Title

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 42(0)

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Publication Date

2020

Gendered Robots Can Change Children's Gender Stereotyping

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Abstract

Research suggests children readily treat robots as social actors and sources of information for learning. Here we ask if children use depictions of gender-counterstereotypic robots (e.g., a female construction worker robot) and gender-stereotypic robots (e.g., a female secretary robot) as sources of information about cultural gender stereotypes. Forty-five 6- to 8-year-old children participated in a short counterstereotyping task. Children in the counterstereotypical condition viewed videos of cartoon female gendered robots with culturally stereotyped masculine occupations, interests in activities, and traits. Children in the stereotypical condition viewed videos of cartoon female gendered robots with culturally stereotyped feminine attributes. Children completed a measure of gender stereotyping before and after viewing the intervention videos. From pretest to posttest, children's gender stereotyping decreased in the counterstereotypical condition and increased in the stereotypical condition. These finding suggest children may learn from robots as models of cultural gender stereotypes.

Keywords: child-robot interaction, social learning, social robotics, social cognition, gender stereotypes

Introduction

Social robots are increasingly being developed to interact with children (Yang et al., 2018). Children are engaging with social robots in educational (Belpaem et al., 2018; Michaelis & Mutlu, 2018), therapeutic (Ricks & Colton, 2010; Scassellati et al., 2018), and childcare settings (Tanaka et al., 2007). Furthermore, robots are being developed to specifically play with, entertain, and supervise children in their homes. Given the potential for social robots to become companions of children's everyday life, there is a critical need to study the mechanisms by which children may learn from social robots and what sorts of information robots might transmit to children.

Recent research suggests children readily treat robots as social actors and sources of social information. Children form meaningful social and moral relationships with robots (Kahn et al., 2012), treat robots as trustworthy and friendly informants in selective trust paradigms (Breazeal et al., 2016; Brink & Wellman, submitted), and socially conform to robots in Asch and moral evaluation paradigms (Vollmer et al., 2018; Williams et al., 2018). Children also treat robots as models for social behaviors, without explicit direction or instruction. For example, children who played a game with a peer-like robot that exhibited behaviors suggestive of a growth mindset, later self-reported a stronger growth mindset and tried harder during a challenging task, compared to children who played with a neutral mindset robot (Park et al., 2017). Similarly, children that interacted with a more creative social robot peer subsequently performed better on a creativity game (the droodle creativity task), compared to children who interacted with a non-creative robot (Ali et al., 2019). Thus, children seem to learn and socially model behaviors and attributes they see in robots.

The present study asks whether robots might transmit cultural stereotypes to children. Research with adults suggests social categories and stereotypes are readily attributed to computers and robots (Nass & Moon, 2000; Eyseel & Hegel, 2012). Gender, in particular, has been found to substantively alter adult human-robot interaction. The gender of robots can influence their persuasive power and levels of human-robot cooperation on gendered tasks (Siegel et al., 2009; Kuchenbrandt et al., 2014). Furthermore, adults judge gendered robots that fulfill gender-stereotypic roles (e.g., a male robot that guards a house or a female robot working in healthcare) as more suitable, acceptable, and likeable than gendered robots in counterstereotypic roles (Eyssel & Hegel, 2012; Tay et al., 2014).

Given these findings, researchers have asked whether gender cues and stereotypes should be exploited to facilitate human-robot interaction, potentially improving rapport and engagement, reducing performance errors, and increasing marketability. Or, whether designers should avoid reinforcing potentially harmful stereotypes, designing gender-neutral or counterstereotypic robots (Eyssel & Hegel, 2012; Nomura, 2017). Nevertheless, many robots already in use are female gendered (rather than male gendered) and provide assistance on every-day tasks that are generally perceived as stereotypically female (e.g., Apple's Siri and Amazon's Alexa; Kuchenbrandt et al., 2014; Devlin, 2018).

In the present study, we extended the line of research on children's social learning from robots to learning about gender stereotypes. Do children treat gendered robots as models for cultural gender norms and stereotypes? To address this question, we developed a task and materials based on the children's gender-counterstereotyping intervention literature (e.g., Coyle & Liben, 2016). Counterstereotyping interventions highlight specific examples of stereotype-inconsistent information (Olsson & Martiny, 2018). For example, a researcher hoping to alter the belief that only men are scientists might expose participants to a vignette about a female scientist. Though more common in adults, studies with children have found brief counterstereotyping interventions can effectively reduce gender-stereotypical beliefs. For example, King et al. (2018) found counterstereotypical messages about toy preferences (e.g., “boys like dolls”, “girls like trucks”) reduce children’s gender-stereotypical beliefs about toy preferences. In another study, brief exposure (less than 3 minutes) to a children’s television series in which a genderless android explicitly chooses to not be male or female reduced children’s gender occupation and activity stereotyping (Beck et al., 2017).

We showed 6- to 8-year-old children cartoon vignettes of gender-stereotypical female robots (e.g., a house cleaning robot that enjoys knitting sweaters) or gender-counterstereotypical female robots (e.g., a construction worker robot that enjoys fixing cars). Importantly, we measured children’s gender stereotyping both before and after the intervention. Based on the breadth of children’s social learning from robots in the current literature (i.e., demonstrations of selective trust, social conformity, and implicitly identifying and modeling growth mindset/creativity), we expected children would treat gendered robots as models of gender-stereotypic cultural knowledge. Thus, we predicted that children’s gender stereotyping would decrease from pretest to posttest in response to vignettes of gender-counterstereotypical robots and increase from pretest to posttest in response to vignettes of gender-stereotypical robots.

Method

Participants

Forty-five 6- to 8-year-old children participated. Children were randomly assigned to either a counterstereotypical condition (N = 24; Mean Age = 6 years, 10 months; 13 female, 11 male) or stereotypical condition (N = 21; Mean Age = 6 years, 10 months; 10 female, 11 male). We recruited and tested children at public playgrounds and childcare centers in a large city in the western United States under a protocol approved by the first author’s institutional review board.

Materials

Gendered Robot Videos Children viewed short animated and narrated cartoon videos about three female gendered robots (see Figure 1). The cover story of the videos suggested that the robots were currently under research and development, but would be manufactured and in people’s businesses and homes in the near future. Each robot had a unique occupation, interest in an activity, and pair of traits. Children in the counterstereotypical condition viewed videos where the three female gendered robots exhibited masculine

Figure 1. Sample screen shots from the counterstereotypical (top) and stereotypical (bottom) gendered robot videos.

occupations (truck driver, construction worker, scientist), interests (build with tools, fix cars, draw cars), and traits (brave & aggressive, confident & strong, adventurous & really smart). Children in the stereotypical condition viewed videos where the three female gendered robots exhibited feminine occupations (house cleaner, nurse, secretary), interests (practice cheerleading, bake cookies, knit sweaters), and traits (talkative & affectionate, neat & helpful, loving & gentle). The feminine and masculine occupations, activities, and traits we used are categorized as culturally stereotyped in the Children's Occupation, Activity, and Trait - Attitude Measure (COAT-AM; Liben et al., 2002).

Both videos were approximately a minute and a half in duration. The design of the cartoon robots in the videos was influenced by prior research on adult and child expectations of gendered robots (Eyssel & Hegel, 2012; Obiad et al., 2015).

Gender Stereotyping Measure We measured children's gender stereotyping before and after viewing the gendered robot videos using items from the COAT-AM (see Table 1; Liben et al., 2002). Children completed 12 items from the Activity Gender Stereotype subscale (e.g., "Who should play basketball? Only boys, only girls, or both boys and girls?") and 12 items from the Occupation Gender Stereotype subscale (e.g., "Who should be a florist? Only men, only women, or both men and women?"). Children also completed the same 12 items from the Occupation Gender Stereotype subscale with illustrated gendered robots as the targets (e.g., "Who should be a plumber? Only Jack-Bots, only Jill-Bots, or both Jack-Bots and Jill-Bots?"). We included robot occupation items to address the potential outcome of children generalizing information from the gendered robot videos to other robots but not humans. Subscale items were scored for stereotypic responses. That is, feminine items assigned to only women, only girls, or Jill-bots, and masculine items assigned to only men, only boys, or Jack-bots.

Procedure

Children completed the task individually with the first author or a trained research assistant at the site of recruitment. Materials were presented on an iPad.

The task proceeded in three phases. First, children completed the 36 item pretest measure of gender stereotyping. Next, children viewed the gendered robot video for their randomly assigned condition, either the counterstereotypical or the stereotypical video. Finally, the children completed the 36 item posttest measure of gender stereotyping.

For both the pretest and posttest, items from each domain (i.e., human activity, human occupation, robot occupation) were presented in blocks. The order of the human activity and human occupation blocks was randomized at pretest and posttest, with the robot occupation block always appearing third. Items within domains were presented in random order at pretest and posttest.

Table 1: COAT-AM items used to measure children's gender stereotyping. Italicized occupations and activities were featured in the gendered robot videos.

Human and Robot Occupation Items:

Feminine	Masculine
secretary	*truck driver*
nurse	*scientist*
house cleaner	*construction worker*
hair stylist	plumber
librarian	dentist
florist	police officer

Human Activity Items:

Feminine	Masculine
practice cheerleading	*build with tools*
bake cookies	*draw cars*
knit a sweater	*fix cars*
baby-sit	fly a model plane
wash clothes	play video games
do gymnastics	play basketball

Results

Did children's gender stereotyping change in response to viewing videos of gender-stereotypical and counterstereotypical robots? Figure 2 summarizes children's overall stereotyping by condition and test. Descriptively, children in the counterstereotypical condition decreased their overall stereotyping from pretest (M = .46, SD = .26) to posttest (M = .41, SD = .27). In contrast, children in the stereotypical condition increased their overall stereotyping from pretest (M = .46, SD = .25) to posttest (M = .52, SD = .26).

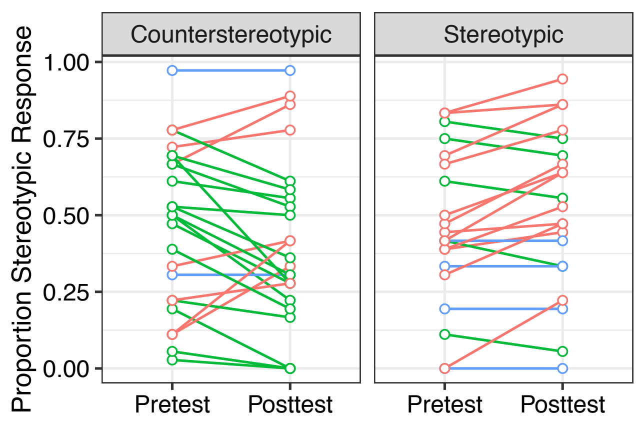

Figure 2: Total proportion of stereotypic responses by condition and test. Paired points represent individual children. Color represents decrease (green), increase (red), or maintenance (blue) of stereotyping from pretest to posttest.

To examine children's response to the gendered robot videos, we estimated a binomial generalized linear mixed model (GLMM) on children's stereotypic responses with condition (counterstereotypical or stereotypical), test (pretest or posttest), domain (human activities, human occupations, or robot occupations), and their interactions as fixed effects and by-participant and by-item random effects. Starting with a maximal random effects structure (Barr et al., 2013), we followed the procedure recommended by Bates et al. (2015) and removed random effects from the maximal model that were not supported by the data. The final model's random effects structure included by-participant varying intercepts and slopes for domain and by-item varying intercepts. Inference for fixed effects was carried out via Type 3 likelihood ratio test (LRT) model comparison.

Figure 3 displays the estimated probabilities from the model. There was an interaction between condition and test, LRT $\chi^2(1) = 15.95$, $p < .001$. Counterstereotypical videos decreased children's odds of stereotyping from pretest to posttest, OR = .72, 95% CI [.57, .91]. In contrast, stereotypical videos increased children's odds of stereotyping from pretest to posttest, OR = 1.45, 95% CI [1.37, 1.87]. There were no other interactions or main effects.

Note, the condition by test interaction remained when only human occupation and human activity responses were analyzed, LRT $\chi^2(1) = 9.93$, $p = .002$. Thus, the observed pattern of results did not rely on the robot occupation items. Further, the condition by test interaction remained when only human occupation and robot occupation responses were analyzed, LRT $\chi^2(1) = 7.96$, $p = .005$. Thus, the observed pattern of results did not rely on human activity differences at pretest. Finally, the condition by test interaction remained when we excluded items for occupations and activities that individual children observed in the videos (e.g., the secretary, nurse, and house cleaner occupations for children in the stereotypic condition), LRT $\chi^2(1) = 4.96$, $p = .026$. Thus, the observed pattern of results involved generalization beyond the specific attributes presented in the videos.

Discussion

Do children treat gendered robots as models for cultural gender stereotypes? Our findings suggest they do. From pretest to posttest, children's gender stereotyping decreased after seeing cartoons of gender-counterstereotypic robots and increased after seeing cartoons of gender-stereotypic robots. Stereotyping interventions like the one we employed are based on the idea that learning information that is counter to one's beliefs about a group can change how one thinks about members of that group in the future. In the present study, children observed information about the occupations, activities, and traits of female robot exemplars and extended that information to their beliefs about what activities and occupations novel male and female robots, boys and girls, and men and women should do. Thus, the present study suggests children may treat robots as models for culturally held beliefs about human groups.

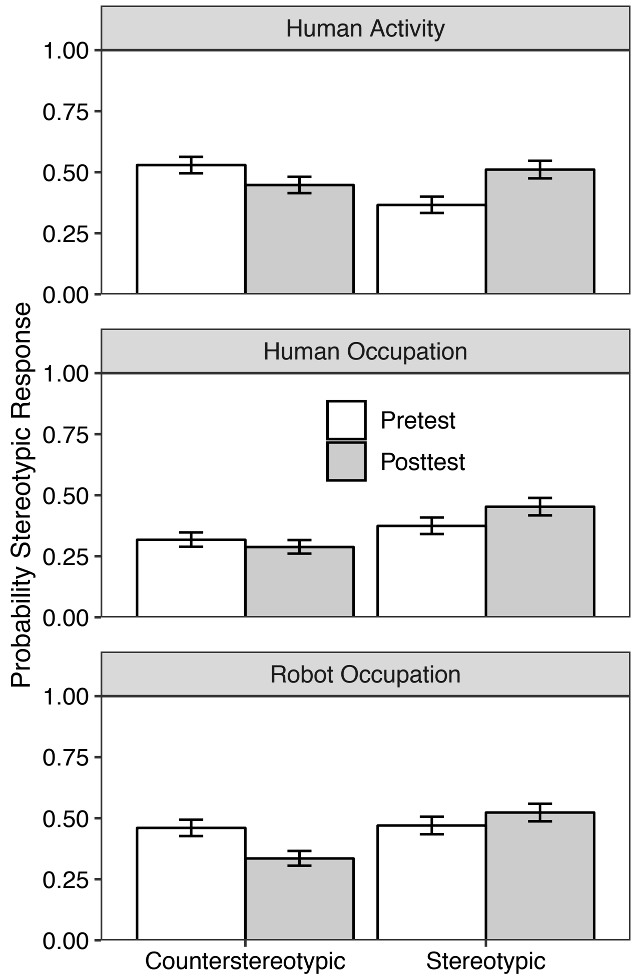

Figure 3: Estimated probabilities of stereotypic responses by condition, test, and domain. Error bars represent standard errors.

Our findings contribute to the growing literature on children's learning from robots. Similar to prior demonstrations of selective trust and social conforming (e.g., Breazeal et al., 2016; Brink & Wellman, submitted; Vollmer et al., 2018; Williams et al., 2018), our results suggest that children treat social robots as "instructors" of cultural knowledge. In contrast to the former examples, children in the present task learned from relatively passive vignettes of robots without any explicit cue to do so. Similar to the findings that children can 'catch' a growth mindset or creativity from a peer robot (Park et al., 2017; Ali et al., 2019), the present study provides an example of children spontaneously identifying and generalizing attributes they see in robots.

From an applied perspective, our findings suggest robots may counteract and reinforce potentially harmful gender stereotypes in children. This is both hopeful and worrisome. These data can be brought to bear on the ethical discussion of whether robot design should leverage gender stereotypes to promote human-robot interaction, deliberately counteract gender stereotypes toward social justice ends, or avoid gendering robots altogether (Eyssel & Hegel, 2012; Nomura, 2017). What is clear is that robots will greatly impact children's cognitive, social, and moral development. It will be imperative for members of the cognitive, developmental, and educational sciences to contribute to the research literature and public discussion of child-robot interaction.

There are critical limitations to the current study that suggest further need for research. First, the intervention in the present task was very minimal. Children did not interact with real social robots (e.g., Volmer et al., 2018) or even view videos of real robots (e.g., Brink & Wellman, submitted). Instead they viewed cartoon vignettes of gendered robots with no contingent interaction. It is possible we would have observed similar results using any cartoon agent with an obviously identifiable gender. However, research does suggest children favor still images of robots over still images of anthropomorphized cartoon animals as sources of information (Oranç & Küntay, 2020). Further, though comparable to other studies (Beck et al., 2017), the manipulation was very brief. It is an open question whether children would respond similarly to more extended, meaningful, and realistic interactions with gendered social robots. As proof of concept, the present data suggest resource-intensive research with real robots is warranted. Second, there is a possibility that the changes we observed were fleeting. While we would not expect long-term effects from such a brief intervention, it is worth noting that even short-term changes in stereotyping behaviors may have lasting effects on attitudes and beliefs (King et al., 2020). Further study will be needed to examine the stability of the observed effects over time. Finally, our study design and sample were not intended to address questions about the gender specificity of children's learning (e.g., are there interactions between learning, child gender, condition, and item gender?) or questions of development (are there interactions with children's age?). Future research could directly examine these issues.

In conclusion, the findings from this study demonstrate that depictions of gendered robots exhibiting cultural gender stereotypes can change children's gender stereotyping in the short term. Critically, our results suggest gendered robots might serve to both reinforce and counteract potentially harmful gender stereotypes in children. The current work expands our consideration of the cultural information social robots may transmit to children. More broadly, this work suggests researchers, developers, and users of social robots need to carefully consider the implications of gendering robots for children.

Acknowledgments

This research was supported by an Oxy Summer Undergraduate Research Fellowship (Ford Foundation Research Mentor's Program) to K. Song-Nichols. We would like to thank Andrew Shtulman, Katherine Chang, and the Oxy Thinking Lab for their feedback and assistance with data collection.

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