The Impact of Human Likeness on the Older Adults' Perceptions and Preferences of Humanoid Robot Appearance*

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Abstract. There's a growing interest towards human–robot interaction (HRI) as an area of research within human-computer interaction (HCI). Although nowadays robotics studies provide enough knowledge on social robots in major settings, there are still a limited number of studies that investigate expectations, attitudes and behaviors towards humanoid robots in the area of HRI. This study aims to investigate the older adults' perceptions and preferences of a humanoid robot appearance, which is planned to assist in healthcare activities. The preferences and the perceptions of a sample of 6 older adults are assessed through semi-structured in-depth interviews. By adopting a user-centered design process through the execution of techniques such as persona and user journeys, two different appearances are designed for the assessment: A cartoon-like, simplistic face with no specific gender and a more realistic feminine illustrative face. Findings support the notion that perceptions evoked in the users would depend on the human likeness of the robot's face. However, gender stereotypes also had impact on the perception and preference of the humanoid faces. A majority of older adults preferred a female human appearance for the robot by referring both to the human likeness and to the task of healthcare. The participants were able to understand the basic facial gestures in both appearances. However, they could not achieve to interpret the intensity of emotions in the expressions. In this context, when compared, simple cartoon-like faces seemed more affective to support detailed understanding of the expressions. Besides, the findings revealed that experience with technology and culture-specific aspects could also affect the perception of robot technology.

Keywords: Humanoid, Robot, Appearance, Perception, Older Adults.

1 Introduction

Nowadays the usage of robots widely spread from industry to domestic environments for end-users in their daily life. Autonomous robots may assist in a range of assistive

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tasks for kids, elder and disabled users. In this context, it is obvious that in the coming future they will need to carry out social and intellectual tasks, as well as the physical ones. Humanoid robots, which adopt the strategy of anthropomorphism through the use of human faces, are the potential autonomous and domestic robots of the coming future. One of the recent search topics in relevant literature is whether perceptions evoked in different user groups would depend on the humanness of the robot's face [1].

The purpose of this study, which is part of a larger holistic study on social robot design, is to explore older adults' perceptions and preferences of robot faces that varied in terms of human likeness. In this context, by the adoption of a user-centered design process and relevant techniques such as persona and user journeys, two different appearances for a social humanoid robot, which is planned to assist in caregiving and nursing activities, are designed. The preferences and the perceptions of a sample of 6 older adults are investigated through semi-structured interviews. The remainder of this paper includes the theoretical background, methodology and results.

2 Theoretical Background

According to Goetz et al. appearance has a major influence on the assumptions people have about applications and functionalities of robots [2]. Relevant literature states that the appearance has to support the correct estimation of the robot's real competencies by the user [3].

Fong et al. (in [2]) proposed four types of social robots due to their appearance: Anthropomorphic, zoomorphic, caricatured, and functional robots. Studies emphasized that human-likeness has an impact on understanding nonverbal communication. Therefore an anthropomorphic appearance in robot design is highly valued since it may provide a better interaction with users [4]. Zoomorphic robots resemble animals to create the impression that a user may expect the robot to behave like an animal. Robots with a caricatured appearance are mainly based on specific facial features like mouth or eyes. The appearances in this category are used to prevent any expectations based on familiarity, which is caused by the realistic look. Functional robots focus on displaying the core functions of the robotic system [2].

In order to delve into anthropomorphism, it should be noted that anthropomorphism entails attributing human-like properties, characteristics, or mental states to real or imagined non-human agents and objects (Epley et al. in [2]). Blow et al. claimed that human form and functionality in robots would enhance and ease the quality of HRI [5]. Humanoid is an umbrella term for anthropomorphic robots whose structural compositions are based on the human form [1]. However, it will possess some human-like features, which are usually stylized, simplified or cartoon-like versions of the human equivalents, including some or all of the following: A head, facial features, eyes, ears, eyebrows, arms, hands, legs [6].

In this context, especially the human face plays an important role in social interactions by serving as a marker of identity and as a canvas for the display of non-verbal social cues [1]. Especially the design of a robot's face is an important issue within the field of HRI, because studies in recent literature prove the fact that most non-verbal cues were mediated through the face [5]. Lohse et al. stated that a robot is perceived as being

anonymous without a face [24]. In this context the physiognomy of a robot changes the perception of its human-likeness, knowledge, and sociability. Therefore, people avoid robots behaving or looking negatively and prefer to interact with positive robots (Gockley et al. in [2]). In addition to that, Bruce et al. state that an expressive face indicating attention and imitating the face of a user makes a robot more compelling to interact with [2].

Briefly, the phenomenon of human-likeness is one of the most popular aspects concerning the theory of anthropomorphism in the field of robotics. This theory claims that the more a robot resembles a human being in appearance the more people expect it to have human-like qualities [2]. In this sense, the impact of human-likeness on robotic interface design is a challenging subject of research in the area of HRI [7].

Although there is ample literature on the design of robotic systems, investigation of the gender differences with respect to the visual aspects of the robotic interface design is limited. Even though gender stereotypes exists in society at large, current research has found few differences in how men and women perceive agents and how people perceive male and female agents [8]. For example, Koda and Maes [9] found no difference in perceptions of intelligence, likeability, and engagingness between visual forms of male and female agents.

Besides, the number of studies with older adults that focuses on the perception of robot appearance is also limited. Most research on robotic appearance has involved younger participants [6]. However, especially in the area of healthcare, this segment is the potential target group to benefit from the use of social humanoid robots.

3 Methodology

The purpose of this study, which is part of a larger holistic study on social robot design, is to investigate older adults' perceptions and preferences of robot faces that varied in terms of human likeness. Below is the research question of the study:

Due to which factors does human likeness affect the older adults' perception and preferences of humanoid robot appearance?

The study aimed to evaluate the human appearance of a humanoid robot, which will be designed to serve for the healthcare needs of older adults. Humanoid faces were designed to be presented on portable tablets, which would be located at the head of the domestic robot – namely *Medibot* - developed in *Galatasaray University*, as part of an ongoing research project (Fig. 1). In this context, two different humanoid faces were designed through a user centered design process. As part of the design process, two personas accompanied by user journeys referring to different healthcare scenarios were created. By referring to the categorization in the relevant literature it was aimed to design illustrative "anthropomorphic" and "caricature" faces, which provided different levels of human likeness [2]. The design process resulted in two different humanoid faces: A simplistic, cartoon-like renditions of human facial shape with no specific gender and a more realistic and sophisticated feminine appearance.

Fig. 1. Autonomous healthcare robot designed in Galatasaray University

Through diverse methodological approaches, researchers from different disciplines attempted to identify the so-called "basic emotions" and associate them with different physical forms of expression. By using psychological experiments, Scherer (in [10]) identified these so-called "basic emotions" and claimed that they could be observed on an intercultural level and supposedly have universal validity. These included: Angry, sad, happy, frightened, ashamed, proud, despairing. These feelings were related to a corresponding emotional state, which in turn had effects on interpersonal relations, attitudes and affective dispositions. There were also efforts to assign these emotions to particular postures and physical forms of expression. In another study, Becker focused on the emotions of astonishment, anger, sadness and happiness [10]. By referring to Becker, for this study three basic emotions, which presented a variation in terms of expression, were chosen for human appearances and the faces were visualized accordingly: Happiness, anger and astonishment.

This qualitative study was based on a semi-structured in-depth interview realized with 6 participants. The sample included 6 older adults with an age range of 40-70 (3 male, 3 female), which represented the target audience and the designed personas as well.

The study procedure was as follows: At the beginning of the study the participants were informed about the goal of the study by the presentation of a large set of face designs. The participants were told that they would be presented with different versions of two different face design models in three successive phases. Each phase included the comparative presentation of the expressions of a basic emotion for two models. Each presentation included both models expressing the same emotion in three different levels of intensity (Fig. 2, Fig. 3, Fig. 4). After each presentation, the participants were asked if they could understand the expressed emotion in the presented face models. In this

context, the participants were also asked to define the level of intensity for each expression within a scale that ranges from 1 to 5. In the next stage of the interview, the participants were asked which face model was more appropriate in expressing the basic emotions. In order to investigate the relation between the human appearance and the task, participants were also asked to make an evaluation by referring to the intended task, namely healthcare. In this context, the participants were asked to choose the most appropriate face model due to the intended healthcare task. The interview was completed with the additional comments of each participant.

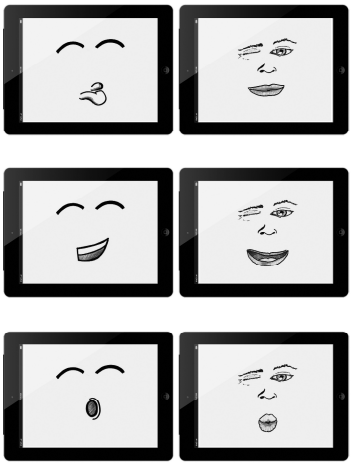

Fig. 2. Expressions for the "Happy Face" (The level of intensity increases from top to bottom)

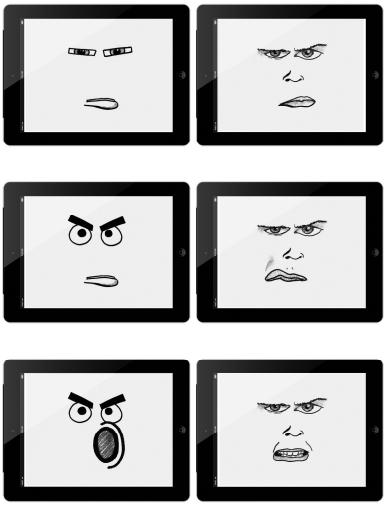

Fig. 3. Expressions for the "Angry Face" (The level of intensity increases from top to bottom)

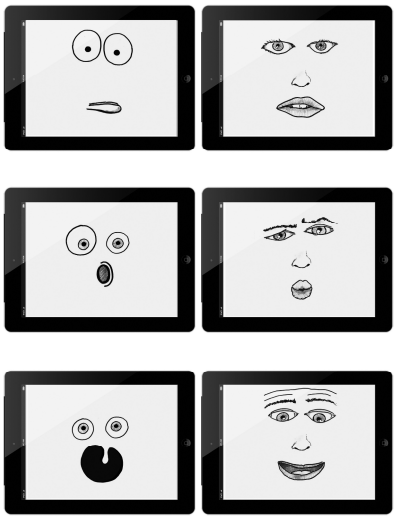

Fig. 4. Expressions for the "Astonished Face" (The level of intensity increases from top to bottom)

4 Results and Discussion

The analysis framework of the study was derived from literature review presented above. It included three different axes: "Perception and Preference of Basic Emotions", "Experience with Technology" and "Trust issues as a Cultural Aspect".

4.1 Perception and Preference of Basic Emotions

The study provided findings on the perception and preference of basic emotions (happiness, anger, astonishment) derived from relevant literature presented above. It should be noted that the findings were analyzed qualitatively and rather than descriptive analysis, insights based on preliminary findings are presented to contribute to further research.

As it was mentioned in the methodology section above, before the interview, three different versions of two different face design models were presented to the participants in three successive phases.

Most of the participants (n=4) stated that the female model was more appropriate in expressing the basic emotions. Only two of the participants preferred cartoon-like models. This finding led us to believe the fact that the rendering of a robotic appearance might contribute to the acceptance of the robotic system by providing familiarity through human likeness.

The participants were able to understand the basic facial gestures, however, it was observed that they could not achieve to interpret the intensity of emotions in the expressions. When they were asked to define the level of intensity for each expression within a scale, surprisingly simplistic cartoon-like faces seemed more advantageous to

support detailed understanding of the expressions. This issue might be related with the technical flaws in drawing some of the detailed expressions of the female model, which might cause confusion. On the other hand, this finding supported the notion that in order to enable the participants to understand diverse emotional expressions, the faces should be drawn in a simplistic style with optimal details that would not cause any confusion.

Finally when the participants were asked to make an evaluation by referring to the healthcare task, all the participants associated the female model with the relevant task. Gender stereotypes in Turkish society were affective in shaping people's expectation of the appearance of the robot. Participants clearly made a link between the nursing task and women, since supporting tasks like nursing are mostly professions associated with women in Turkey.

4.2 Experience with Technology

In the interviews, the participants' experience with computers and Internet were also investigated. The findings showed that 4 participants were regular users of computer technology and the Internet. However, 2 other participants had no prior experience with computer technology and the Internet. The answers revealed that the familiarity and experience with technology might positively influence the participants' approach towards robots. The more familiar and experienced they are with the computer technology, the faster they seem to adopt new innovative tech like social robots.

4.3 Trust Issues as a Cultural Aspect

Findings showed that certain cultural aspects could also have a role in the acceptance of social robotics.

Trust towards machines is one of the most important factors that affect the perception and acceptance of social robot and is frequently investigated in relevant literature. However, this study showed that besides trusting the robot itself, the trust issues about the offline medical community could also play an important role in the acceptance of robot technology in the hospital. This issue was considered as a cultural aspect specifically relating to the Turkish society.

Although patients are accustomed to the high technological environment in hospitals and may seem ready to accepting high-tech robots as well, it was observed that the problem mostly rooted in the prejudices towards the offline world. It was observed that negative trust issues addressing the offline medical community could be barriers in the adoption of the healthcare robots.

The findings revealed that there was a common dissatisfaction among the participants towards medical professionals in the offline world. The expressions of the participants confirmed this finding: "*The medical results should always be presented to a professor or another doctor for second opinion*"; "*You cannot trust the blood pressure results measured by a nurse*", etc. This attitude became evident through the expressions of two participants who lived in Germany for long years. Having the chance to compare the Turkish and German medical ecosystem, they had difficulties

in trusting to Turkish medical authorities. For example, one of those participants had a hearing problem. He clearly stated that he did not have any confidence in the hospital environment in Turkey and would rather prefer to be treated in Germany.

It is obvious that a healthcare robot will face these prejudices about trust towards medical professionals. It may be claimed that for users who have difficulties in trusting real doctors, it may also be difficult to trust a healthcare robot as well. It should be noted that this finding should be investigated in detail with further studies.

5 Conclusion

The purpose of this study, which was part of a larger holistic study on social robot design, was to investigate older adults' perceptions and preferences of robot faces that varied in terms of human likeness. Two different appearances for a healthcare robot were designed for the assessment through semi-structured in-depth interviews realized with 6 older adults. These appearances were as follows: A simplistic, cartoon-like renditions of human facial shape with no specific gender and a more realistic and sophisticated feminine appearance. Findings supported the notion that understanding user perceptions and preferences could enable the design of social robots suited for the extreme target user groups like older adults.

Findings showed that perceptions evoked in the users would depend on the human likeness of the robot's face. Making a robot look more like a real human, rather than a cartoon, was found to support understanding. Most of the participants stated that female appearance was more appropriate in expressing the basic emotions. This finding led us to believe the fact that the rendering of a robotic appearance might contribute to the acceptance of it by providing familiarity through human-likeness. This finding might also be associated with the age of the sample. Recent studies showed that [6] compared to younger adult sample, older adults had less familiarity and experience with robotic technologies. Our study also stated that the experience with technology affected the perception and thus acceptance of robot technology.

Besides, we believe that this finding might provide further information on how older adults perceive this technology. Recent studies showed that older adults' perceptions about a robot's appearance were more likely to be shaped by their expectations than by past experiences with such technology [6]. In this context, older adults' higher preference for a human appearance in our study could also be an outcome of such inexperience, as the most common reason given for the preference a human appearance was "familiarity" with such an appearance. Besides, by referring to the finding that simplistic cartoon-like faces seemed more affective to support detailed understanding of the expressions, it can be proposed that the human appearances should be drawn in a simplistic style with optimal details to enable the participants to understand diverse emotional expressions.

The gender stereotypes people have for individual tasks and social roles clearly influenced their preference for the robotic appearance. Given the fact that the robot would be used for healthcare, the participants linked this task to nursing and eventually to the feminine model. Participants clearly associated the supportive task

the robot could perform with the gender stereotype of women playing more supporting roles.

Findings also showed that certain cultural aspects could also have a role in the acceptance of social robotics. It was found that the prejudices caused by the negative trust issues towards the offline Turkish medical community could be barriers in the adoption of the healthcare robots. In this sense, in order to design robotic interfaces, culture-specific aspects should be taken into account. This finding emphasized the importance of cross-cultural user studies in robotic interface design.

The study is only a first step of a larger study, which aims to explore the perception of humanoid robots' appearance. In the light of these preliminary findings, further research should include empirical studies with different robots appearances and larger / diverse user groups.

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