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Robot Morphology and Children’s Perception of Social Robots: An Exploratory Study

Alex Barco, Chiara de Jong, Jochen Peter, Rinaldo Kühne, and Caroline L. van Straten
Amsterdam School of Communication Research (ASCoR)
University of Amsterdam, Amsterdam, The Netherlands
a.barcomartelo@uva.nl

ABSTRACT

The aim of this study was to investigate whether robot morphology (i.e., anthropomorphic, zoomorphic, or caricatured) influences children’s perceptions of animacy, anthropomorphism, social presence, and perceived similarity. Based on a sample of 35 children aged seven to fourteen, we found that, depending on the robot’s morphology, children’s perceptions of anthropomorphism, social presence, and perceived similarity varied, with the anthropomorphic robot typically ranking higher than the zoomorphic robot. Our findings suggest that the morphology of social robots should be taken into account when planning, analyzing, and interpreting studies on child-robot interaction.

KEYWORDS

Morphology; Child-Robot Interaction (CRI); Anthropomorphism; Animacy; Social Presence; Perceived Similarity

1 Introduction

With the increasing prevalence of social robots in society, the variety of different kinds of social robots also increases, notably in terms of their morphology [1]. The morphology of social robots is often classified into anthropomorphic (i.e., human-like), zoomorphic (i.e., animal-like), caricatured (i.e., cartoon-like), and functional (i.e., form follows function) [2]. Different morphologies can elicit differences in how users perceive and interact with robots, as research on adult robot-users has shown (e.g., [3-5]). Focusing on child-robot interaction (CRI) more specifically, research has shown that robot morphology affects children’s role attribution to, and satisfaction with, robots [6]; their perception of a robot’s emotions [7], feelings, personality, and cognitive abilities [8]; and their attitudes towards robots [9]. Additionally, research has shown that children prefer less anthropomorphic robots over other robots [10-11].

However, to the best of our knowledge there is little research specifically on the extent to which different robot *morphologies* affect *children’s perceptions* of important and often studied robot characteristics (e.g., [12]), such as animacy, anthropomorphism, social presence, and degree of similarity to the user. Without more knowledge about the impact of different robot morphologies on children’s perceptions of robot characteristics, it seems difficult to assess to what extent insights on such perceptions established in CRI research are comparable across different robot morphologies or may be tied to the particular morphology studied (for a similar observation, see [13]). Such knowledge may thus help establish potential boundary conditions of robot morphologies in CRI and thereby specify the generalizability of previous findings.

Against this background, our aim was to explore whether robot morphology (anthropomorphic, zoomorphic, and caricatured) affects children’s perceptions of a robot’s animacy, anthropomorphism, social presence, and perceived similarity to the user. We did not include a functional morphology because it is rather uncommon among social robots [3] that children tend to use.

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2 Method

The study was approved by the Ethics Review Board of the Faculty of Social and Behavioral Sciences at the University of Amsterdam [2019-YME-10542]. Prior to the start of the study, we received active written consent from children’s parents or caretakers, as well as from the Expeditie Next festival (Rotterdam, the Netherlands), where the study was conducted.

Thirty-five children (17 female) aged 7 to 14 (M = 9.91, SD = 1.70) participated in the study. Before participation, children read an introduction sheet in child-appropriate language that explained that participation was voluntary, the collected data anonymous, and that they could stop their participation anytime without giving a reason. Any remaining questions that children had about the introduction, were answered. The study consisted of five-minute individual interactions between the children and three robots: NAO (anthropomorphic; Softbank), Pleo (zoomorphic; Innvo Labs), and Cozmo (caricatured; Anki). With NAO, the children played a guessing game, which we had also used in earlier studies ([14-17]), whereas with both Pleo and Cozmo they interacted freely. They received written, child-appropriate information about Pleo and Cozmo that made suggestions of how to interact with them. The interaction with NAO was based on the Wizard-of-Oz paradigm.

After the first interaction with one of the robots, a research-assistant administered a face-to-face questionnaire (as in e.g., [15]). After completion of the questionnaire, each child also played with the other two robots. For practicality reasons, the first five children interacted first with NAO, the next five with Pleo, and the next five with Cozmo, after which the sequences started with

NAO again. Next, they were debriefed through an information sheet in child-appropriate language. Finally, children were allowed to ask any remaining questions.

Animacy, anthropomorphism, social presence, and perceived similarity were all assessed on a five-point response scale ranging from "Does not apply at all" to "Applies completely." In order to facilitate children's answers, a bar chart from Severson et al. [18] was used, which visualized the response categories (see [15]). Per concept, the items were first subjected to a principal component analysis (PCA; varimax rotation, if applicable) to check their component structure, and subsequently analyzed for internal consistency. After removal of problematic items, we computed scales by averaging the remaining items.

We measured *animacy* with four items inspired by Bartneck et al. [3] and Ho et al. [19], which we successfully used in an earlier study [15]. The PCA elicited two components and the item "[Robot name] can die" correlated slightly negatively with one of the remaining items. After removal of that item, the component structure was one-dimensional (explained variance 48%), but the resulting scale still had a low internal consistency (Cronbach's α = .45, M = 2.73, SD = 0.86, skewness = -0.322, kurtosis = -0.088). *Anthropomorphism* was measured with four items from the technology dimension of Severson et al. [18] Individual Differences in Anthropomorphism Questionnaire-Child Form (IDAQ-CF), in the version used by Van Straten et al. [15]. The component structure was one-dimensional (explained variance 52%). After removing the item "[Robot name] decides for itself what it does," the internal consistency of the resulting three-item scale improved from α = .66 to α = .74 (M = 3.46, SD = 1.03, skewness = -0.549, kurtosis = -0.008). *Social presence* was measured with a 4-item scale inspired by Heerink et al. [20]. The component structure was unidimensional (explained variance 79%; α = .91, M = 2.81, SD = 1.05, skewness = 0.107, kurtosis = -0.518). We measured *perceived similarity* with a 4-item scale adapted from McCroskey et al. [21], which was used successfully in [15], and had a unidimensional component structure (explained variance 53%; α = .70, M = 2.20, SD = 0.69, skewness = 0.336, kurtosis = 0.477). We recorded children's age and biological sex, and assessed whether children had attended a presentation about robots earlier that day (n = 5) or not (n = 30). Finally, we noted whether children were alone while interacting with a robot (n = 33) or not (n = 2).

3 Results

We ran four ANCOVAs controlling for gender, age, attendance of robot presentation, and whether a child interacted with the robot alongside another child. We opted for a Bonferroni post-hoc test because in adjusting the significance level it presents a rather conservative test. Due to space constraints, we only report significant post-hoc differences, with Bonferroni-adjusted p values.

Robot morphology significantly affected anthropomorphism, F (2, 28) = 4.64, p = .018, part. η^2 = .249. Bonferroni post-hoc tests showed that NAO's perceived anthropomorphism (M = 3.84, SD = 0.97) was significantly higher than that of Pleo (M = 3.07, SD = 1.11) and of Cozmo (M = 3.27, SD = 0.91) (p = .047 and .037 respectively). Robot morphology also influenced perceived social presence, F (2, 28) = 6.01, p = .007, part. η^2 = .301. NAO's (M = 3.17, SD = 0.83) perceived social presence was significantly higher than that of Pleo (M = 1.92, SD = 0.63) (p = .008). Moreover, morphology exerted an effect on perceived similarity, F (2, 28) = 4.76, p = .017, part. η^2 = .254. Both NAO's (M = 2.32, SD, = 0.49) and Cozmo's (M = 2.55, SD = 0.79) perceived similarity were significantly higher than that of Pleo (M = 1.67, SD = 0.57) (p's = .039). There was no significant effect of morphology on animacy, F (2, 28) = 0.18, p = .835, part. η^2 = .013. When running the analyses without covariates, the pattern of results largely remained the same, with one exception: The effect of morphology on anthropomorphism was non-significant, F (2, 32) = 2.08, p = .142, part. η^2 = .115.

4 Discussion

The findings of this exploratory study suggest that robot morphology affects children's perceptions of social robots. In terms of its anthropomorphism, social presence, and perceived similarity, the anthropomorphic social robot NAO consistently ranked higher than the zoomorphic robot Pleo. Children's perception of the caricatured robot Cozmo tended to be more similar to their perception of NAO (anthropomorphism notwithstanding), but this requires further research attention. We did not find any differential influence of morphology on animacy, which may result from animacy's unreliable measurement. Overall, our study suggests that findings on social robots' perceived anthropomorphism, social presence, and perceived similarity may not be easily comparable between anthropomorphic and zoomorphic robots. This is plausible given the human bias in the three concepts, but should be systematically taken into account when analyzing and planning research on these concepts. In this context, perceptions of caricatured robots, such as Cozmo, deserve particular attention.

The study has at least five limitations. First, the study draws on a small convenience sample of children, with a large age range, and should be replicated with a more representative sample. Second, although we believe that our results can be interpreted in a causal way, our design lacked internal validity and we cannot preclude the impact of alternative explanations on our results. Third, some qualitative insights may have helped to better understand children's perceptions. Fourth, the interaction with the NAO robot was different (scripted) than the other two interactions (free), which may also have influenced children's perceptions of the robots (see [13] for a similar observation). Fifth and finally, our study may be limited by our choice of robots. Other types of anthropomorphic, caricatured, and zoomorphic robots may have led to different results. This calls for more systematic comparisons of children's perceptions of different types of robots with the same morphology.

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