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When stereotypes meet robots: The double-edge sword of robot gender and personality in human–robot interaction

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ABSTRACT

With the emerging application of social and psychological concepts to human–robot interaction, we investigated the effects of occupational roles (security vs. healthcare), gender (male vs. female), and personality (extrovert vs. introvert) on user acceptance of a social robot. In a laboratory experiment, a robot performed two different roles of a healthcare and security to address the potential usage of social robots at home. During the task, the robot manifested different genders and personalities via nonverbal cues. The results showed that participants (n = 164) preferred the robot with matching gender-occupational role and personality-occupational role stereotypes. This finding implies that the gender and personality of social robots do not monotonically influence user responses; instead, they interact with corresponding role stereotypes to affect user acceptance of social robots. In addition, personality-occupational role stereotypes showed a stronger effect on users' responses than gender-occupational role stereotypes. The overall results lay a foundation for designers to reduce the wide design spaces of social robots by grouping the various parameters under the big umbrella of social role stereotypes.

1. Introduction

The role of social robots has increasingly become diversified when compared to industrial robots that perform monotonous and repetitive tasks in factory settings. In accordance with the rapid development of relevant technologies and the increasing demand for human resources in social settings, robots are expected to play roles that are generally filled by humans in a variety of social contexts, including the home, museums, subways, airports, and hospitals (Lee, Kiesler, & Forlizzi, 2010). Public acceptance of social robots, however, is not simple since successful social robots require a good mixture of state-of-the-art technology and a capacity for friendly social interaction. Among various issues concerning human–technology interaction, user acceptance has been identified as a key element for successful implementation of social robots (Ezer, Fisk, & Rogers, 2009; Heerink, Kröse, Evers, & Wielinga, 2010). Along these lines, interest has recently been rising for the development of socially interactive robots that can accurately mimic human characteristics. This dimension of research aims to develop natural and intuitive human–robot interactions to facilitate user acceptance. One such attempt is to design humanoid robots with human features as well as androids that are aesthetically similar to real human beings. In addition, researchers have started to apply social characteristics in the design of social robots, including exhibiting a natural gaze, gestures, and distinctive personalities (Hwang, Park, & Hwang, 2013; Looije, Neerincx, & Cnossen, 2010).

In spite of the preliminary success in anthropomorphizing robots, simply applying human characteristics to social robots may cause aversive and repugnant psychological responses. For instance, Mori's Uncanny Valley (1970) suggests that human responses toward human-like robots can be revulsive when these robots look and act almost, but not perfectly, like human beings. In other words, when robots become or behave human-like, people start to pay more attention to the subtle differences between the robots and human beings rather than the great resemblance between the two, and this tends to trigger negative responses from people. As such, human social characteristics blindly applied to social robots could negatively influence people's perceptions toward social robots, under certain circumstances (Eyssel & Hegel, 2012).

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Nevertheless, there has not been much empirical research to show the social and psychological implications of such design-related decisions with respect to human–robot interaction. Therefore, the objective of the current study is to identify and investigate human characteristics (i.e., social stereotypes) that influence people's perception and acceptance of social robots. In particular, this study focuses on two roles of home service robots (security and healthcare) to address the current trend of having robots in residential and elderly care environments.

2. Background

The recent shift of attention from industrial to social robots has suggested there is a need for reviewing social traits and concepts that could be applicable to social robots. The following review includes previous efforts toward anthropomorphizing social robots, such as having robots manifest human gender and personality traits in the context of occupational role stereotypes, a well-known social phenomenon in human–human interaction. In addition, we review the literature on the Theory of Planned Behavior (TPB) in order to provide a better understanding of the antecedents for user acceptance of social robots.

2.1. Computers are social actors: anthropomorphizing social robots

As efforts continue to produce social robots that act in a more intuitive manner, there has been a substantial number of studies that examine whether findings from interpersonal relationships can be applied to human–robot interaction (e.g., Eyssel & Hegel, 2012; Tapus, Tapus, & Matarić, 2008). These studies largely rely on the Media Equation or the Computers Are Social Actors (CASA) paradigm, positing that human beings mindlessly respond to computers and other non-human machines (e.g., television or virtual agents) during interactions as if these devices were actual social actors (Nass, Steuer, & Tauber, 1994). Such user responses to artificial human characteristics could be understood in two levels. First, in order to build a social relationship, the user should be able to recognize social cues manifested by the robots. Lee, Peng, Yan, and Jin (2006) defined such recognitions as first-degree social responses since the mere recognition of robots' having social characteristics themselves are mindless social responses that run against the ontological nature of robots. Upon acknowledgement of first-degree social responses, users may experience changes in attitudes and behavior in ways that conform to the recognized social characteristics, which can then be further defined as second-degree social responses.

2.2. Robots that manifest human gender and personality

Social cues of a specific trait tend to portray the social and intellectual attributes of an individual (Powers et al., 2005). Among various social traits, gender and personality have been found to be important for interpersonal relationships, affecting relationship management (Muscanell & Guadagno, 2012) and evoking social stereotypes (Glick, 1991; Glick, Zion, & Nelson, 1988). Hence, arguably, gender and personality can provide important social cues that may trigger certain user responses in human–robot interactions (Lee et al., 2006; Powers et al., 2005).

2.2.1. Gender stereotypes and social robots

When used appropriately, social cues for gender can reduce the efforts to find additional information during interactions. In this regard, researchers have postulated that the gender of social robots helps build a common ground between the users and the robots, thereby facilitating intuitive human–robot interaction (Eyssel & Hegel, 2012; Powers et al., 2005). Earlier research has consistently demonstrated that users have positive attitudes toward social robots that manifest human gender. For example, the gender of social robots can influence their persuasive power (Siegel, Breazeal, & Norton, 2009) and their task suitability (Eyssel & Hegel, 2012; Powers et al., 2005; Tay, Park, Jung, Tan, & Wong, 2013).

In the real world, gender stereotypes are a long-standing concept that highlights social implications resulting from gender cues. The term "stereotype" is defined as a gestalt view of individual perception that emphasizes the notion that certain traits, characteristics, or prototypes are more central and important in organizing our perceptions of other people than other traits (Asch, 1946). As cognitive misers, human judgments are susceptible to heuristics and biases (Tversky & Kahneman, 1974). A similar process happens when we are evaluating or judging others, and stereotypes are triggered automatically as an energy-preserving device inside our cognitive toolbox (Macrae, Milne, & Bodenhausen, 1994). Since the stereotypes of a group provide information about the typical characteristics of the group, this enables an observer to accordingly build certain expectations of an individual who belongs to that group. Having said that, expectancy violation refers to cases where such expectations made through snap judgments are not met. Interestingly, when such expectations are violated, the subjects showing an expectancy violation tend to be negatively evaluated (Mendes, Blascovich, Hunter, Lickel, & Jost, 2007).

One area where the effects of gender stereotypes have been well investigated is in the field of occupations. A plethora of research has shown that people clearly identify certain jobs as masculine or feminine (Crowther & More, 1972; McCauley & Thangavelu, 1991) and would be biased against individuals who do not explicitly conform to the specific gender of these occupational images or stereotypes (Gerdes & Garber, 1983; Rosen & Jerdee, 1974). There is a conspicuous trend for gender stereotyping in the field of social robotics. However, this stereotyping is not well colligated with occupational role stereotypes (Eyssel & Hegel, 2012; Eyssel & Kuchenbrandt, 2012; Powers et al., 2005).

2.2.2. Personality stereotypes and social robots

Along with gender, researchers have also claimed that personality is a key that triggers intuitive responses from users during human–robot interaction (Lee et al., 2006). Personalities often shape the very nature of social relationships and influence the level of satisfaction derived from such interactions (Dryer, 1999), and earlier research has demonstrated that the personalities of social robots influenced user preferences (Tapus et al., 2008), and also affected the perceived enjoyment of the interaction with respect to the perceived intelligence and overall attractiveness of social robots (Lee et al., 2006).

Unlike gender, having robots manifest personalities is much more complicated as a result of the multiple, distinctive dimensions of human personalities. This complexity is exemplified by Goldberg's (1992) proposed Big Five personality types: extroversion, agreeableness, conscientiousness, neuroticism, and openness. Dryer (1999) argues that, among these various dimensions, extroversion (i.e., outgoing-withdrawn) and agreeableness (i.e., cooperative-competence) play important roles in our interaction with non-human agents. In addition, extroversion was found to be the most accurately observable in humans and had the highest agreement among the observers (Kenny, Horner, Kashy, & Chu, 1992). Therefore, a large proportion of research exploring computer and robot personalities has focused on the dimension of extroversion (Dryer, 1999; Isbister & Nass, 2000; Lee et al., 2006; Tapus et al., 2008).