I Don't Always Have Positive Attitudes, but When I Do It Is Usually About a Robot: Development of the Robot Perception Scale

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Abstract

The increasing use of robots and their role in society has important implications for research and development in human-robot interactions (HRIs). The purpose of the present study was to develop a new measure to assess attitudes toward robots in HRIs. Measures of attitudes humans have "about" robots are relatively uncommon. Those that exist have potential problems limiting utilization in research evaluating the human element in HRIs. The Robot Perception Scale (RPS) was developed to redress this gap by examining a new set of factors in unique ways. The RPS consists of two subscales in which participants rate their agreement with statements concerning general attitudes toward robots and attitudes toward human-robot similarity and attractiveness. Findings provide preliminary support for a robotic perception scale that can be used to further our understanding of robots engaged in a variety of HRI settings.

Introduction

The current relationship between society and robots is slowly evolving as robots surpass their initial industrial applications and become capable of participating in more complex social interactions (Bartneck et al. 2005; Kuno et al. 2007). In the near future, as robotic intelligence increases, they will become a normal feature of everyday life. Effective human-robotic partnerships will be essential to a thriving relationship between human and machine in contexts moving beyond strictly work settings to personal interactions such as home care (e.g., babysitting children), home health (e.g., assisting the elderly), or parks and recreation (e.g., serving as a museum guide). These types of personal interactions and the underlying assumptions or expectations that initially prime an individual have already demonstrated the ability to shape relatively lasting attitudes (Nomura et al. 2006).

The purpose of the present study was to provide researchers in human-robot interaction (HRI) with a novel and reliable measure of positive and negative attitudes people may hold toward robots. The Robot Perception Scale (RPS) was developed to examine a number of factors and build upon existing measures such as those developed by Hinds *et al.* (2004), Rau *et al.* (2009), Nomura *et al.* (2008), and Joosse *et al.* (2013). In particular, similarity and attractiveness are more fully addressed in the RPS given that other measures only devote a few questions to examining these components. Furthermore, although the above-mentioned scales might be usable when assessing different robot models, they can only relate findings to a particular robot, not robots more generally. As such, to maintain wide applicability, this measure focuses on the constructs of general attitudes and similarity and attractiveness without addressing specific robot models.

Social Cognition and Attitudes

While studying the behavior of individuals and robots in social contexts is critical to progress in HRI research and the advancement of robotic technology, one recurring limitation has been the lack of emphasis on individual differences in perceptual and reasoning processes addressing behavior within a social environment. *Social cues* (e.g., physical or behavioral patterns), conveyed by an actor and perceived by the observer, assist in judgment of the most appropriate behavioral response. Accordingly, a robot's appearance, voice, and personality all function as essential social cues. However, given the variation in robot appearance, use of such a cue becomes increasingly context-dependent and the importance of individual differences in perception and reasoning increase drastically. *Social signals* – derived from the interpretation and perception of social cues – exist within the confines of the social environment and influence individual perceptions and judgments (Fiore et al. 2013; Wiltshire et al. 2014). *Attitudes* represent the culmination of perceptual and reasoning processes through expression of the feelings, beliefs, and actions toward an agent or object. More specifically, affective feelings, cognitive beliefs, and actual behavioral actions characterize the conceptualization of individual attitudes (Spooncer 1992; Baron and Byrne 1984). In the case of HRIs, an individual's attitude toward robots determines the extent to which they will use it. For example, elderly individuals who exhibit significantly more positive attitudes toward robots are more likely to utilize the robot (Stafford et al. 2014).Thus, positive attitudes do not develop solely from the high usage rates of robotic platforms (Bartneck et al. 2005). Furthermore, attitudes not only affect robot usage, but also levels of trust. When examining automated systems, more positive implicit and explicit attitudes were related to increases in trust (Merritt et al. 2013). The aforementioned research illustrates the compelling connection between attitudes and several factors in HRI. Although factors such as levels of trust and appraisals of reliability, amongst others, have been studied in research on HRI, this study set out to examine the positivity of the interaction based upon a unique measure of similarity and attractiveness. The outcomes of interactions with robots have the potential to influence usage rates as well as attitudes and suggest that favorable attitudes are essential to efficient performance in HRI. Consequently, increasing accuracy in the perception of social cues and interpretation of social signals could be realized through design of a cognitively-similar robot. As such, this study is meant to be a first step toward understanding how individual differences in factors of similarity and attractiveness may be related to attitude positivity and familiarity.

Similarity Attraction Rule

The foremost principle of interpersonal attraction is the *similarity attraction rule*, which argues that the basis for attractiveness is the perceived similarity to another (Byrne 1971; Infante et al. 1990). The association between similarity and attraction is most commonly evaluated in terms of *liking* (Byrne 1971), which has been shown to increase trust (Doney and Cannon 1997). The reality of the similarity matters, but the perception of similarity, the degree to which an individual believes another's distinguishing characteristics are similar to their own, is often more influential when it comes to attraction (Hoyle 1993; Klohnen and Luo 2003; Lee and Bond 1998). However, individuals do not just like those who are similar in personality or thought, but also in behavior. As an example, Dutch restaurant servers who repeated their customer's orders back to them received higher tips, resulting in the conclusion that natural mimicry increases rapport (van Baaren et al. 2003). Additionally, interactions with similar others induce a sense of predictability, feelings of security, and false perceptions of understanding (Murray et al. 1996). This theory is used as the foundation for developing the RPS. In particular, this has implications for a variety of research themes in HRI research (e.g., trust and teaming). Given the points made thus far, perception and reasoning, may share a strong theoretical relationship with attitudes and the similarity attraction rule. As such, investigation into the connection between these factors and robots warrants closer examination. To that end, the RPS was designed to address this gap in the literature.

Method

Participants

Students (N = 121) from a small private Southeastern university were recruited from several classes. Participants ranged in age from 18-36 (M_{age} = 20.26, SD = 1.94). The majority was female (58.7%, n = 71) and Caucasian (73.6%, n = 89). Sample size was determined by the availability of classes to survey and in total, 164 students took part in the study. Participants were only assigned research credit points at the discretion of individual instructors and were not otherwise compensated.

Measures

The *Robot Perception Scale* (RPS) consisted of 35 items that were developed based on previous research (Warta 2014) and current related literature to attain content validity. Participants rated their agreement with the items using a Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Procedure

College students were recruited from courses offered by several departments. To assess test-retest reliability, pre- and post-tests were administered during class time in paper format and consent was acknowledged through students' participation. On the cover sheet of the testing packet, participants were told the purpose of the study and informed that: their involvement was voluntary, no identifiers would be collected on the survey, and their answers on the questionnaire would remain anonymous. They were also instructed that, for the purpose of this study, the word "robot" referred to both the machinery and artificial intelligence aspects of robots.

Results

In total, 10 classes were given pre- and post-tests; one class had a 3-week interval, eight had a 2-week interval, and one had a 1-week interval. Given that three separate time intervals occurred between pre- and post-tests, comparisons across these were performed to determine if there were any observed differences in scores. This analysis showed no significant differences between groups on the pre- or post-tests and they were, therefore, combined for subsequent analyses. Exploratory factor analysis (EFA) was performed using principal components analyses (PCA) with Varimax rotation on both the pre- and post-test items. Preliminary EFA could not obtain a rotated solution, so a subset of the 35 items were removed and the remaining divided into two subscales. This was done using a combination of the initial solution, to divide the items that were correlated with one another, and internal consistency analyses using Cronbach's Alpha, to refine the subscales by dropping the items that did not contribute to internal consistency. Secondary EFA provided a rotated solution confirming the appropriateness of dividing the items into two subscales (Table 1). The first subscale measures *general attitudes toward robots* (GA; 17 items). The second subscale measures *attitudes toward robotic similarity and attractiveness* (SA; 12 items). The GA analyses extracted four components representing attitudes related to the: *acceptance*, *usefulness, usability*, and *reliability qualities of robots*. The SA analyses extracted four components representing attitudes related to: *behavioral and cognitive similarities*, *equality*, *surface feature attractiveness*, and *deep feature attractiveness*. One item on the SA subscale, "Robots should always be submissive to humans," did not load on any components, but exhibited a moderate item-total correlation (pre, post r = .48, .51) and contributed to overall reliability, so it was retained.

Table 1. RPS Subscales and Items: General Attitudes

Acceptance	Usefulness	Usability	Reliability
• Robots are too dangerous to have around children.* • Robots are harmful to society.* • Humans should be comfortable relying on robots. • Robots do not fit into society as I imagine it.* • Robots are normal. • Robots are safe enough to use in a "caretaker" role for the elderly or children. • Robots can be trusted.	• Robots are annoying.* • Robots should only be used as disposable soldiers in society's wars.* • Robots are nothing more than fancy pets.*	• Robots are helpful. • Robots are predictable. • Robots are inefficient.* • Robots are hard-working.	• Robots are unreliable. • Robots are honest. • Robots have been given jobs that only humans should do.*

Similarity and Attractiveness

Behavioral / Cognitive Similarities	Equality	Surface Features	Deep Features
• Robots and humans behave differently.* • Robots and humans have similar communication styles. • Robots and humans approach problems and deal with them differently.* • Robots and humans have different values.*	• Robots should always be submissive to humans.* • Robots and humans are similar to one another. • Robots and humans are equals in society. • Robots and humans are similar to one another on an intellectual level.	• Robots are good-looking. • Robots are attractive.	• Robots are kind. • Robots never feel guilty.*

*Reverse scored

Items were summed on each subscale to obtain a total GA (range: 17-119) or SA (range: 12-84) score. Higher GA scores indicate a positive attitude regarding robots and lower scores indicate a negative attitude. Likewise, higher SA scores indicate greater feelings of similarity and greater evaluations of attractiveness while lower scores reflect the opposite. See Table 2 below for the RPS means, reliability, Kaiser-Meyer-Olkin (KMO) measures, and regression in which the SA scores significantly predicted the GA scores in the post-test. Regression analyses were run since interactions with similar others induce a sense of predictability and security, so it follows that communication and understanding between both parties should be easier, thus allowing more positive attitudes to develop.

Table 2. RPS Results

	GA		SA	
	Pre-test	Post-test	Pre-test	Post-test
Mean (SD)	76.21 (12.07)	74.93 (13.44)	33.33 (9.24)	34.55 (9.38)
Cronbach's Alpha	.846	.876	.782	.809
KMO	.787	.856	.748	.749
Test-retest Reliability	r = .783, p < .0001		r = .709, p < .0001	
Post-test: SA → GA Regression	β = .251, $t(119)$ = 2.79, p = .006 R^2 = .061, $F(1,119)$ = 7.78, p = .006			

Discussion

This study described a preliminary assessment of the RPS, which appears to possess an acceptable degree of internal consistency and test-retest reliability. Overall scores indicated a fairly positive attitude toward robots. Item means also demonstrated that participants did not believe robots were kind or stood on an equal level with humans in society, but they did believe that robots were efficient. In light of the SA subscale demonstrating the ability to predict scores on the GA subscale, this might suggest that similarity and attractiveness play a role in determining an individual's general attitudes toward robots. However, it is not yet clear what level of similarity with robots needs to be present to produce this effect. This study had several limitations that future studies should endeavor to overcome. Specifically, the types of validity measured were only adequate to provide a preliminary assessment of the RPS. However, current literature would suggest that the RPS is the only general robotic scale that assesses both the positive and negative attitudes toward robots and thus remains novel enough to provide a contribution to HRI literature. Predictive, discriminant, and convergent validity should be measured in future studies. Second, the age range of participants was narrow and relatively young, so age differences need to be examined. Given these results, this study provided preliminary support in favor of further investigating and improving upon the RPS for use in research addressing the human element in HRIs. Additional future research includes refinement of the RPS by obtaining a greater breadth and depth of item-related information through focus groups and discussion with subject matter experts in robotics-related fields. Finally, the RPS will be utilized in a HRI experiment to analyze the relationship between attitudes toward robots and the parameters of the interaction.

Conclusion

As robotic intelligence increases, the underlying processes that govern how people perceive and interpret robotic agents are important to expanding our understanding of human-technology interactions and the formation of attitudes in these settings. Such knowledge will facilitate the understanding of how people conceptualize an agent that is human-like, yet not biologically alive, but to some extent, mirrors human cognitive capabilities. To that end, the RPS provides a novel measure of attitudes toward robots more generally while emphasizing the role of similarity and attraction. This can help researchers identify participants who have a positive or negative attitude and effectively use RPS scores to make comparisons between them in the context of different robotic platforms/models. Similarly, those wishing to assess the effect of their artificial cognitive system or robot model on attitudes could employ a pre- and post-test approach. In sum, given the theoretical concepts linking attitudes with such factors as robot usage and levels of trust, the RPS may aid researchers in HRI seeking to create more reliable, trustworthy, and effective systems.

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