RoboTales: Exploring Believability and Ethics in Preadolescent-Robot Interactions

Rafaëlla Maria Alexandra van Nee[1]

Vrije Universiteit Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam, Netherlands
r.m.a.van.nee@student.vu.nl
Student Number: 2648197
Vunet id: rne330

Abstract. This paper explores how preadolescents perceive the believability of narratives delivered by social robots and provides ethical guidelines to ensure responsible interactions. Comprehensive insights were obtained using a combination of quantitative and qualitative techniques, such as a literature study, experiments, and an expert interview. Furthermore, attention is drawn to how age affects perceived believability, as well as the role cognitive development plays in influencing these views. The development of ethical guidelines aimed to ensure that children and robots could interact in a way that was both safe and supportive by addressing important issues such as informed consent, privacy, data protection, and emotional well-being. A user study (N = 99, 8-11 y.o.) provided insights into factors affecting believability, such as concrete narrative components that align with pre-existing perceptions of robots. The research aims to pave the way for a harmonious coexistence between children and robots, where robots serve as facilitators of learning and growth rather than mere tools.

Keywords: Human-Robot Interaction · Narrative Believability · Ethics · Preadolescents · Social Robots

1 Introduction

Ethos is an important concept in rhetoric that comes from philosopher Aristotle. It's about how believable or ethical a speaker or writer seems. At its core, employing ethos means convincing your audience that you're believable and knowledgeable about a topic. Believability is achieved by demonstrating ethical behaviour and expertise and expressing goodwill towards the audience. Ethos is one of the trio of artistic proofs in rhetorical persuasion, alongside pathos and logos. Similarly, believability in narratives depends on emotional impact, consistency, and persuasive power, all essential for truly engaging an audience.

In recent years, the seamless integration of robotic technologies into the tapestry of everyday human activities has marked a profound transformation in human-technology interactions. This transition is especially challenging for vulnerable groups, such as preadolescents [1]. As they navigate the delicate threshold between childhood and adolescence, their interactions with technology hold the potential to shape their developmental journey significantly. With robots increasingly assuming roles that take on more personal interactions, such as storytelling or educational activities, understanding how preadolescents perceive these interactions becomes vital [2], [3]. Given their developing cognitive and emotional capacities, this age group provides a unique perspective on robotic interactions' authenticity and overall impact. In much the same way that ethos underscores the importance of believability and ethical behaviour in winning over an audience, the success of robotic interactions with preadolescents depends on these machines' perceived trustworthiness and consistency.

This paper addresses the research question: How do preadolescents perceive the believability of narratives delivered by robots, and what ethical guidelines are necessary to ensure responsible interactions in these settings? To further refine our understanding, the study addresses the following subquestions: What factors contribute to the believability of narratives delivered by robots to children, including the characteristics of the robot, the narrative features, and the children's age? And, from the perspective of preadolescents, what makes a narrative delivered by robots potentially harmful, and under what conditions do these narratives cross ethical boundaries? These questions are more than academic; they also hold significant implications for integrating social robots into environments where children frequently spend their time. Social robots are designed to interact with people directly, setting them apart from other robotic equipment and giving them an opportunity to affect children's experiences and perceptions [4]. By engaging with children in social contexts, these robots can provide personalized learning experiences and emotional support, fostering a more interactive and supportive environment.

To investigate the research question, we conducted a study exploring how preadolescents perceive the believability of narratives delivered by social robots, using both quantitative and qualitative research methods to provide comprehensive insights. Initially, a literature study was undertaken to identify key factors and existing research in the field of Human-Robotic Interactions (HRI). Subsequently, experiments were conducted with preadolescent participants interacting with robots. The experiments were designed to measure the perceived believability of robot-delivered narratives during storytelling sessions. Based on these insights, combined with literature research and an expert interview, ethical guidelines were made to ensure responsible and supportive interactions between robots and children.

The findings of this study can guide curricula design, shape educational policies, and inspire the development of future robotic companions adapted to the specific needs of children. Grasping these concepts is important as several factors can shape children's perceptions of authenticity, including the robot's design, interactive features, and communicative and responsive demeanour during narrative sessions [5], [6], [3], [7]. These characteristics can either enhance or diminish the child's level of engagement and trust in the robot. Understanding and integrating these factors is not merely technical but also philosophical, bridging the gap between technology and the human experience. It challenges us to reflect on how technology shapes our understanding of ourselves and our relationships with the world.

The nature of this research, intertwining robotics, education, psychology, and ethics, underscores the importance of a holistic approach to designing and deploying robotic systems. This method ensures that technological breakthroughs meet children's ethical and developmental demands. Through this research, we aim to contribute to the growing field of HRI by providing insights into preadolescent views and proposing frameworks for ethical involvement. Particularly, this paper seeks to fill gaps in current research that have not yet thoroughly addressed the need to protect children as they interact with advanced technology. By examining how preadolescents perceive the authenticity of robotic interactions, we aim to understand key aspects of trust and emotional connection.

2 Related Work

In exploring human-robot interactions, particularly concerning narrative applications for preadolescents, a diverse body of research forms the foundation of our current understanding. Building on this foundation, the concept of 'suspension of disbelief' becomes meaningful, especially in narrative contexts performed by robots. This term, coined by S. Coleridge, suggests that audiences are prepared to put aside scepticism in pursuing pleasure in a narrative [8]. S. Coleridge was convinced that if a narrative emits "a human semblance or atmosphere of truth", it will enable readers to "suspend disbelief" and lose themselves in the narrative. The principle becomes particularly relevant when exploring new interactions, such as narratives delivered by robots and robot characteristics.

2.1 Robot Characteristics

Careful attention to character design is essential to enhance the believability and effectiveness of these interactions [9], [10]. J. Xu emphasizes the importance of character design in boosting narrative believability. He discovered that participants' levels of trust were higher when they perceived robots as having human-like traits [11]. This includes having expressive eyes, a mouth that can mimic speech, and facial expressions that can display a range of emotions. A robot designed with human-like features can significantly enhance the suspension of disbelief among humans, especially children.

The incorporation of human-like characteristics into robots has significant ethical implications, particularly in terms of robotic design. Ensuring that human-robot interactions are comfortable and building trust—rather than frightening—requires certain design decisions. Central to this issue is the uncanny valley phenomenon. This phenomenon occurs when robots look almost human but have slight imperfections that cause discomfort or eeriness. To mitigate this effect, robots should be designed aesthetically pleasing yet not overly realistic [12], [10]. Rather than being angular and mechanical, a robot's appearance should be approachable and friendly, with soft, inviting features to enhance the overall perception and comfort between human-robot interactions. By making robots look less like machines and more like friends, the texture and stiffness of robots' surface materials should also be carefully considered [13]. This can assist in lessening any possible anxiety or fear in children. Moreover, one of the main factors influencing human discomfort during human-robot interactions is perceived uncertainty in a robot's movement [14]. Ensuring that robots move predictably and smoothly can significantly enhance comfort and trust in these interactions.

Furthermore, the storytelling experience can be greatly enhanced by a robot's ability to modulate its voice, changing pitch, tone, and tempo to suit different characters or dramatic moments [15]. This vocal expressiveness makes the story more believable and captivating by drawing children further into the narrative world and encouraging them to suspend disbelief. Maintaining this delicate balance can be achieved by designing robots with a well-balanced combination of human-like and robotic features so that children find them interesting and believable without discomfort.

Another important factor that makes robot interactions more credible is their ability to respond in real-time. A robot that can respond to a child's questions, body language, or facial expressions in a prompt and suitable way gives the impression that it is present and paying attention [16]. Real-time responsiveness enhances the conversational and organic feel of the exchange while also supporting the coherence and plausibility of the storyline. This aligns with S. Coleridge's ideas about creating an authentic story setting [8]. Thus, the robot's ability to respond swiftly supports its effectiveness as an educational tool. It confirms its capacity to deliver compelling and realistic stories that captivate young audiences, consistent with S. Coleridge's focus on fostering deep engagement through lifelike interactions.

2.2 Robotic Narratives

T. Beelen further explored the relationship between children's trust in robots and the information they provide, finding that trust in the robot did not necessarily lead to acceptance of its information [17]. This suggests a complex dynamic where the believability of the robot's character plays a crucial role. Still, other factors, such as the content's relevance and accuracy, are also vital in determining whether children accept the information presented. Adding interactive components that let children react and feel heard can enhance the narrative experience, making it more captivating and immersive [18]. This is supported by M. Ligthart, who reported that allowing children to make choices and share their thoughts could improve their involvement and agency in storytelling interactions with robots, indirectly influencing how believable children find the robot [6]. By carefully considering these factors, designers can create robotic storytellers that capture children's imaginations and establish a foundation of trust and engagement, resulting in more effective and meaningful interactions.

Additionally, fusing reflective storytelling techniques with a preference for realistic narratives can increase children's emotional engagement with robotic storytellers, making the stories more convincing and effective [19]. The distinctions children make between factual and imaginative content offer a roadmap for developing robotic narratives that are both informative and engaging. Understanding this is beneficial for our research, helping to shape narratives that are both believable and educationally valuable.

Furthermore, research on preadolescents' perceptions of robot-delivered narratives indicates that they generally have a positive attitude towards these robots [2]. Studies have shown that robot-assisted storytelling can lead to positive outcomes for preadolescents. For instance, C. Hsieh found that children pay more attention to, enjoy, and feel more independent when interacting with a storytelling robot [20]. Additionally, Ligthart et al. found that giving robots memory-based personalisation techniques helps create positive social cues and a sense of closeness while also sustaining children's curiosity over time [21]. This is important because it highlights how personalized interactions can make robots more engaging and relatable to children, thereby enhancing their overall believability. Believability plays a key role here, as making robots appear more lifelike and relatable significantly enhances how preadolescents perceive their narratives, thus boosting their effectiveness in storytelling and educational contexts. Despite these advancements, significant gaps remain in our understanding of how narrative engagement through robots can be optimized. For example, there is limited research on effectively tailoring robotic narratives to different developmental stages, ensuring that the content is age-appropriate and engaging. As A. Peebles et al. observes, from early childhood through adolescence, children's cognitive and social skills develop and change, influencing their interactions and preferences [22]. Tailoring robotic storytelling to align with these developmental stages can ensure the content is age-appropriate and engaging. In doing so, we increase the level of trust and impact of the narratives delivered by robots, creating stories that children can truly immerse themselves in. Our research attempts to significantly contribute to this important field by creating methods for effectively adapting robotic narratives to various developmental stages.

2.3 Ethical Considerations

The ethical landscape in human-robot interactions with children involves safeguarding children's privacy, ensuring their autonomy, and managing the robot's influence. Children's vulnerability to manipulation and persuasion and the need for ethical standards to protect them are complex issues, making it imperative to adopt ethical norms that protect them while fostering a positive interaction experience [23], [24], [25].

E. Velner's research unveils an innovative approach to maintaining ethical standards through real-time trust monitoring and robotic interventions. This approach solves any ethical quandaries dynamically, guaranteeing that children's interactions with robots are constantly monitored and changed to avoid any violations of ethical behaviour [26]. Such approaches are essential for creating an atmosphere where children may interact securely and benefit from robotic technologies. This is especially pertinent to our question about developing ethical rules to enable the appropriate use of believable narratives in child-robot interactions. The method assures ethical considerations are built into the technology, allowing for fast changes tailored to the children's real-time replies. A proactive approach can considerably limit the possibility of robotic narratives being misused or hurting children, creating a safe atmosphere and promoting beneficial educational and developmental outcomes.

Additionally, L.J. Hubbard expands the discussion to include robots' ability to encourage contemplative storytelling and creative play, both of which are necessary for emotional and cognitive growth. This perspective emphasises that robots can deeply and meaningfully interact with children and support their developmental journeys instead of just delivering information [19]. The integration of reflective storytelling into robotic interactions implies that these technologies have the potential to go beyond mere narrative delivery, encouraging greater emotional and intellectual involvement. This perspective underpins our exploration into how narratives delivered by robots can resonate deeply with preadolescents, fostering both believability and engagement.

Furthermore, as children forge bonds with robots and increasingly rely on them for education and companionship, it's fundamental to keep an eye on and evaluate these interactions all the time. This continuous monitoring ensures that robots don't unintentionally reinforce bad habits or dependencies and instead help children grow. Drawing from S. Nyholm's insights, a key point to be gained is the significance of differentiating between robotic and human minds. Although it's common for people, particularly preadolescents, to think that robots and people have similar minds, it's vital to recognise that people and robots have different inner lives. Only then can moral guidelines be developed that prevent undue emotional attachments or excessive reliance on robots [27]. Establishing a framework for ongoing ethical assessment makes it possible to modify laws in response to new knowledge, guaranteeing that robotic technologies continue to be helpful and safe even as children's needs change.

Even with such enhancements, there are still significant gaps. One significant knowledge gap is the inability to effectively adapt robotic narratives to various developmental stages so that the content is interesting and age-appropriate. Children's preferences and interactions with robots change as their cognitive and social skills develop from early childhood through adolescence, underscoring the need for flexible storytelling techniques. Ensuring that the content is age-appropriate safeguards children from exposure to sensitive or complex material that may be too advanced for their developmental stage while promoting effective learning and engagement. Another gap lies in the ethical incorporation of these technologies in educational settings. Data security, privacy, and the possibility of relying too much on robotic systems at the expense of human connection are examples of ethical problems. To ensure that the employment of robotic storytelling complies with the highest standards of child protection and educational integrity, addressing these ethical difficulties calls for extensive guidelines and regulations. This focus on ethical guidelines is particularly relevant to our research, as it underscores the importance of developing frameworks that ensure the safe and effective use of robotic systems. By combining our study with these considerations, we can more effectively build robotic systems that are both technologically adept and culturally and ethically resonant, maximising the educational benefits of such encounters while minimising potential risks.

3 Research Questions and Hypothesis

Our research investigates preadolescents' perceptions of the believability of robot narratives and the necessary ethical guidelines for responsible interactions. The primary objectives are to define norms for ethical behaviour and comprehend how narrative components affect believability. The purpose of the research questions and hypotheses is to investigate these themes. Therefore, our research question is:

> *How do preadolescents perceive the believability of narratives delivered by robots, and what ethical guidelines are necessary to ensure responsible interactions in these settings?*

Additionally, we have these hypotheses to explore:

- **H1:** We expect that as children grow older, the believability of robots decreases.
- **H2:** We expect that contextually relevant narratives will increase the perceived believability of the narrative.

4 Methods

This study investigated preadolescents' perceptions of the believability of robot narratives. Additionally, we aimed to gather information to create ethical guidelines for ensuring responsible and supportive interactions between robots and children. Two primary methods were used to achieve this goal: an expert interview and a user study.

4.1 Expert Interview

Purpose and Design The interview aimed to gain detailed insights into different dialogue techniques that effectively increase children's perception of believability in robot narratives while ensuring ethically sound interactions. This component addressed the research question: What ethical guidelines are necessary to ensure responsible interactions in child-robot interactions? And, what makes a narrative delivered by robots potentially harmful, and under what conditions do these narratives cross ethical boundaries? Qualitative data was obtained through an interview with a professional in the field.

Procedure The interview was conducted in person and recorded for detailed analysis. The expert was asked several questions about dialogue strategies, effective and ineffective interaction strategies, age differentiation, and ethical considerations. The appendix contains the questions that were asked during the interview.

4.2 User Study

Participants This study involved 99 students aged between 8 and 11 from two different schools in the Netherlands. Before participation, parental and child consent were obtained, guaranteeing compliance with ethical standards regarding the involvement of minors in research. This component addressed the research question: How do preadolescents perceive the believability of narratives delivered by robots, and how does age variation affect this perception?

Experimental Design The study employed a between-subjects design for two sessions. Every session was designed to measure the participant's responses and interactions with the robot.

Materials A range of materials was utilized for this study.

- **Robot (NAO):** The NAO robot Leo, a programmable social humanoid robot, delivered the narratives. The robot had pre-programmed dialogues and interactive capabilities to effectively engage the participants. The robot's design and functionalities were tailored to create an engaging storytelling experience.
- **Books:** Books that were appropriate for the study's age were selected. Each child was given a book to read and discuss with the robot during the sessions.
- **Questionnaires:** Digital post-interaction questionnaires were created to evaluate children's perceptions of several factors, such as how believable the robot narratives were. These questionnaires were structured to capture both immediate reactions and reflective insights

Procedure Several steps were taken to prepare for the study. All necessary software was launched during the initialization phase. Participants were then briefed about what was expected of them during their interactions with the robot. This briefing was designed to be both engaging and informative, aiming to ensure that the participants felt comfortable and ready to participate. Then, they were individually guided to an empty classroom and were instructed to sit on a rug in front of the robot. The researcher remained in the room at a distance to minimize interference.

In **Session 1**, participants were introduced to Leo and had their first conversations with him. Directly after the session, post-session questionnaires were distributed to collect data.

In **Session 2**, participants listened to interactive narratives told by the robot and were invited to contribute to the stories. Post-session questionnaires were distributed directly afterwards to collect data.

Furthermore, participants were exposed to stories delivered by the robot with specific narrative variations designed to test believability. Children were exposed to two distinct narrative conditions. In the Book Narrative Condition, Leo, the robot, explained that it could choose books for the children based on their interests and mentioned having a real bookcase filled with various books. In contrast, the Dream Narrative Condition did not include these elements. Instead, Leo engaged the children in conversations about their dreams and asked if it could visit their dreams the next night. Additionally, both conditions included a neutral statement where Leo claimed, "I can dance by myself." This statement measured the general believability of fantastical elements in Leo's narratives.

Every participant had two sessions, with one of the narrative variations in each. This design allowed us to track shifts in perceptions of believability for the robot's different claims and observe any shifts in the children's believability of the robot. This setup allowed us to compare the perceived believability of narratives that are contextually relevant to book selection versus those that focus on imaginative and fantastical elements like dreams and assess the impact of a neutral fantastical statement on overall believability.

4.3 Measures and Instruments

We created a questionnaire to answer our research question. Each of the four questions on the questionnaires had a five-point Likert scale. The questions were designed to measure the children's perceptions of the robot's capabilities and the believability of the narratives. The original questions used in the questionnaire are in Dutch and can be found in the appendix. The translated questions are as follows:

1. Leo can choose books for children himself.
2. Leo has a real attic full of books.
3. Leo can visit my dreams.
4. Leo can dance by himself.

The fourth question was a control question to measure general believability. The questionnaire aimed to collect participants' honest responses and observations about their interactions with Leo. This helped us understand the immediate and lasting impressions created by the robot's narratives.

4.4 Ethical Considerations

We prioritized children's autonomy. Ensuring the safety and privacy of all participants. The consent process involved the children as well as their parents. Children gave their assent, and parents gave informed consent, guaranteeing that participation was voluntary and predicated on a full comprehension of the goals and methods of the study. Additionally, all of the data was anonymized to safeguard the participants' privacy. Confidentiality was upheld throughout the study by securely storing personal data and limiting access to the research team only. Furthermore, the children's welfare was of utmost importance. Every interaction was watched closely to address any indications of discomfort or distress. To help children feel safe and supported throughout the research process, they were frequently reminded of their right to withdraw from the study at any time. Lastly, The study was carried out following high ethical standards due to the careful observation of interactions and the thorough evaluation of scripts and LLM-generated content. We meticulously reviewed the interaction scripts to ensure all content was age-appropriate and engaging for the children. This involved reading over each script and making necessary adjustments to ensure suitability. The language models (LLMs) generated sentences were tailored for each child and were reviewed for appropriateness. This process ensured that the interactions were respectful and effective, creating a positive and safe experience for the children.

4.5 Assumption Testing

We used the Mann-Whitney U test to ensure a robust analysis of the believability of robot narratives under various conditions. This approach allowed us to accurately determine whether one condition tended to be more believable than the other.

Normality Testing We used the Shapiro-Wilk test to determine whether our data was normally distributed. The findings showed that non-parametric tests were more appropriate because most conditions did not meet the normal distribution criteria. Furthermore, this test ranks the data to compare the distributions of two independent groups rather than comparing means.

Thus, our study was suitable for the Mann-Whitney U test for several reasons: First, the Shapiro-Wilk test results demonstrated that our data did not have a normal distribution. Second, and more appropriate for non-parametric data, the test compares ranks to assess distribution differences. Lastly, it works well with non-parametric and ordinal data, which is similar to the responses on our Likert scale.

5 Results

The following data includes the outcomes of two sessions, emphasising the differences in believability ratings between year groups 5, 6, and 7 and the various questions that measure the believable nature of the robot's narratives. Additionally, the overall believability was evaluated irrespective of age. Furthermore, an ethical guideline was created using an expert interview and related work.

5.1 Results for Overall Narrative Believability

This study employed the Mann-Whitney U test to analyze the differences in the believability of robot narratives between two conditions across all combined year groups (5, 6, and 7). The results for each question are summarized in Table 1.

Table 1. Mann-Whitney U Test Results for Believability Ratings

Question	**U-value**	**p-value**
Q1: Leo can choose books for children himself.	1163.0	0.661
Q2: Leo has a real attic full of books.	794.0	0.002
Q3: Leo can visit my dreams.	1333.0	0.444
Q4: Leo can dance by himself.	1164.5	0.670

Question 1: Leo can choose books for children himself. There was no significant difference in believability ratings between the No Books narrative condition and the Books narrative condition ($U = 1163.0$, $p = 0.661$). This suggests that the believability of the narrative, where Leo claims to choose a book himself, was perceived similarly between the two conditions.

Question 2: Leo has a real attic full of books. There was a significant difference in believability ratings between the No Books narrative condition and the Books narrative condition ($U = 794.0$, $p = 0.002$). This indicates that the believability of the narrative, where Leo claims to have a real bookcase, was perceived differently between the two conditions.

Question 3: Leo can visit my dreams. There was no significant difference in believability ratings between the Dream narrative condition and the No Dream narrative condition ($U = 1333.0$, $p = 0.444$). This shows that the believability of the narrative, where Leo claims to visit the child's dream, was perceived similarly between the two conditions.

Question 4: Leo can dance by himself. This served as a control question; there was no significant difference in believability ratings between the Dancing narrative conditions ($U = 1164.5$, $p = 0.670$). This suggests that the general perception of Leo's dancing ability was consistent across both conditions.

These results show how preadolescents perceive various aspects of robot narratives' believability. In particular, the noteworthy outcome for question 2 implies that believability may be influenced more by some claims about the robot's capabilities than by others.

Additionally, Table 2 summarizes the mean believability ratings for four questions across two sessions, as well as the differences between these sessions. The p-values indicate that there are no significant differences in believability ratings between Session 1 and Session 2 for any of the questions.

Table 2. Overall Differences Between Session 1 and Session 2

Question	Session 1 Mean	Session 2 Mean	Difference	p-value
Q1	4.212	4.162	-0.051	0.905
Q2	3.677	3.818	0.141	0.247
Q3	3.061	3.000	-0.061	0.766
Q4	4.152	4.162	0.010	0.946

5.2 Results in Age Differences

For each year group, the Mann-Whitney U test results indicated varying levels of believability across different questions. The results shown in Figure 1 and Figure 2 give an overview of the perceived believability within the different sessions. This analysis aimed to determine if the conditions had different effects on the perceived believability of the robot's narratives between the year group of the preadolescents. By comparing the responses across these year groups, the test assessed whether there were any statistically significant differences in their believability ratings.

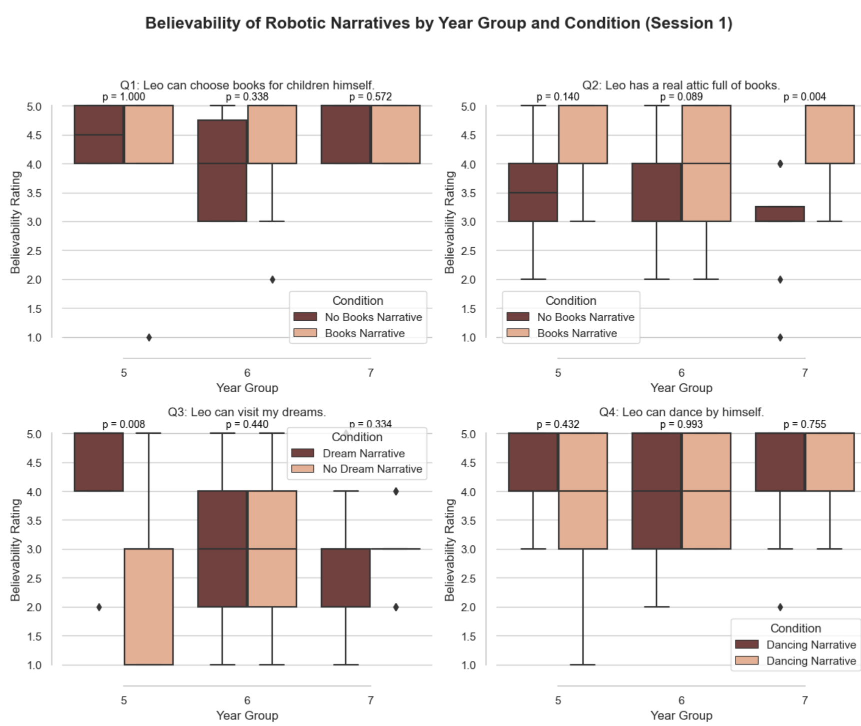

Fig. 1. Results session 1 - Condition & Year Group

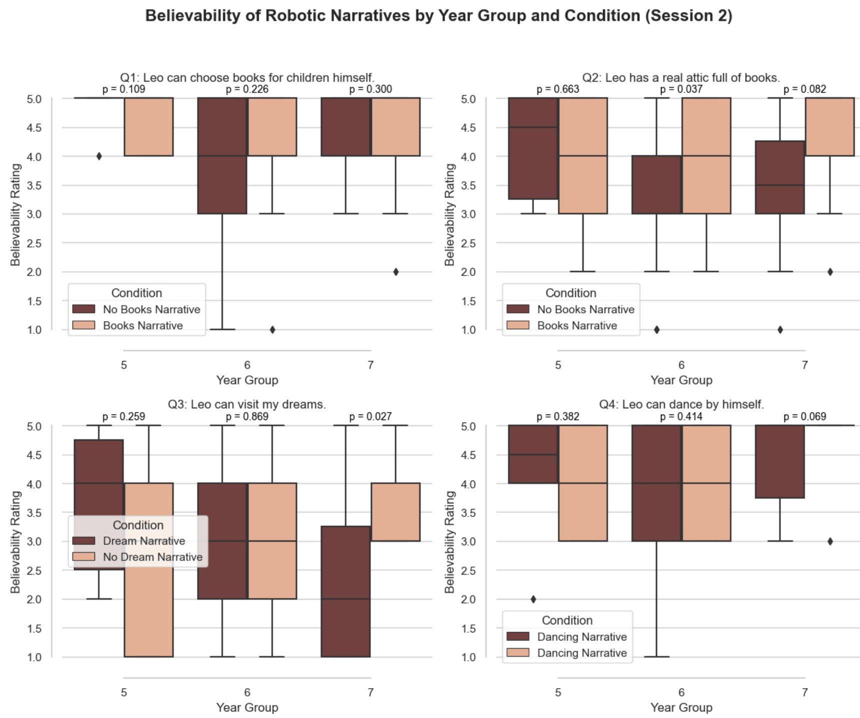

Fig. 2. Results session 2 - Condition & Year Group

Session 1: Question 1: Leo can choose books for children himself. For question 1, the Mann-Whitney U test results show no significant differences in believability across all year groups. The p-values for year groups 5, 6, and 7 were 1.000, 0.338 and 0.572, respectively. This suggests that there is no difference in believability between the two conditions within the different year groups.

Question 2: Leo has a real attic full of books. A significant difference was observed for question 2 in year group 7, with a p-value of 0.004. This result indicates that students in this year group found the claim about Leo having a real book attic more believable in the Books narrative condition than in the No Books narrative condition. There is also a marginally significant difference found for year group 6 with a p-value of 0.089. Although this result did not reach conventional levels of statistical significance, it suggests a trend towards finding the claim about Leo having a real book attic more believable in the Books narrative condition compared to the No Books narrative condition. In contrast, year group 5 did not show a significant difference, with a p-value of 0.140.

Question 3: Leo can visit my dreams. For question 3, a significant difference was observed in year group 5, with a p-value of 0.008. This result suggests that students in this year group found the claim about visiting dreams more believable in the Dream narrative condition compared to the No Dream narrative condition. Year groups 6 and 7 did not show significant differences, with a p-value of 0.440 and 0.334, respectively.

Question 4: Leo can dance by himself. The control question yielded p-values of 0.432, 0.993, and 0.775 for year groups 5, 6, and 7, respectively, indicating that there were no significant differences in any of the year groups. This suggests that the general perception of Leo's dancing skill was constant under all circumstances, acting as a reliable control question.

Session 2: Question 1: Leo can choose books for children himself. For question 1, the Mann-Whitney U test results showed no significant differences in believability across all year groups. The p-values for Year Groups 5, 6, and 7 were 0.109, 0.226, and 0.300, respectively. This indicates that the perception of Leo's ability to choose books was consistent across different age groups.

Question 2: Leo has a real attic full of books. A significant difference was noted for question 2 in Year Group 6, with a p-value of 0.037. This suggests that students in this year group found the claim about Leo having a real attic of books more credible in the Books narrative condition compared to the No Books narrative condition. Additionally, there was a marginally significant difference for year group 7, with a p-value of 0.082. Although this result did not reach traditional levels of statistical significance, it indicates a trend towards believing the claim more in the Books narrative condition compared to the No Books narrative condition. In contrast, year group 5 did not show a significant difference, with a p-value of 0.663.

Question 3: Leo can visit my dreams. For question 3, a significant difference emerged in year group 7, with a p-value of 0.027. This result indicates that students within this year group found the claim about Leo visiting dreams less believable in the Dream narrative condition compared to the No Dream narrative condition. Year groups 5 and 6 did not show significant differences, with p-values of 0.259 and 0.869, respectively.

Question 4: Leo can dance by himself. For question 4, all year groups did not show significant differences, with p-values of 0.382, 0.414, and 0.069, respectively. This acts as a reliable control question.

5.3 Development of Ethical Guidelines

Ensuring responsible interactions between preadolescents and robots requires comprehensive ethical guidelines. These guidelines, developed through an expert interview and a literature study, cover important aspects such as age-appropriate content, privacy, consent, and emotional well-being. Section 5.4 contains the full guidelines, while the interview questions can be found in section B of the appendix. Below, we describe how the interview and related work together led to developing these ethical guidelines.

Interview Results The insightful information obtained from the interview greatly influenced the development of these ethical guidelines for preadolescent robot interactions. The main topics discussed were the significance of data protection and privacy. Furthermore, the discussion points out that children are very aware of technology malfunctions, which is ethically significant as it underscores the need for transparency about the robot's limitations to build trust and the importance of respecting each child's unique needs to promote equitable interactions. Emphasis was also placed on strong data security protocols and openness in the data collection procedures. These steps build trust with both children and their guardians, addressing concerns about data misuse and ensuring the integrity of the interactions.

Another important factor that emerged was informed consent. To make sure that participants are fully aware of the nature of the study and their rights, the interview placed a strong emphasis on the necessity of obtaining consent from both children and their guardians. This strategy ensures that voluntary participation upholds ethical standards while respecting the autonomy of the young participants. The interview results also emphasised children's susceptibility to deceptive practices, highlighting the significance of openness and moral design in robot interactions. The guidelines seek to uphold the integrity and reliability of the robot's interactions by refraining from any manipulative practices. The requirement to identify and handle any indications of distress guarantees that the guidelines safeguard children's mental health by offering a nurturing atmosphere that fosters well-being.

Modifying interactions in a developmentally appropriate way was also felt imperative. According to the interview results, children's interests and cognitive capacities change as they age, so it's important to ensure the robot's content is entertaining and appropriate for various age groups. Furthermore, the interview highlighted the significance of a purpose-driven design and the ongoing assessment of ethical implications. These procedures ensure the technology maintains its ethical integrity while fulfilling a significant educational role and responding to user feedback.

Lastly, it was noted that child protection policies and unambiguous reporting procedures were essential components. By taking these precautions, study participants are protected from possible harm and ethical responsibility is upheld throughout. All in all, the insights from the interview offered a thorough grasp of the moral issues that must be considered when creating educational robot interactions for children. Preadolescent users will benefit from a safe, interesting, and instructive experience when these insights are incorporated into the guidelines, guaranteeing their practicality and alignment with professional recommendations.

Related Work Results The related work also showed important information that impacted the development of these ethical guidelines for interactions between preadolescent robots. There is an emphasis on the necessity of dynamic robotic interventions, and real-time trust monitoring was one important realisation [26]. This approach ensures that interactions are continuously evaluated and modified, fostering a safe environment for children. Incorporating ongoing assessment and real-time modifications into the guidelines ensures that the robot interactions stay morally upright and sensitive to the children's needs.

A noteworthy finding further showed the importance of robots in encouraging imaginative play and reflective storytelling, as these activities are essential for emotional and cognitive development [19]. This perspective influences the ethical guidelines because they highlight the importance of age-appropriate content and educational value. From an ethical standpoint, it is imperative to create robot interactions that encourage and enhance children's developmental paths, encouraging more in-depth emotional and cognitive involvement while ensuring these engagements are enriching.

Additionally, it highlighted the dangers of children developing unwarranted emotional attachments or dependencies on robots. This information was used to inform the guidelines on ethical design and interaction transparency to ensure that children comprehend the nature of robots and don't grow up with unreasonable expectations or dependencies [27]. This was added to the guidelines through thorough training and ongoing communication with guardians, educators, and children to address concerns and guarantee that the implementation is ethically and culturally appropriate.

5.4 Ethical Guideline

Category	**Guidelines**
Privacy and Data Protection	**Data Security:** Implement robust data protection measures to safeguard children's personal information from unauthorized access and misuse.
	Data Minimization: Collect only the required data for the study and ensure it is anonymized wherever possible.
	Transparency: Clearly inform children and their guardians about what data is being collected, how it will be used, and who will have access to it.
Autonomy and Consent	**Informed Consent:** Obtain informed consent from both the children and their guardians before interacting with the robot.
	Voluntary Participation: Ensure that participation is entirely voluntary and that children can opt-out without any negative consequences.

Category	Guidelines
Non-Manipulative Practices	**Transparency in Interactions:** Design robot interactions to be transparent, avoiding any manipulative practices.
	Ethical Design: Ensure that the robot's behaviour is consistent with ethical standards, avoiding manipulative or coercive actions.
Emotional and Psychological Well-being	**Monitor Emotional Impact:** Assess the emotional and psychological impact of robot interactions on children regularly.
	Provide Support: Ensure that a system is in place for children to seek support if they feel uncomfortable or upset.
Age-Appropriate Content	**Developmentally Appropriate Interactions:** Tailor the robot's interactions to be age-appropriate.
	Content Suitability: Ensure that the robot's content is suitable for the children's age group and free of inappropriate material.
Ethical Use of Technology	**Purpose-Driven Design:** Design the robot's functionalities with a clear educational or developmental purpose.
	Continuous Evaluation: Continuously evaluate the ethical implications of robot interactions.
Safeguarding and Reporting	**Child Protection Policies:** Adhere to child protection policies and ensure that all personnel involved are trained in child safeguarding practices.
	Reporting Mechanisms: Establish clear reporting mechanisms for any ethical concerns or incidents.
Implementation	**Training:** Provide comprehensive training for all researchers and staff on these ethical guidelines.
	Communication: Maintain open lines of communication with children, guardians, and educators.
	Documentation: Document all consent processes, data handling procedures, and any incidents.

6 Discussion

The findings of our study indicate that preadolescents' perceptions of the believability of robot narratives vary slightly. One important finding was that students in year groups 6 and 7 believed more often that the robot had a real attic full of books when they were in the Book narrative condition compared to the No Book narrative condition. In contrast, there were no noticeable variations in how each age group responded to Leo's remarks regarding picking books or visiting dreams. These results indicate that we cannot draw definitive conclusions about the factors influencing believability across different age groups. Thus, while Hypothesis 2, which posited that contextually relevant narratives would increase the perceived believability of the narrative, cannot be fully confirmed, the significant findings in question 2 indicate the potential for further research in this area.

Similarly, Hypothesis 1, which suggested that the believability of robots would decrease as children grow older, cannot be confirmed. The data revealed some minor differences in preadolescents' assessments of believability, but they were not enough to support a strong pattern of believability decline with age. This suggests that, despite potential age-related variations in children's perceptions of robot narratives, our study did not yield strong evidence to support Hypothesis 1.

When observing the overall perceived believability of the questions regardless of age, the findings show that the believability of the question where Leo claims to have a real book attic was perceived higher in the Books narrative condition compared to the No Books narrative condition. For the other questions, no differences were found in the perceived believability of the robot's narratives. Similar to the findings across age groups, these results are not definitive enough to draw strong conclusions. Hence, the results do not fully support Hypothesis 2, which suggests that contextually relevant narratives can enhance believability. However, the significant finding in question 2 indicates that further investigation into the factors affecting overall narrative believability is worthwhile.

6.1 Interpretations of the results

Significant results were found for question 2 in both year groups 6 and 7. Likewise, a significant result was found for question 2 concerning overall perceived believability, regardless of age. The notable difference between the conditions in question 2 could be attributed to the highly concrete and tangible nature of the claim that Leo has a real attic full of books. This specificity makes it easier for students to visualize and believe when explicitly stated. In contrast, the other questions (e.g., Leo choosing books, visiting dreams, dancing by himself) are more abstract or less concrete, making the explicit detail less essential for believability.

Another explanation for the significant results found in question 2 is that the perceived functionality and capabilities of robots might influence preadolescents. The claim that Leo, a robot, has a real attic full of books is more believable because it aligns with students' understanding of robots having specific storage capabilities or being part of a structured environment. Robots are often associated with organization and storage functions, which makes the idea of a robot managing an attic full of books seem plausible. In contrast, the other scenarios, such as Leo choosing books, visiting dreams, or dancing by himself, involve activities that are more anthropomorphic and abstract, requiring a level of cognitive and emotional processing that students might not readily associate with robots. These activities imply a level of autonomy and creativity that students may find harder to attribute to a robot, making these scenarios less believable. Thus, the believability of the scenario in question 2 might be due to its alignment with common perceptions of a robot's functional and storage-related capabilities.

6.2 Implications of the Results

When designing narratives involving robots for younger students, it is beneficial to focus on scenarios that are concrete and tangible. Providing specific, vivid details can enhance believability and engagement. For example, emphasizing a robot's organizational functions or physical capabilities might be more effective than highlighting abstract or highly anthropomorphic traits. Additionally, the familiarity with certain robot functionalities makes specific scenarios more believable, suggesting the importance of building on existing knowledge. Introducing new concepts by relating them to familiar ones can enhance comprehension and acceptance among students. For instance, leveraging students' understanding of robots as organizers or storage managers can serve as a foundation for gradually introducing more abstract and complex robotic capabilities. This approach not only makes initial content more accessible and engaging but also helps expand students' perceptions and understanding of robotics in a structured and incremental manner.

6.3 Ethical Guidelines for Responsible Interactions

Among the most important contributions of this study is the creation of ethical guidelines for appropriate robot-child interactions. These guidelines, which address important issues such as privacy, data protection, informed consent, and children's emotional well-being, were developed after an expert interview and a comprehensive review of related work. Age-appropriate content, open, non-manipulative practices, and ongoing ethical assessment are all emphasised in the guidelines. The significance of these guidelines is profound, considering children's susceptibility to manipulation and the possible enduring effects of robotic interactions on their growth. By following these ethical guidelines, it is achievable to integrate robots into learning environments while maintaining ethical integrity and fostering positive developmental outcomes.

6.4 Future Work and Limitations

Future research should focus on testing the interpretation of our results, specifically whether concrete and tangible narratives that align with pre-existing perceptions of robots increase the believability of the robot's narratives for preadolescents. This goal can be achieved by utilizing a broader array of narratives and corresponding questions. By doing so, we can gain a more comprehensive understanding of what makes robot interactions believable and engaging for preadolescents.

Additionally, the current study focuses on immediate reactions and short-term perceptions of believability. While these insights are valuable, they do not capture the potential long-term effects of robotic interactions on children's cognitive and emotional development. Longitudinal studies are essential for upcoming research. By conducting long-term studies, researchers could see how prolonged interactions with robots affect children's cognitive and emotional development over time. These investigations may shed light on the possible advantages and disadvantages of frequent interaction with social robots over the long run, which could improve policies governing their application in learning environments.

Lastly, our research aimed to identify differences between various age groups. The participants in our study, aged 8 to 11, represent a relatively narrow age range. By focusing on such a small cluster, we may overlook differences between developmental stages that are also integral to the educational system. Future research should include participants from a broader age range to make clearer comparisons between different developmental stages, enabling us to draw more comprehensive conclusions about the educational benefits on a larger scale.

7 Conclusion

This study explored preadolescents' perceptions of the believability of narratives delivered by social robots, as well as the ethical considerations required to ensure responsible interactions. Through a combination of quantitative experiments and qualitative insights from an expert interview, we identified key factors that influence the believability of robot narratives. Our user study (N = 99, 8–11 years old) suggests that tangible and concrete narrative components, especially those that align with pre-existing perceptions of robots, increase preadolescents' perceptions of robot narratives' believability. Although the results were not definitive enough to confirm our hypotheses, the significant findings suggest potential avenues for further research.

The ethical guidelines developed through this study offer a robust framework for ensuring responsible robot-child interactions. These guidelines help ensure that robots are incorporated into learning environments in a way that benefits and safeguards young students by considering important concerns such as informed consent, privacy, and children's emotional health. These guidelines were largely shaped by the insights obtained from expert interviews and an extensive literature study.

In conclusion, our research provides valuable insights into how to enhance the believability of robot narratives for preadolescents and outlines practical ethical guidelines for their responsible implementation. By focusing on creating believable and ethically sound interactions, we can ensure that robots serve as effective facilitators of learning and growth. This study helps paving the way for a future where robots are thoughtfully integrated into children's lives, supporting their developmental journeys and fostering a harmonious coexistence between children and robots, where robots serve as facilitators of learning and growth rather than mere tools.

References

1. B. Cagiltay and B. Mutlu, “Toward family-robot interactions: A family-centered framework in hri,” in *Proceedings of the 2024 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 76–85, 2024.
2. C. Lin, K. F. MacDorman, S. Šabanović, A. D. Miller, and E. Brady, “Parental expectations, concerns, and acceptance of storytelling robots for children,” in *Companion of the 2020 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 346–348, 2020.
3. N. Caruana, R. Moffat, A. Miguel-Blanco, and E. S. Cross, “Perceptions of intelligence & sentience shape children’s interactions with robot reading companions,” *Scientific Reports*, vol. 13, no. 1, p. 7341, 2023.
4. E. Pashevich, “Can communication with social robots influence how children develop empathy? best-evidence synthesis,” *AI & SOCIETY*, vol. 37, no. 2, pp. 579–589, 2022.
5. M. Escobar-Planas, V. Charisi, and E. Gomez, “" that robot played with us!" children’s perceptions of a robot after a child-robot group interaction,” *Proceedings of the ACM on Human-Computer Interaction*, vol. 6, no. CSCW2, pp. 1–23, 2022.
6. M. E. Ligthart, M. A. Neerincx, and K. V. Hindriks, “Design patterns for an interactive storytelling robot to support children’s engagement and agency,” in *Proceedings of the 2020 ACM/IEEE international conference on human-robot interaction*, pp. 409–418, 2020.
7. N. Caruana, R. Moffat, A. Miguel-Blanco, and E. S. Cross, “Talk, listen and keep me company: A mixed methods analysis of children’s perspectives towards robot reading companions,” in *Proceedings of the 10th International Conference on Human-Agent Interaction*, pp. 239–241, 2022.
8. S. T. Coleridge, *Biographia Literaria: Samuel Taylor Coleridge*. Oxford, 1985.
9. M. Rheu, J. Y. Shin, W. Peng, and J. Huh-Yoo, “Systematic review: Trust-building factors and implications for conversational agent design,” *International Journal of Human–Computer Interaction*, vol. 37, no. 1, pp. 81–96, 2021.
10. J. Pinney, F. Carroll, and P. Newbury, “Human-robot interaction: the impact of robotic aesthetics on anticipated human trust,” *PeerJ Computer Science*, vol. 8, p. e837, 2022.
11. J. Xu, K. Rogers, A. Howard, *et al.*, “The effect of conceptual embodiment on human-robot trust during a youth emotion classification task,” in *2021 IEEE International Conference on Advanced Robotics and Its Social Impacts (ARSO)*, pp. 211–218, IEEE, 2021.
12. K. C. Yam, Y. Bigman, and K. Gray, “Reducing the uncanny valley by dehumanizing humanoid robots,” *Computers in Human Behavior*, vol. 125, p. 106945, 2021.
13. C. McGinn and D. Dooley, “What should robots feel like?,” in *Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 281–288, 2020.
14. D. Aéraïz-Bekkis, G. Ganesh, E. Yoshida, and N. Yamanobe, “Robot movement uncertainty determines human discomfort in co-worker scenarios,” in *2020 6th International Conference on Control, Automation and Robotics (ICCAR)*, pp. 59–66, IEEE, 2020.
15. B. De Carolis, F. D’errico, and V. Rossano, “Pepper as a storyteller: exploring the effect of human vs. robot voice on children’s emotional experience,” in *Human-Computer Interaction–INTERACT 2021: 18th IFIP TC 13 International Conference, Bari, Italy, August 30–September 3, 2021, Proceedings, Part II 18*, pp. 471–480, Springer, 2021.

16. N. Calvo-Barajas, G. Perugia, and G. Castellano, "The effects of robot's facial expressions on children's first impressions of trustworthiness," in *2020 29th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, pp. 165–171, IEEE, 2020.
17. T. Beelen, E. Velner, K. P. Truong, R. Ordelman, T. Huibers, and V. Evers, "Children's trust in robots and the information they provide," in *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, pp. 1–7, 2023.
18. I. Kay, C. M. Sylla, M. M. Gil, M. Ozkar, A. P. Caruso, and U. Aydın, "M&m-monnom meets mobeybou: Digital interfaces for children's embodied interaction," in *Proceedings of the 21st Annual ACM Interaction Design and Children Conference*, pp. 617–620, 2022.
19. L. J. Hubbard, Y. Chen, E. Colunga, P. Kim, and T. Yeh, "Child-robot interaction to integrate reflective storytelling into creative play," in *Proceedings of the 13th Conference on Creativity and Cognition*, pp. 1–8, 2021.
20. J. Chen Hsieh and J. S. Lee, "Digital storytelling outcomes, emotions, grit, and perceptions among efl middle school learners: Robot-assisted versus powerpoint-assisted presentations," *Computer Assisted Language Learning*, vol. 36, no. 5-6, pp. 1088–1115, 2023.
21. M. E. Ligthart, M. A. Neerincx, and K. V. Hindriks, "Memory-based personalization for fostering a long-term child-robot relationship," in *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, pp. 80–89, IEEE, 2022.
22. A. Peebles and M. N. Snyder, "Media use and socioemotional learning," *The International Encyclopedia of Media Psychology*, pp. 1–10, 2020.
23. I. Stapf, C. Biess, J. Pfetsch, and F. Paschel, "Respecting childrens rights in research ethics and research methods," *Journal of Children and Media*, vol. 17, no. 3, pp. 393–399, 2023.
24. E. D. Mayasari, "Ethical considerations in conducting research with children," in *Parezja. Forum Młodych Pedagogów Przy Komitecie Nauk Pedagogicznych PAN*, vol. 18, pp. 64–73, Wydawnictwo Uniwersytetu w Białymstoku, 2022.
25. M. Aparicio Payá, R. Morte Ferrer, M. Toboso Martín, T. Ausín, A. Monasterio Astobiza, and D. López, "An ethical framework for robotics and children: Vulnerability and promotion of autonomy," *Neue Technologien–neue Kindheiten? Ethische und bildungsphilosophische Perspektiven*, pp. 85–105, 2020.
26. E. Velner, "Measuring trust in children's speech: Towards responsible robot-supported information search," in *Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 748–750, 2023.
27. S. Nyholm, *Humans and robots: Ethics, agency, and anthropomorphism.* Rowman & Littlefield Publishers, 2020.

A Original and Translated Questions

A.1 Original Questions in Dutch

1. Leo kan zelf boeken kiezen voor kinderen.
2. Leo heeft een echte boekenzolder.
3. Leo kan mijn dromen bezoeken.
4. Leo kan zelf dansen.

A.2 Translated Questions in English

1. Leo can choose books for children himself.
2. Leo has a real attic full of books.
3. Leo can visit my dreams.
4. Leo can dance by himself.

B Interview Questions

B.1 Original Dutch Questions

1. Kunt u enkele dialoogstrategieën opnoemen die educatieve robots kunnen gebruiken om aan te sluiten bij de cognitieve capaciteiten en emotionele behoeften van kinderen van 8-11 jaar?
2. Kunt u voorbeelden geven van effectieve en ineffectieve interactiestrategieën?
3. Zijn er richtlijnen gedefinieerd vanuit het vakgebied kind en media voor het maken van / inzetten van narratieven (bijvoorbeeld voor media karakters of reclame)?
4. Is er differentiatie in leeftijd? Zo ja, wat zijn de richtlijnen / adviezen / tips?
5. Hoe kunnen we dit vertalen naar narratieven voor robotdialogen?
6. Hoe wordt de balans tussen educatie en entertainment behouden in robotdialogen voor deze doelgroep?
7. Hoe kunnen we ervoor zorgen dat kinderen veilig zijn als ze met educatieve robots omgaan?
8. Zijn er ethische overwegingen waar rekening mee gehouden zou moeten worden bij het ontwerpen van robotdialogen voor kinderen?
9. Zijn er nog andere overwegingen of adviezen die u essentieel vindt om te delen?

B.2 English Translation

1. Can you name some dialogue strategies that educational robots can use to align with the cognitive abilities and emotional needs of children aged 8-11?
2. Can you provide examples of effective and ineffective interaction strategies?
3. Are there guidelines defined by the field of children and media for creating/using narratives (for example, for media characters or advertisements)?
4. Is there differentiation by age? If so, what are the guidelines/advice/tips?
5. How can we translate this into narratives for robot dialogues?
6. How is the balance between education and entertainment maintained in robot dialogues for this age group?
7. How can we ensure that children are safe when interacting with educational robots?
8. Are there ethical considerations that should be taken into account when designing robot dialogues for children?
9. Are there any other considerations or advice you find essential to share?