Robot Age: Considering Robot Origin and Voice Accent

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Abstract

This paper investigates how social cues may influence judgements of a robots perceived age. To investigate this topic a 3 x 3 factorial study was run with the Misty II robot presenting with American, Chinese, and Mexican national origins and voice accents. In the study, the participant's task was to estimate the robots' age as a function of the robot's origin and spoken accent. The results showed that Misty was thought to be the age of a teenager, but that females judged Misty to be significantly older than males. However, versions of Misty which presented with an American accent tended to produce more agreement among males and females in estimates of robot age than robots presenting with an accent identifying a Chinese or Mexican identity. Implications for the design of robot support systems for the elderly is discussed.

Introduction

As robots are used as companions and assistants one of the challenges facing designers is to create robots that support older adults' ability to live independently and safely in their own homes and community. This is an especially timely topic given epidemiologic studies have indicated that by 2050 people over 60 will represent 22% of the world population (Kanasi, Ayilavarapu, and Jones 2016).

With robots beginning to assist in the care of an aging population, there is an important need to determine which characteristics of a robot effectively support human-robot interaction (HRI). For HRI, research has shown that the physical and behavioral characteristics of the robot can influence performance with the robot and its evaluation (Barfield 2023a,b). Further, research has shown that people anthropomorphize robots by ascribing human characteristics to the robot based on various aspects of the robot's design (Fink 2012). Given users of different ages are beginning to interact with robots and doing so in social contexts, this paper presents an exploratory study that examined how robot national identity triggered by robot voice accent and place of origin influenced estimates of the robot's age.

When considering age as a factor influencing HRI, one can consider the age of the user interacting with the robot, or conversely, the user's judgment of the perceived age of the robot they are interacting with. Thus far, there have been numerous studies focusing on the effect of the user's age in response to various design features of a robot. For example, (Betlej 2022) investigated factors proposed to influence the design of an age-friendly robot and from a participatory design perspective advocated for the elderly to be involved in the design process. Based on interviews conducted with people aged 70 and over they found that the elderly expressed positive attitudes toward humanoid robots when their shapes resembled objects they were familiar with, and that there was a preference for voice-activated robots. Not surprisingly, the elderly expressed an interest in interacting with robots that contributed to their well-being, education, and daily activity (Betlej 2022).

In another study, Tu, Chien, and Yeh (2020) asked older adults to view pictures of 83 robots and respond whether the robot would be an acceptable service provider or companion. From the results of the study, older adults preferred humanlike over non-humanlike robots. Further, (Chen 2018) exploring an elder's acceptance of social robots in a domestic setting found that the elders were especially favorable towards robots as companions when they displayed humanlike social skills. Additionally, in one of the few studies discussing robot features in relation to judgments of robot age, Perugia et al. (2022) reported that the more a robot was judged as humanlike, the older it was perceived.

From the above brief discussion, the physical and behavioral features of a robot can determine how the robot is perceived and evaluated by users. However, a relatively unexplored topic of research in HRI is how different features of a robot's design influence decisions about the robot's perceived age. To contribute to this topic, the current study investigated whether a robot's stated origin of production and ethnic voice accent, both of which can trigger a social identity for a robot, influenced judgments of the robot's age. If the robot's perceived age is dependent on its place of origin or voice accent, such features could impact the design of robot support systems for individuals including older adults aging in place.

Considering robot origin of production, Eyssel and Kuchenbrandt (Eyssel and Kuchenbrandt 2012) found that the stated national origin of a robot influenced its evaluation and particularly the level of anthropomorphism received by the robot. Further, Barfield (2023a) found that a match in voice accent between the user and robot led to a more fa-

vorable impression of the robot. Given a lack of data on how judgments of robot age may be dependent on social cues, the following research questions were posed.

RQI: Will judgments of robot age be dependent on the robot's stated national origin?
RQ2: Will judgments of robot age be dependent on the robot's voice accent indicating a particular robot national identity?

For each of these questions the goal was to provide baseline data on estimates of robot age based on cues used to trigger a social identity and to suggest guidelines for the design of robots interacting with people in social contexts.

Methodology

Experiment Design

To explore whether robot origin and robot voice accent influenced the estimate of a robot's age, a 3 x 3 between-subject study was run with robot origin (America, China, Mexico) and robot voice accent (American, Chinese, Mexican accent) serving as independent variables. Given participants overwhelmingly identified with an American nationality, the use of a robot presenting with an American, Chinese or Mexican identity allowed robots with similar or dissimilar identities as the user to be evaluated. In addition, the particular robot accents and origins were selected because China and the United States are leaders in robotics technology and the three robot origins were chosen to be different from the German and Turkish robots used in the study by Eyssel and Kuchenbrandt (2012) thus expanding the range of robot national origins evaluated in HRI research.

Participants

With IRB approval, 747 participants were recruited from mTurk (Mean age = 34.06, std = 6.50). Of the participants, 164 identified as female whose mean age was 34.89 (std = 9.11) and 583 identified as male whose mean age was 33.83 (std = 5.53). Given the between-subject design 83 participants were paired to each treatment condition. Of the participants, 635 identified as White (85% of the subjects), 4 as Black or African American (0.54%), 18 as American Indian or Alaska Native (2.4%), 84 as Asian (11.2%), and 6 (0.8%) as other. The results of the judgments of robot age based on the ethnic identity of the participants were similar, so the analysis presented below is based on the combined data across participants.

Procedure

In the study, Misty II (Fig. 1) spoke one of nine narratives using three different voice accents in a female-gendered voice stating three different national origins. The voice accent was created using text-to-voice software from the TTSMP3 website (htpps://ttsmp3.cpm/) which allowed sampled voice accents to be selected. A manipulation check confirmed that the voice accents were sufficient to create a robot with a particular national identity. The above techniques are consistent with past research to create robots that have social characteristics (Barfield 2023a,b; de Graaf and Ben Allouch 2015; Eyssel and Kuchenbrandt 2012; Hankerson et al. 2016; Smith et al. 2020).

Figure 1: The Misty II robot.

Robot Narrative

Given an online study, participants viewed a pre-recorded video of the Misty II robot speaking the different narratives using English spoken with a Chinese, Mexican, or American accent. An example of one of the nine narratives follows (the other eight narratives changed only the spoken accent and robot origin and for brevity are not presented here):

(China stated origin/Chinese accent) Hi, I am a robot and I was built in China. I will be working with you in an information search task. For our first information search task we have been asked to search for information about the country of India. I'll start by finding some basic information which I will show you. When you see the information take some time to study it as you will be asked questions about the information later.

After viewing Misty II speak one of the nine narratives, the participant completed an online survey. Only the data on the estimate of robot age pertinent to the topic of this paper is presented here.

Results

Overall, the mean age of Misty II was estimated to be 14.21 years (std = 14.20); thus the robot was judged as approximately 20 years younger than the mean age of the participants (34.06). Further, an examination of the mean estimates of age across robot accent and origin revealed similar estimates for Misty's age, whether the voice accent was American (14.51), Chinese (13.21), or Mexican (14.91); or the robot origin was America (13.77), China (15.62), or Mexico (13.24) (F_{origin} (2, 8) = 3.40, $p > .05$; F_{accent} (2, 8) = 3.11, $p > .05$).

Interestingly, female participants judged the age of Misty II as significantly older (Mean = 22.14, std = 13.97) compared to the male participants estimate of robot age (Mean = 15.08, std = 13.88) (t(241) = 3.66, $p < .001$). Further, the correlation between the participants age and the estimated age of the robot was r^2 = -.58 ($p < .05$), indicating that the older the participant, the lower the estimate of the robot's age.

When examining the magnitude of the gender differences in estimates of robot age, there was a tendency for the dif-

ferences in the estimates of age by male and female participants to be smaller when Misty's voice accent and origin was American. Table 1 shows mean estimates of age for the Misty II robot for participants based on their gender.

Even though female participants judged the Misty II robot to be older than male participants they evaluated the Misty II robot to be 13.48 years younger than themselves, while male participants judged the robot to be 16.76 years younger. These results for robot age are interesting in light of findings by Perugia et al. (2022)) indicating that in terms of the attribution of age to robots selected from the ABOT dataset (htpp://www.abotdatabase.info/) they found that the majority of age estimates were below 50, with a wide range from 3.32 to [rarely] 74.03. Perugia et al. (2022) also reported that the more the robot was thought to be humanlike, the older it was perceived to be. In my data, the combination of robot features which led to the highest mean estimate of robot age occurred when female participants viewed a version of Misty with a Chinese accent and stated origin as China (22.14) and for female participants when Misty presented with a Chinese accent combined with an origin from Mexico (21.44).

Discussion

Overview

Perugia et al. (2022) commented that robots are imbued with age and gender cues and that a robot's perceived age influences people's perceptions and interactions with the robot. However, there has been scarce research conducted to determine how the social cues used to design a robot influence the user's perception of the robot's age. It seems reasonable to conclude that the perceived age of a robot should be an important consideration for an aging population who require companionship and home assistance. In this context would elders act upon the decisions of a robot perceived to be significantly younger than themselves? Would they desire the companionship or assistance of a robot that is similar in age or younger, or even older than themselves? These are relatively unexplored topics within HRI and that will be more fully addressed in a future study by the author.

In terms of the perception of robot age, what do we know from the literature? From the research to date, people do attribute age to a robot based on features of the robot's design. For example, the results of Perugia et al. (2022) showed that different humanoid robots were most often judged to be between 25 and 50 years old. Interestingly, the current study produced an even younger estimate of age for the Misty II robot. Additionally, Perugia et al. (2022) reported that current humanoid robots are not commonly thought to be above 50 in age. So, if there is a desire to create robots with a perceived age over 50 that interact with the elderly, research to determine which social and physical cues signify an elderly robot needs to be conducted as the design of elderly robots has not been a focus of the robotics community.

Given the age estimate of Misty, an important question is whether elders would trust a robot perceived to be much younger than themselves. On this point I would imagine that there are tradeoffs to consider when a robot is thought to be younger or older than the user. For example, an older appearing robot used as a source of information may be preferred if the validity of the information is critical or the information requires expertise which comes with age, or concerns "adult" topics. However, under some scenarios, the elderly may prefer a robot in the age range of a grandchild as a companion, this is a question to be answered in future research. Additionally, it is possible that age could be a fluid concept in HRI given a minimum set of cues can signal the concept of robot age. Therefore, the same robot could possibly project a different age for different tasks, however, the extent to which this could create confusion and mistrust would need to be determined.

Contributing to the past research on the perception of robot age, in the current study two cues, robot origin and voice accent, were thought to influence estimates of robot age. Answering RQ's 1 and 2, overall, estimates of age were relatively the same across the levels of robot origin and voice accent Thus, both cues were effective in producing a perceived age for Misty in the teenage range.

Design Guidelines

From the above results, design guidelines can be proposed, which should be considered tentative given the exploratory nature of the research. If elders prefer companionship or assistance from a robot that is significantly younger than themselves the facial features and morphology of the robot can be manipulated to achieve that goal. For example, the current results for the estimate of Misty's age may be attributed to the robot presenting with large eyes, wide cheeks, small stature, and a female gendered voice, all cues thought to affect the perception of age.

Further, there were pronounced gender differences in the estimates of robot age which implies that for the elderly, their gender should be taken into account when designing robot support systems for aging in place. In the current experiment female participants judged the Misty II robot to be significantly older than male participants across all combinations of robot origin and robot voice accent. From this I conclude that whether there is a gender match or mismatch between robots and elders is a factor to consider in the design of robot support systems for aging in place.

In the current study, a match in origin and voice accent between user and robot resulted in a lower estimate of age for the Misty II robot, therefore, future research should be done to determine how matches in social cues creates a younger appearing robot, or mismatches create an older appearing robot, and if so, the relevance for aging in place in either case.

Conclusions

The use of robotics in health care and the home is of increasing importance, as the proportion of older adults in our population increases. It is thought that robots can help older adults to age in place by increasing wellness, providing rehabilitation, and assisting with activities of daily life (Betlej 2022). From my data, robot origin and robot voice accent as manipulated in the study while leading to a robot thought to be approximately 14 years old, did not lead to different

		Robot Accent		
		China	**America**	**Mexico**
Robot Origin	**China**	M = 15.08 (std = 13.88) F= 22.14 (std = 13.97)	M = 14.23 (std = 13.52) F = 17.17 (std= 11.72)	M = 13-37, (std = 12.72) F = 21.44 (std = 20.85)
	America	M = 11.11 (std= 11.59) F = 14.95 (std= 11.89)	M = 14.35 (std = 17.69) F = 16.80 (std = 21.34)	M = 13.76 (std = 16.45) F = 17.12 (std = 14.68)
	Mexico	M = 8.68 (std = 10.11) F = 18.39 (std = 18.37)	M = 13.37 (std = 12.72) F = 15.44 (std = 10.54)	M =14.20 (std = 12.54) F = 18.37 (std = 11.87)

Table 1: Mean age estimates for male and female participants for the Misty II robot based on robot origin and robot voice accent.

responses in the perception of robot age (across the levels of the IV's). Given Eyssel and Kuchenbrandt (2012) previously found that a robot which matched the national identity of the participants was anthropomorphized more so than a robot presenting with a different national origin, the current study provides preliminary evidence that this may not be the case when robot age is considered as a function of robot origin and spoken accent. To extend my work, more social cues need to be manipulated to determine their effect on judgments of robot age. And an extension of the study using an elderly population should be done to more fully explore how social factors influence judgments of robot age which in turn can lead to the design of robot support systems for the elderly aging in place.

Impact Statement

The current work is in the formative work stage in which the research methodology is being fine-tuned and a broader range of subjects in terms of age will be incorporated in future studies to test whether social cues affect an elders evaluation of robot age. The main contribution of the work is to begin the discussion of how estimates of a robot's age may depend on the social cues presented by a robot. The research discussed in the paper focusing on the influence of social cues for estimates of robot age is significant for aging in place for several reasons. It is necessary to determine how social cues influence an elders interaction with robots, and it is necessary to determine how an elders estimate of the robot's age influences their acceptance of the robot in terms of trust and forming an attachment to the robot.

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