Child's Personality and Self-Disclosures to a Robot Persona "In-The-Wild"

Anouk Neerincx[1], Yanzhe Li[2], Kelvin van de Sande[1], Frank Broz[2], Mark Neerincx[2], and Maartje de Graaf[1]

***Abstract*— Social robots can support children in their socio-emotional development [38]. To improve the cooperation between a child and a social robot, a good relationship is vital. Self-disclosure is an essential element for building personal relationships. Yet, knowledge about the effects of self-disclosure in child-robot interactions is still lacking. To investigate effects of robot persona, child personality, and self-disclosure category on self-disclosure in child-robot interaction, we have conducted a field study at a science festival in which children had a conversation with a robot that either behaved human-like or robot-like. The results show a significant difference in the amount of self-disclosure (in conversation duration) between the two robot personas. Additionally, significant relationships were found between conscientiousness and extraversion and amount of self-disclosure (in word count). The participant disclosed significantly more about the category 'Attitudes and Opinions' than about 'School'. Finally, a thematic analysis shows that the content of the conversations can be categorised in five plus one themes. Between robot personas, the content of the conversations did not differ in terms of conversation themes. However, in both conditions, we found that children generally feel comfortable sharing unpleasant experiences about present themes (such as COVID) in a first encounter with a robot.**

I. Introduction

Social robots are increasingly being deployed in the fields of healthcare, education, and entertainment, and have shown to be useful and effective for children in various ways (e.g., [4], [12]). Children generally respond positively to the implementation of social robots [9]. Successful cooperation between humans and social robots depends on a good relationship and interpersonal communication, for which reciprocal self-disclosure is essential [10]. Previous research indicates that, for adults, self-disclosure is affected by factors such as personality and self-disclosure category [32]. Self-disclosure is an important element for a child's social development [5], and robots can assist children in this development. This paper investigates the role of robot persona (i.e., human-like or robot-like), self-disclosure category, and child personality on child's self-disclosure during an interaction with a robot.

II. Related Work

A. Self-Disclosure & Robot Persona

A robot can appear and behave in different ways. Even though robots, in theory, can take on any physical form, those modelled after humans have shown to be particularly influential. Many current social robots have human appearance features such as eyes, hands, or faces [34] and several researchers believe human-like robots are most suitable for human-robot interaction [2], [17]. Previous HRI studies found that when a robot appears more human-like, people are more likely to take advice from the robot [35], take the robot's visual perspective [44], empathize with the robot [36], and even expect the robot to make moral decisions that are similar to those made by humans [27]. However, human-like appearance come along with certain risks [34] given that human resemblance may generate unrealistic expectations [11]. When those expectations are not met, people may lower their assessments of the robot, discontinue relying on the robot, or even stop interacting with the robot [34]. Many studies indicate that a robots' appearance should match its intended task [13], [16], [22]. This is why social robots often have a humanoid appearance and express human-like behaviour in HRI research. However, it is still unclear what the exact influence of the human-like behaviour is versus other types of behaviour, especially in social robots that already look human-like. Studies on different types of robot personas remain fragmented, lacking a coherent framework [37]. That is why our study focuses on human-like versus robot-like personas, both with the same embodiment (i.e. humanoid).

B. Self-Disclosure in Child-Robot Interaction

Self-disclosure can be described as statements that reveal personal information [19] and is essential in relationship building. Encouraging self-disclosure is therefore a common strategy in building a relationship between an agent and an interaction partner [1], [10], [29], [41]. Psychology research shows that people disclosed more to persons they like [15], [20], [43], however the effect of likeability on self-disclosure in an HRI context are mixed with some studies indicating a positive effect (e.g., [31]) while others report null-results (e.g., [6], [14]. Yet, building a relationship is necessary for successful human-robot collaborations [18], which can be established through self-disclosures [6]. Self-disclosure can be stimulated in various ways, for example by reciprocal self-disclosure [14], [29]. A recent study in the field of CRI found that especially reciprocal self-disclosure from the agent was effective, besides less energetic behaviour and waiting time before responding [24].

C. Self-Disclosure & Child's Personality

The degree of self-disclosure is not only related to likability of the conversation partner or reciprocal self-disclosure, it can also be linked to the human's personality. Psychology

*This work was not supported by any organization

[1]Anouk Neerincx, Kelvin van de Sande, and Maartje de Graaf are with the Department of Information and Computing Sciences, Utrecht University {a.neerincx, m.m.a.degraaf}@uu.nl, k.vandesande@students.uu.nl,

[2]Yanzhe Li, Frank Broz, and Mark Neerincx are with the Department of Intelligent Systems, Technical University of Delft {y.li-42, f.broz, m.a.neerincx}@tudelft.nl,

research found that personality traits, as well as gender, can be related to self-disclosure. People scoring high on extraversion tend to disclose more, compared to people with introversion tendencies [30]. Similarly, in HRI research, a positive effect of extraversion have been reported along with a positive effect of agreeableness and a negative effect of conscientiousness on self-disclosure [32].

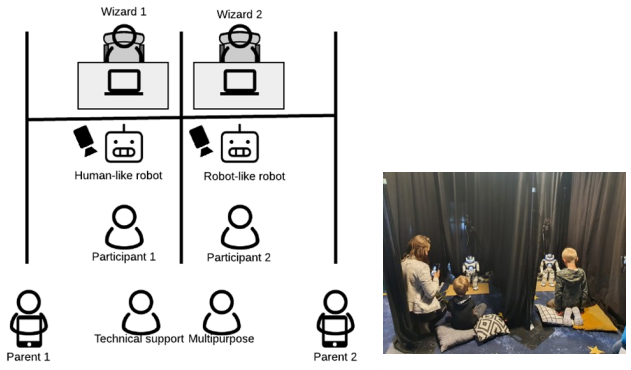
III. Methods

This study investigates the effects of robot persona, child personality, and self-disclosure category on self-disclosure during a field study at a science festival in which children had a conversation with either a human-like or robot-like robot.

A. Research set-up & Materials

1) Location: The field study took place at science festival "Expeditie NEXT" in the city center of Franeker, the Netherlands, May 6th, 2022. This free science festival is organized yearly by the Dutch Research Agenda (NWA) for children between the ages of 6 and 12 with the goal to "reach people who are not easily introduced to science and show them what science contributes to our daily lives" [1].

2) Research set-up: Our study was located in the city library with two separate booths divided by soundproofing curtains, behind which the wizards were located (see Figure 2 for a schematic overview of our research set-up).



(a) Schematic set-up of the study.

(b) Picture of the research set-up.

Fig. 1: An overview of our research set-up.

3) Materials: Participants completed the online questionnaires (pre and post interaction) on three tablets at the festival site. Name tags were used to give the participants their participant ID. Two video cameras (one in each booth) were used to record the interactions. Two wireless lavalier microphones were used to record the sound. Two headphones connected to the cameras were used by the wizards to listen to the responses of the children. Two NAO robots from Aldebaran Robotics were used, programmed and controlled using scripts written in the "Robots in de Klas" [2] platform. A Wizard of Oz method was used to control the dialog.

[1]https://www.nwo.nl/bijeenkomsten/expeditie-next-het-nationale-wetenschapsfestival-voor-kinderen

[2]https://www.interactive-robotics.com/onderwijs/

4) Robot Persona Design: To design the two different robot personas (human- and robot-like), different behavioural features were used (i.e., dance, gestures, vocal utterances, voice settings, and dialog content), based on previous research [32]. To keep the basic embodiment the same for each persona, two NAO robots were used. However, the voice settings differed between the robot personas. Table I gives an overview of the gestures and sounds added, the voice settings as well as the disclosing statement per robot identity. These gesture and sound additions were applied at the same time and to the same extent in each condition.

5) Research Team: The research team consisted of three wizards, two technical support, and three hosts. The hosts would receive the participants, inform them about the study, give them a participant code and a microphone, and direct them to the study location, as well as helping the parents and the children with completing the questionnaires. The three wizards would rotate the two wizard positions (as seen in Figure 2) and operate the robots by selecting one of four responses to the participant's answer (see Table III for the WoZ instructions). Technical support assisted in setting up and resolve potential technical issues during the experiment.

B. Procedure

1) Informing participants & Pre-questionnaire: At the festival, participants were received and briefed about the experiment by one of the hosts. After agreeing to participate, the child would be labeled with a participant code (including an indication for the persona condition), and asked to wait in line to meet one of the robots. While waiting, the parent was asked to provide informed consent and complete the *pre-questionnaire* on a tablet, while the child could participate in a drawing activity to pass the time.

2) The Child-Robot Interaction: When it was the child's turn, the host would direct them to one of the booths. The participant would take a seat and the wizard would then start the interaction. The robot would introduce itself, execute a dance, and ask the participant some introductory questions to break the ice. Then, the robot would disclose something about its own COVID experiences to stimulate child's self-disclosure (based on the robot persona; see Table I 'Robot self-disclosure'). Finally, the robot asked if the participant would answer some questions about their experiences during the pandemic. If the participant answered with 'yes', the robot would start with asking the five questions seen in Table II. If the answer was 'no', the robot would thank the participant for their time and direct them back to a researcher. During the conversation the robot was able to give four different responses to each answer (see Table III). When all questions were asked, the robot would thank the participant for their time and direct them back to a researcher.

3) Post-questionnaire: After the conversation with the robot, the child would complete the *post-questionnaire*, with the parent's help if needed. Finally, the participants were thanked for their time and asked to return the tablet.

TABLE I: Gestures, sounds, voice settings, and robot self-disclosure of the two robot personas (human-like and robot-like)

Robot persona	Gestures	Sound	Voice settings	Robot self-disclosure
Human-like	Waving, looking around, and scratching head	Thinking ('Hmmm..')	Pitch: normal, speed: slow	Scheduled appointment with human at the wrong time
Robot-like	Eyes blinking, robotic look around, and robotic arms	Robotic sounds ('Bleep bleep')	Pitch: low, speed: slow	Was not able to clean because of empty battery

TABLE II: Questions asked by the robot, including question number and category of the question

Question#	Question	Category
Q0	Can you give answers to the following questions about your experiences during COVID?	Opening question
Q1	What did you think about your parents being home more often during COVID?	Attitudes and Opinions
Q2	Have you been ill during COVID? If yes, how was that?	Body
Q3	Were you worried about COVID? Were you anxious or afraid for example?	Personality
Q4	Were things more difficult or harder at school because of COVID?	Studies
Q5	Did COVID affect playing with friends?	Tastes and Interests

TABLE III: Response opportunities for the robot (response 1 after satisfying answer, response 2 after no answer, response 3 after unclear/short answer, and response 4 to repeat the question)

Response#	Response	Participant answer
R1	Thank you for your answer! That's what I wanted to know. Let's move on to the next question.	After a satisfying disclosure (over 3 words)
R2	I understand you'd rather not say anything about it. Let's move on to the next question.	No answer
R3	Could you tell a bit more about this?	Unclear or very short (1-3 words)
R4	*REPEAT QUESTION*	Did not understand the question

C. Measures

The *pre-questionnaire* consisted of a short version of the Hierarchical Personality Inventory for Children (HiPIC) [40], measuring Big-5 personality traits through 18 items, and asked to provide their age and gender.

The *post-questionnaire* consisted of the Godspeed questionnaire [3], adapted for children, including five questions about the robot on a five-point Likert scale (fake or real, like a machine or a human, stood still or moved a lot, unkind or kind, and dumb or smart). To measure robot acceptance, a question asked if the participant would like to have the robot at home [25], on a five-point Likert scale. The two questionnaires were matched based on participant code.

During the *interaction*, the robot would ask five questions based on previous research ([32]) and Jourard's Self-Disclosure Questionnaire ([21]). Each question represented a different self-disclosure category (see Table II). Responses of the children were recorded by means of cameras and microphones. The breadth of self-disclosure was measured by word count and duration, while the depth would be measured by self-disclosure category and thematic analysis.

D. Participants

Participants were recruited through voluntarily sampling. In total 76 participants entered the experiment of whom 37 had a conversation with the robot-like robot and 39 with the human-like robot. Of the participants 42 were male, 27 were female, and 7 were unknown. The average age was 9 years old (ranged between 4 and 14 years old of which 61.6% between 7 and 11 years old, M = 9.11, SD = 2.431). Two Independent-Samples T-Test showed no significant differences in gender ($t(64) = -0.743, p = 0.460$) nor age ($t(64) = 0.050, p = 0.960$) between robot personas, which shows that gender and age were balanced across conditions. The average scores (out of 5) per personality trait were 4.1 for conscientiousness, 2.8 for benevolence, 4.2 for imagination, 2.9 for emotional stability and 3.4 for extraversion. Three participants participated twice because of technical complications and were thus excluded from the self-disclosure analysis, resulting in 73 participants (of which 36 in the robot-like condition and 37 in the human-like).

E. Data Processing & Analysis

The pre- and post-survey results were recoded into numerical values and reversed-coded where needed. The scores of the questions to the *pre-questionnaire* were used to calculate the Big 5 personality traits [28]. The files of the recordings of the conversations were first cut into separate files per participant, and conversations were transcribed per participant using those video files. Notations per participant were made on whether or not parents or siblings interfered, and if there had been a robot error during the conversation. The amount of spoken words by the participants per question was calculated as well as the word count said during the opening and end statements of the conversation. If a question was not asked the data would be marked as missing and not as zero words said, as this could skew the results. Additionally, the statements of the participants were analysed though a thematic analysis based on grounded theory and open coding [39] by two independent researchers.

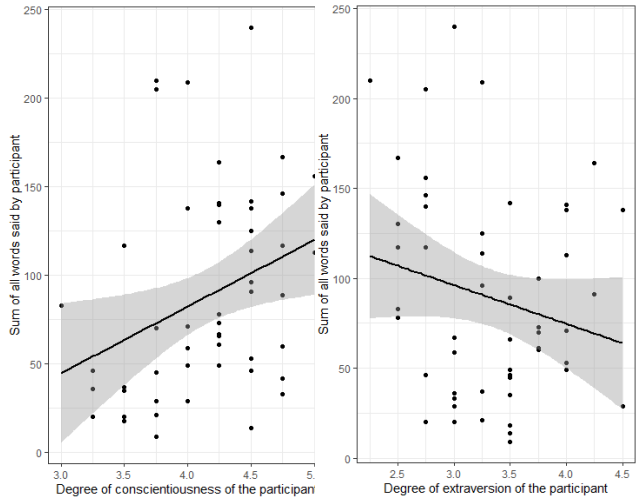
IV. Results

A. Perception of Robot Persona

Due to the non-normality of the data, a Mann-Whitney U test was used to investigate the differences in Godspeed results per robot condition. No significant differences between robot conditions (i.e. human-like and robot-like personas) were found based on the Godspeed measures, meaning that there is no evidence that children perceived the robot persona's differently.

B. Breadth of Self-Disclosure

To quantitatively calculate the amount of self-disclosure, word count as well as conversation duration are used.



(a) Concientiousness ($\beta = 41.61, p = 0.014$).

(b) Extraversion ($\beta = -45.19, p = 0.013$).

Fig. 2: Multiple linear regression results on word count.

1) Self-disclosure & Participant Personality: After removing cases with parent/sibling input in the child-robot conversations as well as one outlier (with a total word count of 417, while the mean word count was 82.47), 58 cases were included to test the effect of child personality on the child's self-disclosure with two separate regression analyses. First, a multiple linear regression showed that Big-5 personality traits significantly predict word count ($R^2 = .24, F(5, 44) = 2.779, p = 0.029$), specifically, the degree of conscientiousness ($\beta = 41.61, p = 0.014$) as well as extraversion ($\beta = -45.19, p = 0.013$) significantly predicts word count (see Figures 2a and 2b).

A second multiple linear regression showed that Big-5 personality traits do not significantly predict conversation duration ($R^2 = .030, F(5, 43) = 1.298, p = 0.283$).

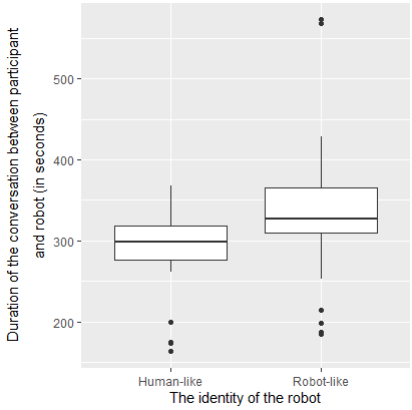


Fig. 3: Boxplot of the mean conversation duration per robot condition ($t(71) = 2.870, p = 0.005$).

2) Self-disclosure per Robot Condition: The effect of robot persona on self-disclosure in terms of word count was investigated with an Independent-Samples T-Test. No significant differences in sum of words were found between the two conditions ($t(71) = 0.634, p = 0.528$), where the robot-like robot contained 88 words on average ($M = 87.55, SD = 73.99$) and the conversations with the human-like robot contained 78 words on average ($M = 77.51, SD = 60.81$).

However, when looking at average conversation time, an Independent-Samples T-Test shows a statistically significant difference between the different robot personas ($t(71) = 2.870, p = 0.005$). The average conversation duration was higher for the robot-like robot ($M =$ 05:37 minutes, $SD =$ 01:22), compared to the human-like robot ($M =$ 4:51 minutes, $SD =$ 00:48). The overall average conversation duration was 5:14 minutes. Figure 3 shows the comparison between the two different robot conditions.

C. Depth of Self-Disclosure

1) Self-disclosure per Category: To investigate self-disclosure based on content, we first analyzed the amount of self-disclosures per question category (based on [21], [32]). A Friedman test was used to account for the non-normality of the data and to study the within-subject differences per question. Results show a significant difference, $\chi^2(4) = 14.879, p = 0.005$. Figure 4 shows a bar chart with the mean of the word count for every category (School: μ = 8.883, Personality: μ = 9.797, Body: μ = 11.381, Tastes and Interests: μ = 12.426, and Attitudes and Opinions: μ = 13.935). Further pairwise comparisons show only a significant difference in median between the topic 'School' and 'Attitudes and Opinions' ($p = 0.030$).

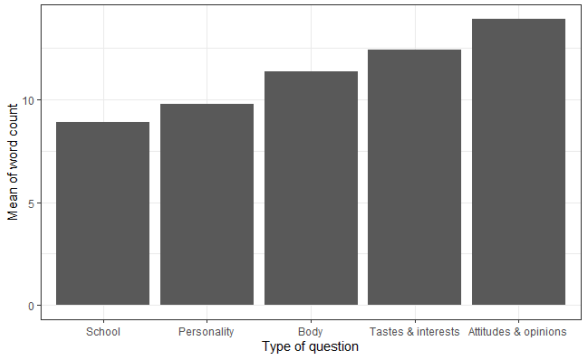


Fig. 4: Bar chart of the mean word count per question category. Pairwise comparisons of the Friedman test ($\chi^2(4) = 14.879, p = 0.005$) shows a significant difference between the category "School" and "Attitudes & Opinions" ($p = 0.030$).

2) Thematic Analysis: To gain further insights in the depth of self-disclosures, a thematic analysis was carried out (see Figure 5). The goal of the thematic analysis is to gain more insights in what children (want to) share with a robot they encounter in a public space.

The content of the conversations was labeled with 44 distinct codes, which were grouped into six different

themes ('COVID', 'School', 'Parents', 'Friends', 'Home', and 'Other'). Most children spoke about 'COVID' with 312 codes and the least talked about was 'Home' with 35 codes. The themes 'School', 'Parents', 'Friends' and 'Other' each contain 90, 87, 87, and 241 codes respectively. Figure 5 shows an overview of the encoded themes, sub-themes, and their relationships with each other.

'COVID' was the most popular theme during the conversations. Participants talked about their experiences during the pandemic; what they did, the COVID measures, they themselves or someone else getting COVID and what that was like, or they shared their opinion about the COVID period and the disease itself. For example, one child explained to the robot what it was like to get COVID *"I had to, I had COVID once and then the whole class had corona and then I had to stay home. And then I got really sick and I had to puke a lot. Nasty. Not nice."*. Another child talked about their experiences with the COVID measurements: *"Well corona was a nasty period. We were at home all the time and not at school so I started to get bored and I couldn't really do anything. I wasn't really allowed to go outside. I haven't been so much sick but just not nice. Certainly doing nothing all the time actually is just boring."*. Some children also expressed being afraid of themselves or their *parents* getting sick *"Yes sometimes [I was afraid]. My father was also in the hospital and he has heart problems so you hope he doesn't die"*

The pandemic also affected *school* attendance, and correspondingly, how participants were playing with *friends*. Having to stay home due to the COVID measures made them see friends less because they would typically only see them at school: *"I miss my girlfriends and then you come to school and then you see them and then you go straight to them."* They could, however, play with friends and call them online: *"Well, I have seen them less often, but I have spoken to them a lot through online gaming and through chatting and calling, etc."* For some other participants the COVID measures had no effect on playing with friends. One child says that because of the school closings and them being done with school work earlier than a typical school day, they had more time to meet and play with friends: *"I could see them more often because we didn't have to go to school and classes finished earlier."*

The participants talked about *'Home'* mainly in two ways, namely that they either were home a lot or that they were home-schooled during the pandemic due to the COVID measures in place. Having school at home was paired with having homework, and their parents would often help with that. This made school easier for some but harder for others given varying levels of their parents competence in explaining the learning materials. (*"Well the class had to stop. I thought that was really stupid because it meant I couldn't see my friends. And it was much more difficult because you didn't get a good explanation from the teacher. And also we could only see each other on the computer, I didn't like that at all."*). Most participants liked to be home-schooled by their parents because they were spending more time together, but not every child felt that way *"Well, my father and mother were always home and it was nice, but I didn't like it too much because I also wanted to learn at school myself. But for the rest it was fine."*. However, not all the parents were at home (more often) during the pandemic (*"My parents were not home more often during COVID because they do special work"*).

The remaining conversation topics were labeled as *'Other'*, and include mainly questions from participants to a nearby person or comments to and about the robot. These topics include characteristics of the conversation and relationship development with the robot, such as asking the robots age, and comments on participant's perception of the robot (e.g., *"You're welcome sir. That's okay Mr. Nao. Good luck, will miss you. Thank you, at least you're still shorter than me."*.

The differences in the conversation themes and how much is said between the two robots were minimal. One notable difference was in giving a direct opinion about the COVID disease itself (e.g., *"COVID was a nasty period"*). This happened 12 times and total, of which 11 times this was done was in a conversation with the robot-like robot. Another notable difference was in sharing their experience during the pandemic. This was done in a conversation with the human-like robot 25 out of 40 times total over both conditions.

In conclusion, it seems that the majority of children almost immediately have a kind of relationship of trust with the robot to share unpleasant experiences about current themes (such as COVID). The child's conversations with the robot provide a rich picture of their perception of the world (school, parents, friends and home situation).

D. Other Observations

After debriefing the participants on the COVID topic of the conversation, some participants did not want to participate in the study anymore. Some participants did not want or could not say anything about certain topics. Some others seemed unsure about certain topics. A few participants also said they could say more about something (after the question if they could elaborate about a certain topic) but then did not say more.

V. Discussion

Self-disclosure is an essential aspect of interpersonal communication, and for relationship development specifically. The research that has been done in the field of Human-Robot Interaction and self-disclosure is mostly focused on adults. In our study, investigating self-disclosure in conversations between robots and children, has provided insights in what kind of robots are best suited for relationship building with children to ensure satisfying child-robot interactions and cooperations. This is important for robots to effectively support children in the education and healthcare domain.

In the field of child-robot interaction, the effects of child personality, robot persona, and conversation topic on child's self-disclosure are still unclear. This paper presents a real-world study on child's self-disclosure in a first one-on-one

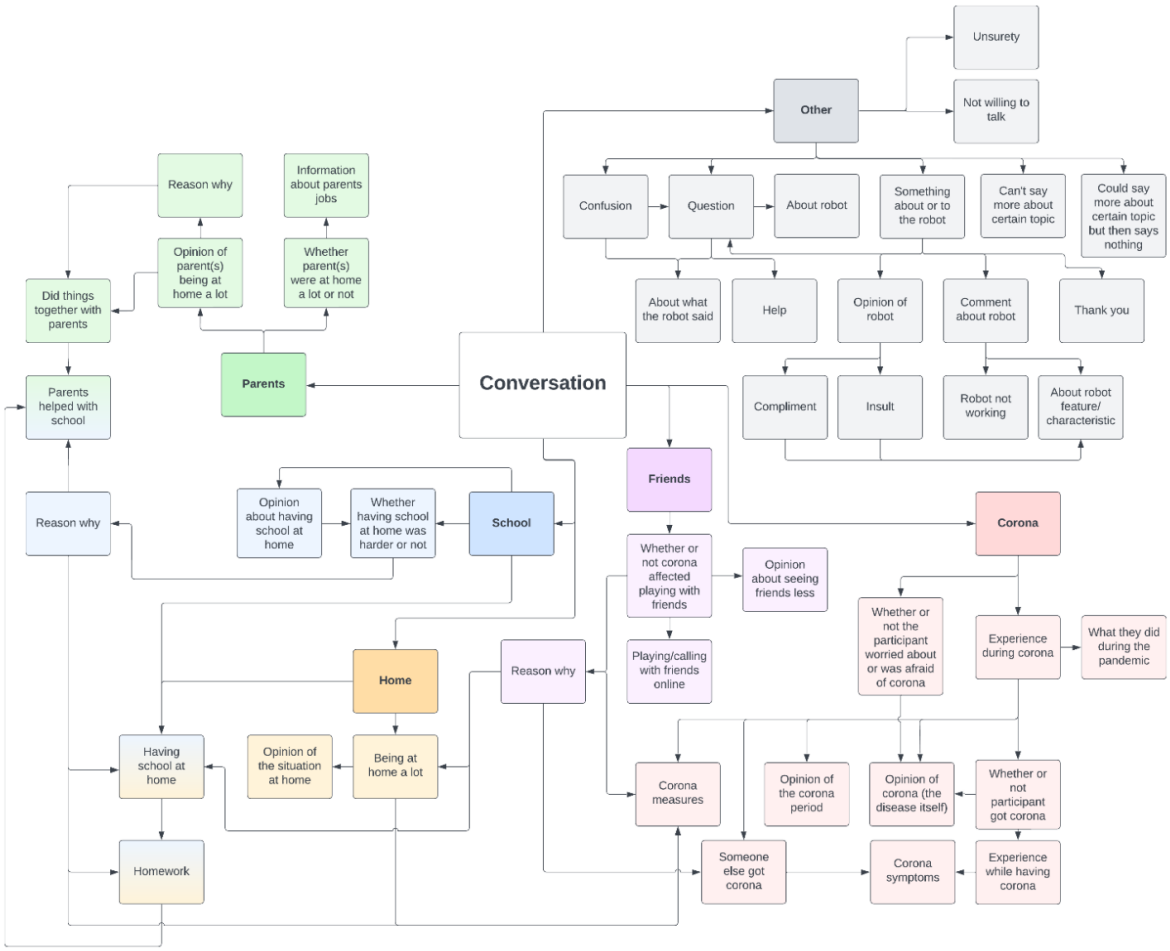


Fig. 5: Outcome overview of the thematic analysis: Children's world of COVID-experiences at home and school, with family and friends, and corresponding characteristics of the conversation with the robot.

encounter with a robot at a science festival which generated several interesting findings.

First, we found that children tend to tell more (in word count) about their attitudes and opinions compared to other conversation topics such as school. These findings further emphasize our previous results on self-disclosure in adult human-robot interaction where we reported that adults talk more about attitudes and opinions as well in a similar setting [32].

Second, we found that children would speak longer with a robot-like robot persona, compared to a human-like robot (in conversation duration). Based on previous research [33], we expected that children would disclose more to a human-like robot. According to the Expectancy Violation Theory [7], this might be because the robot-like robot would behave more in line with what the children were expecting, causing them to feel more comfortable during the interaction. Another reason for this finding could be that a child would feel even less judged by a robot expressing more robot-like behaviour as compared to a human-like robot [26].

Third, we found an effect of Big-5 personality traits on the amount of self-disclosure in a child-robot interaction. The amount of conscientiousness had a positive effect on self-disclosure, while extraversion had a negative effect on self-disclosure (on word count). This contradicts previous research in a similar setting with adults [32], where we found adults scoring higher on the personality characteristic extraversion having longer duration conversations with the robot, and adults scoring higher on conscientiousness having shorter conversations. In previous research, it was found that more extraverted children usually self-disclose more, also towards robots [24]. In our study, the negative relationship could be explained because the extraversion levels of the robot might not have matched the level of extraversion of the participant [8].

Finally, our thematic analysis shows that the majority of children almost immediately have a trusting relationship, enabling them to share personal experiences on contemporary topics such as COVID. The discussed themes provide us with insights in how they experience the world (school, parents, friends and home situation). On the one hand, this offers interesting opportunities to "empower" children (self-awareness about the situation) with a "robot buddy" as support. On the other hand, this places high demands on

the social embedding and intelligence of the robot in order to handle the information responsibly (e.g. privacy) and prevent possible negative consequences of self-disclosures.

A. Limitations

Real-world research is still lacking in the field of HRI, which emphasizes the added value of our field study. However, we did encounter some challenges in our real-world study set-up. For example, the research location was quite noisy and busy, which might have impacted the concentration and feeling of privacy of the participants. Additionally, the participants knew they were being filmed and recorded, which might have influenced their behaviour. Finally, we encountered some technical issues such as robot errors. While this is the reality of dealing with robots and this could also happen in more natural circumstances, it did lead to incomplete interactions that had to be removed from our dataset for final analysis. Also, not all children felt comfortable talking about COVID and therefore already dropped out of the study before talking to the robot.

Our analysis of the Godspeed questionnaire results revealed no discernible differences in participants' perceptions of robots with human-like or robot-like personas. However, we did observe a significant difference in conversation duration between the two robot conditions. It is possible that the effect of robot persona on conversation duration occurred on an unconscious level, which is difficult to capture through self-reported measures [23]. Regarding robot perception, the physical embodiment of the robot may have contributed to the similar results for both conditions.

Despite the limitations of the field study, there were no major issues during the interactions, resulting in successfully collecting data of 76 children.

B. Future Work

Our current findings point to several future research directions. An interesting question that arises from our research is why the conversations with the robot-like robot were significantly longer than the conversations with the human-like robot. Future research should further investigate potential causal effects of robot persona's or childrens' reasoning behind some of the findings reported in this paper.

For future research, we would recommend running the field study in a different, more private setting, to study the effects of more privacy on self-disclosure. Moreover, elaborated speech settings could enhance conversation quality by making the questions and answering bi-directional and, with that, appear less like an interview and more in line with a natural conversation.

Self-disclosure is important to the development of relationships. Relationships develop over time, however, and the longer people spend time with each other the more they disclose to each other [1], which then leads to stronger relationships again. The interaction with the robot was at first encounter. The results could be different if multiple or later encounters are researched. Also, the group of participants was randomly split in two groups, one per robot behaviour. It would be interesting to know what the results of the field research would be if all children had a conversation with both robots. Some personality types might prefer different types of robot personas, since humans tend to prefer others with similar characteristics as themselves [8], which is also the case in HRI [42]. Additionally, the effects of personality traits on the amount of self-disclosure only appeared after cases with parent and/or sibling input in the interaction were removed. For future work, it would be interesting to dive deeper into the influence of bystanders on the amount and content of self-disclosure taking place.

Another interesting result include the 'Other' category of our thematic analysis. These category described different comments that we could not categorize under the main themes, but might include indications of the relationship development between the child and the robot (for example, compliments/insults, expressions of confusion, thanking the robot). These expressions might include potential barriers and facilitators for self-disclosure. It would be interesting to study this in more detail for future research, to see whether these expressions can be seen as vocal indications of the child-robot relationship development.

VI. Conclusion

This paper presents results on the effects of child personality, self-disclosure category, and robot persona (human-like vs. robot-like) on child's self-disclosure.

First, the effect of Big-5 personality traits on the self-disclosure of a child was studied. We found a positive effect of conscientiousness on word count, meaning that more conscientious children would disclose more. Also, we found a negative effect of extraversion on self-disclosure, contradicting previous research. This emphasizes the need for future research on the effect of child personality in CRI.

Regarding robot persona, a statistically significant difference was found between the robot-like and human-like robot, regarding average duration of the conversation. Conversations between children and the robot-like robot tended to last significantly longer than conversations between children and the human-like robot.

Additionally, we found a difference between the categories of 'School' and 'Attitudes and opinions', where children would talk more about 'Attitudes and opinions'. This is in accordance with previous research with adult participants [32].

A thematic analysis shows that, while we found no outstanding differences between robot personas, children generally immediately feel comfortable sharing unpleasant experiences about current themes, such as COVID.

Acknowledgements

We would like to thank the visitors and organizers of Expeditie NEXT festival, as well as Harriët de Groot, Merel van den Berg, Vivian Vriezekolk, Ruud de Jong, and Johanne Pielage for their help in executing the study.

REFERENCES

[1] I. Altman and D. A. Taylor, *Social penetration: The development of interpersonal relationships.* Holt, Rinehart & Winston, 1973.

[2] R. Ambrose, S. Askew, W. Bluethmann, and M. Diftler, "Humanoids designed to do work," in *2nd International IEEE/RAS Conference on Humanoids*, no. JSC-CN-6991, 2001.

[3] C. Bartneck, D. Kulić, E. Croft, and S. Zoghbi, "Measurement instruments for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots," *International journal of social robotics*, vol. 1, pp. 71–81, 2009.

[4] T. Belpaeme, J. Kennedy, A. Ramachandran, B. Scassellati, and F. Tanaka, "Social robots for education: A review," *Science robotics*, vol. 3, no. 21, p. eaat5954, 2018.

[5] D. Buhrmester and K. Prager, "Patterns and functions of self-disclosure during childhood and adolescence." 1995.

[6] F. Burger, J. Broekens, and M. A. Neerincx, "Fostering relatedness between children and virtual agents through reciprocal self-disclosure," in *Benelux conference on artificial intelligence*. Springer, 2016, pp. 137–154.

[7] J. K. Burgoon, "A communication model of personal space violations: Explication and an initial test," *Human communication research*, vol. 4, no. 2, pp. 129–142, 1978.

[8] D. Byrne, W. Griffitt, and D. Stefaniak, "Attraction and similarity of personality characteristics." *Journal of Personality and social Psychology*, vol. 5, no. 1, p. 82, 1967.

[9] A. Coninx, P. Baxter, E. Oleari, S. Bellini, B. Bierman, O. Henkemans, L. Cañamero, P. Cosi, V. Enescu, R. Espinoza *et al.*, "Towards long-term social child-robot interaction: using multi-activity switching to engage young users," *Journal of Human-Robot Interaction*, 2016.

[10] P. C. Cozby, "Self-disclosure: a literature review." *Psychological bulletin*, vol. 79, no. 2, p. 73, 1973.

[11] K. Dautenhahn, "Robots as social actors: Aurora and the case of autism," in *Proc. CT99, The Third International Cognitive Technology Conference, August, San Francisco*, vol. 359. Citeseer, 1999, p. 374.

[12] J. Dawe, C. Sutherland, A. Barco, and E. Broadbent, "Can social robots help children in healthcare contexts? a scoping review," *BMJ paediatrics open*, vol. 3, no. 1, 2019.

[13] M. M. A. De Graaf and S. Ben Allouch, "The evaluation of different roles for domestic social robots," in *RO-MAN 2015*. IEEE, 2015, pp. 676–681.

[14] F. Eyssel, R. Wullenkord, and V. Nitsch, "The role of self-disclosure in human-robot interaction," in *2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*. IEEE, 2017, pp. 922–927.

[15] M. P. Fitzgerald, "Self-disclosure and expressed self-esteem, social distance and areas of the self revealed," *The Journal of Psychology*, vol. 56, no. 2, pp. 405–412, 1963.

[16] J. Goetz, S. Kiesler, and A. Powers, "Matching robot appearance and behavior to tasks to improve human-robot cooperation," in *RO-MAN 2003*. IEEE, 2003, pp. 55–60.

[17] S. Hashimoto, S. Narita, H. Kasahara, K. Shirai, T. Kobayashi, A. Takanishi, S. Sugano, J. Yamaguchi, H. Sawada, H. Takanobu *et al.*, "Humanoid robots in waseda university—hadaly-2 and wabian," *Autonomous Robots*, vol. 12, pp. 25–38, 2002.

[18] A. Hentout, M. Aouache, A. Maoudj, and I. Akli, "Human–robot interaction in industrial collaborative robotics: a literature review of the decade 2008–2017," *Advanced Robotics*, vol. 33, no. 15-16, pp. 764–799, 2019.

[19] C. E. Hill and S. Knox, "Self-disclosure." *Psychotherapy: Theory, Research, Practice, Training*, vol. 38, no. 4, p. 413, 2001.

[20] S. M. Jourard, "Self-disclosure and other-cathexis." *The Journal of Abnormal and Social Psychology*, vol. 59, no. 3, p. 428, 1959.

[21] ——, *The transparent self*. Van Nostrand Reinhold Company, 1971.

[22] S. Lee, I. Y. Lau, and Y. Hong, "Effects of appearance and functions on likability and perceived occupational suitability of robots," *J. of Cognitive Engineering and Decision Making*, vol. 5, no. 2, pp. 232–250, 2011.

[23] Y. Li, F. Broz, and M. Neerincx, "Human-or machine-like music assistive robots effects on fluency and memory recall," in *Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction*, 2023, pp. 167–171.

[24] M. Ligthart, T. Fernhout, M. A. Neerincx, K. L. van Bindsbergen, M. A. Grootenhuis, and K. V. Hindriks, "A child and a robot getting acquainted-interaction design for eliciting self-disclosure," in *Proceedings of the 18th international conference on autonomous agents and MultiAgent systems*, 2019, pp. 61–70.

[25] R. Looije, M. A. Neerincx, and V. d. Lange, "Children's responses and opinion on three bots that motivate, educate and play," 2008.

[26] G. M. Lucas, J. Gratch, A. King, and L.-P. Morency, "It's only a computer: Virtual humans increase willingness to disclose," *Computers in Human Behavior*, vol. 37, pp. 94–100, 2014.

[27] B. F. Malle, M. Scheutz, J. Forlizzi, and J. Voiklis, "Which robot am i thinking about? the impact of action and appearance on people's evaluations of a moral robot," in *2016 11th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. IEEE, 2016, pp. 125–132.

[28] I. Mervielde, F. De Fruyt, and B. De Clercq, *HiPIC: Hiërarchische Persoonlijkheidsvragenlijst voor Kinderen*. Hogrefe, 2009.

[29] Y. Moon, "Intimate exchanges: Using computers to elicit self-disclosure from consumers," *Journal of consumer research*, vol. 26, no. 4, pp. 323–339, 2000.

[30] A. J. Mullaney, *Relationships among Self-disclosive Behavior, Personality, and Family Interaction.* Fordham University, 1963.

[31] J. Mumm and B. Mutlu, "Human-robot proxemics: physical and psychological distancing in human-robot interaction," in *Proceedings of the 6th international conference on Human-robot interaction*, 2011, pp. 331–338.

[32] A. Neerincx, C. Edens, F. Broz, Y. Li, and M. Neerincx, "Self-disclosure to a robot" in-the-wild": Category, human personality and robot identity," in *2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*. IEEE, 2022, pp. 584–591.

[33] Y. Noguchi, H. Kamide, and F. Tanaka, "Effects on the self-disclosure of elderly people by using a robot which intermediates remote communication," in *2018 27th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*. IEEE, 2018, pp. 612–617.

[34] E. Phillips, X. Zhao, D. Ullman, and B. F. Malle, "What is human-like? decomposing robots' human-like appearance using the anthropomorphic robot (abot) database," in *Proceedings of the 2018 ACM/IEEE international conference on human-robot interaction*, 2018, pp. 105–113.

[35] A. Powers and S. Kiesler, "The advisor robot: tracing people's mental model from a robot's physical attributes," in *Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-robot interaction*, 2006, pp. 218–225.

[36] L. D. Riek, T.-C. Rabinowitch, B. Chakrabarti, and P. Robinson, "Empathizing with robots: Fellow feeling along the anthropomorphic spectrum," in *2009 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops*. IEEE, 2009, pp. 1–6.

[37] L. Robert, "Personality in the human robot interaction literature: A review and brief critique," *Proceedings of the 24th Americas Conference on Information Systems*, pp. 16–18, 2018.

[38] F. O. Soares, S. C. Costa, C. P. Santos, A. P. S. Pereira, A. R. Hiolle, and V. Silva, "Socio-emotional development in high functioning children with autism spectrum disorders using a humanoid robot," *Interaction Studies*, vol. 20, no. 2, pp. 205–233, 2019.

[39] D. Walker and F. Myrick, "Grounded theory: An exploration of process and procedure," *Qualitative health research*, vol. 16, no. 4, pp. 547–559, 2006.

[40] L. Watteyne, "Een multi-informantstudie van temperament en persoonlijkheid bij 6-7 jarigen gebaseerd op een computergestuurd handpopinterview, het vijf factoren model en het model van rothbart en derryberry." Master's thesis, Ghent University, Belgium, 2009.

[41] J. Weizenbaum, "Eliza—a computer program for the study of natural language communication between man and machine," *Communications of the ACM*, vol. 9, no. 1, pp. 36–45, 1966.

[42] S. Whittaker, Y. Rogers, E. Petrovskaya, and H. Zhuang, "Designing personas for expressive robots: Personality in the new breed of moving, speaking, and colorful social home robots," *ACM Transactions on Human-Robot Interaction (THRI)*, vol. 10, no. 1, pp. 1–25, 2021.

[43] M. Worthy, A. L. Gary, and G. M. Kahn, "Self-disclosure as an exchange process." *Journal of personality and social psychology*, vol. 13, no. 1, p. 59, 1969.

[44] X. Zhao, C. Cusimano, and B. F. Malle, "Do people spontaneously take a robot's visual perspective?" in *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction Extended Abstracts*, 2015, pp. 133–134.