# The Development of an Online Research Tool to Investigate Children's Social Bonds with Robots

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**Abstract.** As children are increasingly exposed to robots, it is important to learn more about the social interaction and bond that may develop between robots and children. In this paper we report the development of an interactive tool to measure children's attitudes toward social robots for children ages 6-10. A first version of the KidSAR instrument was tested and a pilot study was carried out to evaluate and improve the design of the KidSAR (Children's Social Attitude toward Robots) tool. The pilot study involved a small scale field experiment assessing whether children feel more social connection with a robot in a caring role compared with a role where it needed to be taken care of. The final KidSAR tool was developed after evaluation of children's responses and observation of children using the tool.

**Keywords:** Social robot, children, Icat, human-robot interaction, KidSAR, human-robot social bond.

## 1 Introduction

In the near future, the number of robots in everyday life will increase as well as the application areas in which they are used [11]. When robots need to fulfill social roles in society, such as nanny, butler or servant, homework buddy, companion and pet [11, 9], such robots need to be able to communicate and cooperate with other robots and humans, they need to be social [8]. Social robots are designed to have long-term interaction or even maintain social relations with humans [2, 3]. Furthermore, when a social bond between a robot and human can develop, people may feel more confident in integrating robots in their daily lives [13]. A robot that appears to have social behavior and is more socially communicative is accepted more easily and makes people feel more comfortable [15, 13, 19]. Social robots are already present in society, in particular in the service sector, the education sector and the entertainment sector [6]. Entertainment and educative robots include robotic toys for children and therefore, children are at present exposed to robots.

As children are increasingly exposed to social robots, it is important to learn more about the social bond that may develop between robots and children. This paper reports the development of an online data collection tool for measuring children's attitudes toward and social bonds with robots.

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## 2 Theoretical Background

### 2.1 Children's Emotional and Social Bonds with Robots

The most important emotional bond, especially for young children, is the bond with the primary caregiver(s)(parents)[20]. This caregiver can take on multiple roles; a child will seek an attachment figure when under stress but to seek a playmate when in good spirits [22, 20]. When children grow older, their social network starts expanding, and they form new social bonds. An important social bond is friendship. The concept of friendship depends on age and experience with social interaction [14]. By the age of six, children can act intelligently on their environment with planned behavior and reflection [14]. Children of ages 6 to 10 years can see other points of view than their own. Friends are those who give help and who are likeable. Trust and intimacy also become important; a friend is someone one can trust with a secret. Also, at this age a child can see a friendship as temporarily, a friendship can start when playing with someone and end when playing is finished [14]. A social bond for children (6-10) can therefore form during a short time-span of interaction and trust and intimacy are attained through social acts such as telling secrets and helping each other.

When children develop an emotional or social bond with robots, the interaction between children and robots will be affected. Even though research suggests that human robot social bonding may improve interaction, more research on robot sociality, expression ability, sensory and recognition ability and meta level communication mechanisms, is necessary [10]. Previous research on virtual characters found empathy and believability important aspects of character creation [16][17]. Empathy concerns the character's ability to observe the emotion the human is having and responding emotionally [16]. Believability can increase with autonomy [16], the expression of emotion [7] and the consistency of the character's personality [26]. It is likely that children will also find a robot more believable when it can exhibit accurate empathic behavior (infer the right emotion and respond accordingly), has a certain degree of autonomy in it is behavior and displays behavior consistent with its personality.

### 2.2 Survey Tools for Children

A lot of research has been done about human robot interaction, but there are no measurement tools available specifically designed to measure children's responses to robots. The Negative Attitudes toward Robots (NARS scale) [24], anxiety towards robots scale [23], the user acceptance of technology [31], and the source credibility scale [25] are often used in HRI research. Many of the items in such studies were developed for adults where children do not have acquired the reading skills necessary to understand the questions just yet [36]. Previous work has shown [35] that adults have problems with questions that are very complex or when they have to retrieve information from memory [28]. For children, such problems are magnified; because ambiguity is more difficult to compensate for or has a larger impact [12] and children's cognitive, communicative and social skills are still developing [37]. For written questions, children have trouble with questions that use negations [33] [32].

Children ages 6-10 are able to participate in software usability testing [34], due to formal education; they can carry out a task and follow directions. Furthermore, they are not self-conscious about being observed, they will try new things with ease and answer questions when prompted. Six and seven year olds will sit at a computer but become shy or inarticulate when talking about their experiences. Ten year olds have more computer experience and are more ready to critique the software [34]. Van Hattum & De Leeuw [38] report successful administration of the Computer Assisted Self-Administrated interview (CASI) in the age group 8-11. CASI was designed so that questions look simple and attractive; using CASI was more effective compared to using pen and paper. In order to cater for child participants in the ages 6 to 10, the survey items cannot be complicated, especially text should be easy to read and ambiguity free. Visual stimuli are preferred over questions in text to aid human cognition [37], but movies can easily lead to information overload [1]. Other problems in this age group are lack of concentration and motivation [29], and a survey should be fun to complete and short.

## 3 Developing the KidSAR Instrument

A first version of the KidSAR (Childrens' Social Attitudes toward Robots tool) consisted of ten items. Four items (trustworthiness, honesty, intelligence and care) were inspired by McCrosskey's source credibility scale [25]. Four by the interpersonal attraction scale (friendship, bonding, physical proximity and care for robot) [27]. One (intension to use) from the user acceptance of information technology scale [31] and one concerned the location of intended use of the robot. The items were designed to be visual and interactive (see Fig. 1).


**Fig. 1.** Example questions from the first version of the KidSAR tool (translated)

## 4 Evaluating the KidSAR Instrument

A first study to evaluate the KidSAR tool was carried out in a pilot study assessing whether children have more positive social responses to robots in a caring role or robots in a role where they need to be taken care of. From previous studies on Tamagotchi [18, 30] and analyses by Turkle [39], we expected that children would respond

more positively to a robot that they need to take care of compared with a robot that takes care of them. The experiment was conducted in the Science museum Nemo in Amsterdam, the Netherlands, over a period of seven days. There were always two researchers present, one with the child and another who controlled the Icat from behind a screen (Wizard of Oz setting). Parents were asked permission for their children to participate and were asked to wait outside the room. There was a frost glass panel between the waiting area and the experiment room so that parents could observe the physical interactions between child and robot/ researcher. In total 47 children participated, their average age was 9 (Range 6-11, SD=1.4), 51% were male, 49% were female. The data collection involved role-play games between the Icat robot and one child participant at a time. In play, children experiment with alternative roles which allow them to perceive the world and themselves from different perspectives and role playing is an important part of child development. In each data collection session, the participant was asked to do a role playing game with the iCat robot. Afterwards the child was asked to fill in the KidSAR tool on a computer. Children were randomly assigned to one of two scenarios. In the 'robotcare' scenario, the participant was in a role where the robot had to be taken care of and nurtured. In the 'childcare' scenario, the robot had to take care of and nurture the child. The two scenarios were exactly the same except for the role reversal. Robot responses were generated from a prerecorded script. In the robotcare condition the robot had an androgynous computerized children's voice. In the childcare scenario the robot had an androgynous computerized adult voice. During the role playing game, the robot and child would learn each other's names and ages and they play three games. One game where the robot or child fell during playing outside and needed a kiss on the hand (this is a common and non-controversial way to sooth a child after hurting their hand without injury in the Netherlands). In another game, the robot and child mimicked emotions such as angry faces, happy faces. Finally the child or robot sang a song for the other to relax and say goodbye.

## 5 Results

Concerning the study results, no significant differences were found between the two conditions. The robot in the robot care condition scored higher averages on truthfulness, trustworthiness, perception of how much it cared for the participant and how much the participant cared for the robot. The robot in the childcare condition scored higher on perception of interpersonal closeness, strength of social bond and intention to use the robot. In observing usability of the tool, we found that children in general seemed to enjoy answering the questions. The younger participants (6) had some difficulty reading the text of questions, but found answering easy. Older children aged 10 and 11 found the experiment often a bit childish, especially the girls.

From the data we decided to remove some items, redesign the remaining items and add new items. The item 'preferred location of future use' needed to be eliminated,

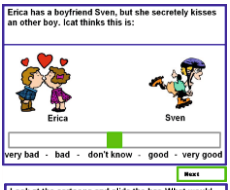
because the reasons for choosing a particular location (such as bedroom or park) were not clear with intent of future use in mind. The item 'care for the robot' did not seem to measure what it was intended to. The simple 2 or 3 point scale that was used in almost all questions, to keep it easy and fun for children did not allow for reliability testing and was redesigned.

## 6 The Final KidSAR

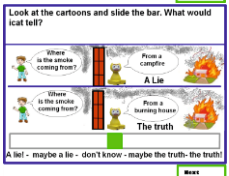
The items derived from the source credibility scale offered valuable insight into participant's attitudes toward the robot and therefore, the final KidSAR was designed to resemble the original scale more. Nine items were developed based on the original 18 items source credibility scale. The other questions were not included because they involved complex language (e.g. phony/ sincere), were too complex visually (like untrained/ trained) or would resemble another question and the KidSAR needed to be as short as possible (like inexpert/ expert). In Fig. 2 are the final 13 questions of the KidSAR. In order to carry out formal reliability analyses, all items have been redesigned to allow for a 5-point answer in either a scale or dragging options for response categories. The tool is developed in Adobe flash Cs4, from a set-up screen the researcher can enter a name and load three pictures of a robot of choice. The questions are generated with these pictures for online survey deployment, and randomized for each individual session. The researcher receives a unique identifier code and will be able to generate an excel sheet with results after completion of the survey. The original KidSAR did not include demographics. The final KidSAR includes questions to select basic demographics (age, gender, country). When opening the tool in flash, the researcher can easily add more questions, or adapt existing ones. The final KidSAR allows for an option to have the text for each question read out loud.

## 7 Discussion and Conclusions

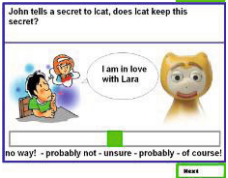
In this paper we report the development and preliminary evaluation of the KidSAR evaluation tool. The KidSAR makes minimal use of text and focuses on visual interactive actions to indicate answers. Even though this is a first evaluation of the KidSAR tool, the research is ongoing and the authors believe it will offer a valuable resource to researchers interested in investigating children's responses to social robots. The tool's effectiveness will need to be compared to more traditional quantitative data collection instruments such as text-based survey. Further validation research is needed to establish how effective the tool is in yielding valid responses from participants. Finally, the KidSAR tool has been developed and tested in the Netherlands, in future research we aim to evaluate cultural applicability of KidSAR and develop versions for international deployment as well as a version for visually impaired children.




**Trustworthiness 1:** *Ethical.* Children ages 6-10 grasp the concept of having a boy/girlfriend.

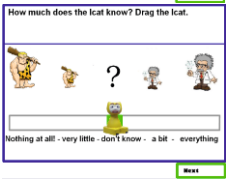



**Trustworthiness 2:** *Honesty.* The question is derived from [21] and adheres to young children's conceptualization of lying.

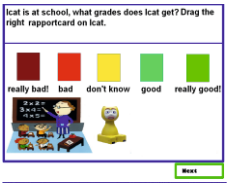



**Trustworthiness 3:** *Trustworthy.* Measures whether Icat will keep a secret. An important aspect of child friendship [14].

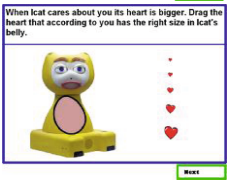

**Competence 1:** *Intelligence.* Symbols were chosen to represent smart or not so smart. These can be dragged onto the robot.



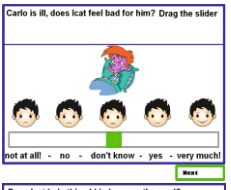

**Competence 2:** *Knowledgeable.* Again symbols are used to represent knowledge.



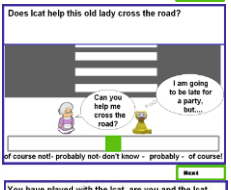

**Competence 3:** *Capability.* Children can relate to the concept of performing well at school.




**Caring1:** *Cares.* A heart is a common way to express ones love or caring for another. The child chooses the size of the heart to represent how much Icat cares.

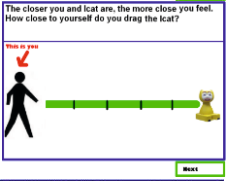



**Caring 2:** *Has best interest at heart.* Being ill is something children don't like, and are familiar with.




**Caring 3**: *Self centeredness.* Helping an old person is something most children can relate to.


**Perceived social bond 1:** This measure is to assess what type of social bond the child and robot have.




**Perceived social bond 2:** This question is inspired by the interpersonal closeness scale [4].


**Intent to use 1:** Measures wheter the child wants to use the robot again.


**Intention to Use 2:** Measures if the participant would use the robot on a daily basis. Inspired by Hu et. al. [5].

**Fig. 2.** The final KidSAR items (translated)

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