttons to listen to its clicking sound.

Video camera

Video enabled the designers to both look back at their own interactions, and those of other teams with the same toys and other children. The designers said this made them realize each child is unique. *"Each child is different, not all kids react to the same toys in the same way."* In the second phase of the project, the videos were shared with the new team members. The designers felt they knew much more then what was visible in the movies.

Postcards and printer

The designers were assigned to send (absent) caregivers a postcard about their encounter with the children. Clearly, the designers enjoyed decorating the postcards (see figure 11) and we received enthusiastic reactions from parents. The postcards also aimed to open up the communication channels for the rest of the project between designers and caregivers. The designers did involved parents and children several times during the continuation of their design project to gain more information and evaluate prototypes. The exact role of the postcards in this process is difficult to pinpoint, but we think it is important to keep all parties informed.

Figure 11. (left) Designers give a postcard with pictures of the children to thank the teacher. (right) A postcard made by the designers.

Figure 12. The designer has put the pictograms on the table to structure playing for the child.

Pictograms

Two out of five teams used the pictograms to ease the transition from one toy to the other (see figure 12). One team played with the same child two times; once at home, and once at school. *"It really helped him to stop and go on with the other. It just went smoothly at school"* (from the plenary meeting). The other team used the pictograms to ask the child to change the toy. *"I just showed one child a pictogram, and he would get the toy by himself!"* (from the plenary meeting). These two teams learned from experience the value of using pictograms for these children, and were proud when they succeeded.

7. The role of the toys in the interaction

For their second visit, the designers were instructed to interact with the children using the seven toys. The children, designers, and the toys played a role in this interaction. As result of autism, most children preferred to play by themselves with the toys. The children communicated with their body. Sometimes, the children pushed the designers away or kept the toy visible for themselves. If the children were not able to cope with the toys by themselves, they sometimes asked the designers to help out. At these moments, the children grabbed the designers' hand and used them as an instrument.

Still, the designers tried to interact with the children as instructed. We noticed that the extent to which designers tried to intervene in the child's play, seemed to relate to the personal interaction style of the designers. Some preferred to observe, while others were very reactive on the child's behaviour and trying to be part of their game. Moreover, the designers felt difficulties in triggering them to play with them sometimes. *"I did not want to force the children to play with these toys at that moment"* (from plenary meeting).

Also the different toys influenced the interaction between the designer and the child. The house, memory game, and animal sounds had more buttons or elements to use. Therefore, these toys gave the designer more starting points for interaction. However, toys with limited ways to play, such as the tumble toy, were easy for the child to keep to himself. Shaking or turning the tumble toy can hardly be done together. We observed that toys with more starting points elicited the designers more often to intervene in the child's play compared to toys that the child could easily keep to himself. By means of manipulating the objects, designers were looking for the child's boundaries.

Surprisingly, the house was a toy that made the designers feel confident in the interaction with the children. Even though the children did not always see the toy as a house, the designer knew actions he or she could try with the puppets, the doorbell and the house. Because children with autism often lack fantasy play, we expected meaningful toys to be unimportant. However, we underestimated the fact that meaningful toy gives the designer starting points for interacting with the children, even though they learned from own experience that storytelling does not work.

In the learning process of the designers, many moments refer to miscommunications between themselves and the children. As described earlier, the designers often tried to help the children play the game according to its 'purpose', while the children enjoyed something else about the toy. These moments are miscommunications between the designer and the child. *"It was too much, he became nervous. The boy thought, don't explain me something I cannot understand. Just let me play!"* (from plenary meeting). Also, the children often reacted differently from what the designers expected. *"We learned most from the unexpected moments, these moments stick to you and are easy to communicate to others"* (from a designer's notebook). In some way, some toys bring out these miscommunications. For example, the mirror shows that the children do not recognize themselves, and the house shows they lack fantasy play. In the future, we should develop toys that elicit these miscommunications between designers and children with autism.

8. Conclusions

In this paper, we presented a set of toys to facilitate contact between designers and children with autism. Results show that the toys shown in this paper played an important role in direct contact with these users. The toys bring out particular behaviours, give a handhold to structure the interactions, and allow the designers to explore the

possibilities in interacting with the children. Especially, a meaningful toy that has elements to manipulate, such as the house with the puppets, provides starting points for designers to interact with the children. In further studies, we want to investigate how interactions with difficult-to-reach users, but also their caregivers can be used in design projects for these users.

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