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What You Do Is Who You Are: The Role of Task Context in Perceived Social Robot Personality

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Abstract— **People tend to unconsciously attribute personality traits to all kinds of technology including robots. But what personality do they want robots to have? Previous research has found support for two contradicting theories: similarity attraction and complementary attraction. The similarity attraction theory implies that people prefer a robot with a similar personality to their own (e.g., an extroverted person prefers an extroverted robot). According to the complementary attraction theory, people prefer a robot's personality opposite to their own (e.g., extroverted people prefer an introverted robot). In contrast to both theories, we argue that what is considered an appropriate personality for a robot depends on the task context. In a 2x2 between-groups experiment (N=45), we found trends that indicated similarity attraction for extrovert participants when the robot was a tour guide and complementary attraction for introverted participants when the robot was a cleaner. These trends show that preferences for robot personalities may indeed depend on the context of the robot's role and the stereotype perceptions people hold for certain jobs. Robot behaviors likely need to be adapted not in complimentary or similarity to the users' personality but to the users' expectations about what kind of personality and behaviors are consistent with such a task or role.**

I. Introduction

Robots are no longer dull mechanical pieces of equipment designed to carry out simple, everyday tasks in factories that no human is willing to do, or able to do due to hazardous conditions. Instead, robots enter our homes and workspaces to assist and sustain independent living. Thus, robots operate in environments specifically designed for humans. Fong et al. [1] distinguish social robots from conventional robots by emphasizing that social interaction with users plays a key role. Social robots are envisioned to autonomously interact with humans in a socially meaningful way [2]. To work with humans in environments designed for humans, robots should be designed optimally for such conditions, in form, behavior, and personality.

Regarding the personality, among others, Lee et al. [2] discovered that people indeed attribute personality traits to technology. In their study, participants preferred a robot personality similar to their own personality. This is in line with the similarity attraction theory. However, the complementary attraction theory - which claims the opposite to be true - has also received support over the last years [3]. Therefore, we propose that other factors are at play and influence the users' preference for a robot's personality. One of these factors could be the context of the task, the role the robot has, and stereotypes connected to these. We hypothesize that people also project such stereotype expectations on robots in certain roles. The goal of this study is to gain a deeper understanding into the extent to which task context influences the preference for and perception of a robot's personality.

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II. Theoretical Background

Personality greatly impacts human behavior and interpersonal communication. McCrae and John have provided one of the best known definitions of personality as "the most important ways in which individuals differ in their enduring emotional, interpersonal, experiential, attitudinal, and motivational styles" [4]. For years, researchers have looked into determining personality traits (or dimensions). A personality trait can be defined as a characteristic of an individual that exerts pervasive influence on a broad range of trait-relevant responses [5]. Theorists proposed any number between three, sixteen or even 4000 different traits, however, in recent years, there has been a general consensus on five traits, also called the Big Five personality traits or Five-Factor Model [6]. This model measures individual personality differences using five different traits: extroversion, conscientiousness, agreeableness, neuroticism and openness to experience. These measures capture attitudinal, experiential, emotional, interpersonal, and motivational styles of the user [7].

People implicitly assume that certain occupations require certain personalities. The stereotype images we have of other people who are employed in a certain field of work are called occupational images. They have, among others, been researched for scientists [8], salesmen [9], accountants [10], librarians [11], lawyers [12] and college students of different faculties [13]. Research on occupational stereotypes confirms that images of occupations are actually images of people who hold those jobs. What we know about jobs, in other words, has more to do with what we know about people in those jobs than the tasks the jobs actually involve [14], [15]. According to Gottfredson [16] "people perceive occupations similarly no matter what their sex, social class, educational level, ethnic group [...], and occupational preferences or employment", which, according to Glick [14], leads to the conclusion that people organize their images of occupations in a highly stereotyped, socially learned manner.

A. Categories of Occupations

There is a widely accepted model to categorize occupations linked to personality profiles: Holland's

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RIASEC occupational model [17]. This model clusters occupations according to personality types for people that typically flourish in that particular job category. The six different occupation codes are realistic, investigative, artistic, social, enterprising and conventional. Most U.S. jobs are in the realistic (66.7%), conventional (13.4%) and enterprising (11.1%) categories [17]. There have been attempts to match the Big Five personality traits with the Holland codes. For instance, Barrick and Mount [18] found that high extroversion, agreeableness, and conscientiousness scores were predictors of managerial behavior. In another study, the extrovert people were mostly associated with enterprising and social jobs, while openness was more associated with artistic and investigative occupations [19]. Similar evidence was found by Barrick, Mount and Gupta [20]. In a meta-analysis of 21 studies containing 41 samples (N=11559), they found extroversion for instance correlated with enterprising ($p=0.41$) and social ($p=0.29$) and less with the other four occupational types. These results are in line with the findings of Broday & Sedgwick [21], who also showed that introversion was correlated with realistic and artistic occupations while extroversion with enterprising and social occupations. This research shows that our occupational images are actually based on the personality of people who work in certain professions.

B. Attribution of Traits to Technology

We assume that people do not only attribute certain traits to other people, they also attribute those traits to technology. This behavior can be explained by means of the media equation theory, which states: "Individuals' interactions with computers, television, and new media are fundamentally social and natural, just like interactions in real life" [22]. Because robots tend to have anthropomorphic features, it is generally expected that people respond to robots in a similar (social) way as they respond to people [23]. Concerning perceptions of the robot's personality, especially the extroversion / introversion dimension of the Big Five Personality scale has been applied, for instance in studies on human robot distancing [24], non-verbal cues from interactive characters [3], and perceived robot personality [22], [25]. Besides "recognizing" a machine as a person, Reeves and Nass discovered that people also hold computers to a social norm [3] based on their own personality. As mentioned above, two theories on the effect of the own personality exist: similarity and complementary attraction. According to the similarity attraction theory, people seek out people (or intelligent agents) who have similar personalities (e.g., demographics, ethnicity, political attitude). The complementary attraction theory states that people seek out others whose personalities complement their own and thus provide a counter-balance [2], [3]. Support has been found for the similarity attraction theory in research on computer voices [25]-[28] and for the complementary theory for virtual agents [3] and the AIBO robot [2].

C. The Matching Hypothesis

Knowing that people attribute specific personality traits to others in particular occupations, it is possible that people also attribute personality traits to robots, depending on the task of the robot. A social robot helping elderly in their home will probably require a different personality than a security robot checking people's ID at a security desk. Goetz et al. [3] found evidence for this matching hypothesis, which states that appearance and social behavior of a robot should match the seriousness of the task and situation. First, in an online survey, participants were given the choice which robot they would want for a given task. Participants preferred a human-like robot for artistic, enterprising, conventional, and social tasks, while the mechanical robot was chosen for investigative and realistic tasks. Similar support for the matching hypothesis was found in an experiment that exposed participants to tasks with different levels of sociability (teaching, tour guide, entertainment, and security guard). Li, Rau, and Li [29] found that participants had higher active response in the tasks with higher sociability (teaching, tour guide, and entertainment) than in the task with low sociability (security guard).

D. Suitable Tasks for Robots

But which tasks do people want a social robot to perform? Takayama et al. [30] found that people prefer robots for jobs that require memorization, perceptual skills, and service orientation, whereas people are preferred for jobs requiring artistry, evaluation, diplomacy, and social skills in general. These results are roughly in line with the results from Dautenhahn et al. [31] who found that people were more comfortable with a robot performing household tasks than social tasks like looking after children. Similarly, a survey of 442 participants showed that people would like a robot in their house to do household tasks like vacuuming and packing the dish washer, preparing their food, and watering the garden [32]. Based these findings we chose to include two distinct tasks in our experiment, namely a cleaning task and a (tour) guiding task. Cleaning, a household task, can be considered stereotypically introvert while on the other hand guiding is considered a very extrovert task.

III. HYPOTHESES

Based on the literature review above, we expect that attribution of robot personality traits is not only dependent on people's own personality, but also on the task of the robot and stereotype expectations of people that carry out such tasks. Our study includes a cleaning task and a tour guide task that are described in more detail in Section IV.

We expect that people hold stereotype expectations of a cleaning robot as introverted, while a tour guide robot will be expected to be more extroverted. This expectation leads to our hypotheses:

H1: Rather than the similarity- or complimentary attraction rule, we expect that people prefer a museum guide robot that is extroverted instead of introverted, and they prefer a cleaning robot that is introverted instead of extraverted.

Furthermore, when asked to give an opinion, we expect people to heed the advice of someone who is considered a subject matter expert, thus leading to our final hypothesis:

H2: Participants will comply significantly more with the tour guide robot's favorite painting when choosing their own favorite painting as compared to the cleaning robot.

IV. Method

A controlled 2x2 between-group lab experiment was conducted to investigate the effects of task on attributed personality. The robot personality was manipulated (introvert / extrovert) as well as the task (tour guide / cleaning task).

A. Sample

A total of 45 participants (39 males and 6 females), aged between 18 and 29 (M=21.22, SD=2.51) participated in the study. 91.1% of the participants had Dutch nationality. 48.9% of the participants had a background in Information Science and 40% in Artificial Intelligence. 42.2% of the participants indicated that they had seen social robots before and 20% previously interacted with them. 37.8% had no prior experience with social robotics. Each participant was randomly assigned to one of four conditions: introvert-cleaning (11 participants), introvert-tour guide (10), extrovert-cleaning (14), and extrovert-tour guide (10).

B. Independent Variables

The robot used in the experiment was a NAO robot by Aldebaran Robotics, operated using pre-defined scripts. These four scripts (introvert-cleaning, introvert-tour guide, extrovert-cleaning, and extrovert-tour guide) included actions such as NAO pointing its arm at certain angles toward either paintings or objects, making cleaning motions on the floor with a cloth, telling something about a fictional artwork using the built-in speech synthesizer, and walking a few steps forward. The extrovert and introvert cleaning tasks lasted 127 and 140 seconds, respectively. Tour guide tasks lasted a little longer, 155 and 195 seconds. Both introvert tasks lasted longer than the extrovert tasks because of the slower speech rate of the robot that was part of the manipulation as explained in the following.

Programming the robot based on existing human-robot interaction literature, we designed the introverted/extroverted robot behavior manipulation. The differences between introvert and extrovert behavior can be divided into two categories: kinesics and paralinguistic cues [33]. The extrovert robot used larger, faster and more frequent body movements (use of arms). A faster speech rate, higher volume and more varied pitch are indications of an extrovert personality, as well as the amount of speech [26]. In the experiment, the extrovert robot talked more. The speech volume of the introvert robot was set to 70% of the normal / extrovert volume and the speech rate was set to 65%, respectively. Furthermore, the introvert robot would bow its head down slightly when talking to the participant.

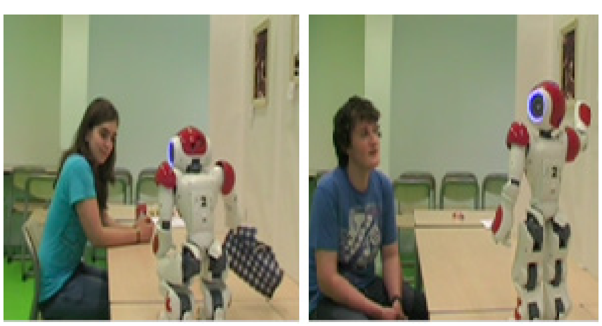

Figure 1. Robot in the cleaning (left) and tour guide (right) condition

Both tasks were set in a nondescript neutral environment with a wall with three paintings and a desk in front. The cleaning task consisted of the robot cleaning the desk area in front of the paintings (Figure 1, left). The participants had to remove two obstacles (cans) to help the robot clean. In the tour guide task, the robot pointed the participants to each painting and provided information about the three artworks (Figure 1, right). During both tasks, the robot moved from the right corner of the desk towards the participants who were seated on the left in front of the third of three paintings.

C. Dependent Variables

A post-experiment questionnaire consisting of 59 items was developed based on previous work. This questionnaire was developed to measure the following constructs: extraversion of the participant using ten items from Internet Personality Inventory, which is a short five-factor personality inventory from the International Personality Item Pool (IPIP) [34] (see Table 1). These ten items were measured using 7-point Likert scales.

Robot extraversion was additionally measured using a scale developed by Wiggins [35], consisting of both introvert (6) and extrovert (7) items, measured using a 7-point Likert-type scale (see Table 1). Because of the participant population, a Dutch translation of the items was provided to aid participants.

Since the robot's human-likeness might affect the perception of its personality, perceived human-likeness of the robot was measured using a 7-point Likert-type scale consisting of seven items developed by Ho & MacDorman [36].

Also trust conveys a lot of information about the users' attitudinal response towards robots. We therefore included a measure of trust: the 7-point Likert-type Source Credibility Scale [37], consisting of eight bipolar items. Next to trust, likeability is an important indicator of which robots people prefer. It was measured using five items on a 7-point Likert-type scale, which was developed by McCroskey & McCain [38].

Intelligence of the robot was measured by a subset of the Godspeed questionnaire [39]. These five items were measured on a 7-point Likert-type scale. At the conclusion of the questionnaire, participants were provided with the six RIASEC occupational categories, as well as two or three example jobs associated with that particular category, based upon [17]. Participants were asked to indicate on a 7-point Likert-type scale how well they believed the robot would perform in that type of job.

TABLE I. ROBOT PERSONALITY MEASURES

Robot personality (Wiggins measure), α=0.827
Cheerful (opgewekt) **
Enthusiastic (enthousiast) **
Extroverted (Extrovert) **
Unrevealing (verhullend)
Vivacious (levendig, pittig) **
Inward (naar binnen gekeerd) **
Outgoing (uitbundig) **
Undemonstrative (gereserveerd)
Jovial (joviaal) **
Bashful (verlegen, schuchter) **
Introverted (introvert) **
Perky (brutaal, eigenwijs)
Shy (verlegen) **
Robot personality (IPIP measure), α= 0.804
The robot is the life of the party**
The robot is quiet around strangers*, **
The robot feels comfortable around people
The robot doesn't like to draw attention to him/herself*, **
The robot starts conversations**
The robot has little to say*
The robot talks to a lot of different people at parties**
The robot doesn't talk a lot*, **
The robot doesn't mind being the center of attention
The robot keeps in the background*, **
* Item reversed prior to analysis
** Item combined into "robot personality" measure (α=0.877)

D. Experiment Procedure

After entering the experiment room, the participant was informed of the overall experiment procedure and the purpose of the study. After having filled in the consent form, the participant was introduced to the robot, and asked to sit and watch the robot.

The duration of the task was between two and three minutes, depending on the condition. During the experiment, the robot would first tell either that it cleans the floor around these three paintings or that it provides information about the artworks in this room. The experiment concluded with the robot asking the participant which of the three paintings was the participants' favorite. Having given the answer to the robot, the experimenter informed the participant that the experiment was over.

After completing the post-experiment questionnaire, the participant was given a chupa chup lollypop (non-students) or a lollypop and course credit (students) as reward for participating in the experiment. The total length of the experiment was about 15 minutes.

E. Data Analysis

After checking internal consistency and normality of the items that make up the set of measures, 53 items were included in the final set of measures.

Because of the high internal consistency of both robot personality measures we ran a principal component analysis (PCA) on the 23 robot personality items in order to create a combined internally consistent measure of robot personality. The Kaiser-Meyer-Olkin (KMO=0.557) measure verified the sample was, although just, suited for analysis. Bartlett's test of sphericity (X^2 (253)=501.7, $p<0.01$) indicated that correlations between items were sufficiently large for PCA. 17 items were found to explain 27.38% of the variance. These items, marked with (**) in Table 1 were combined into one robot personality measure, with α=0.877.

Based upon their average personality score (between 1.0 and 7.0), participants were classified as either introvert, extrovert, or neutral participants. Participants who scored below 4.0 on extroversion were classified introvert, above 5.0 extrovert and between 4.0 and 5.0 as having a neutral personality. Participants having a neutral personality were excluded from the final part of the analysis (see "Participant personality and trust" in the next section). A major problem with this part of our analysis is the limited amounted of remaining participants: of the 25 remaining participants (55.56%), 15 were classified as having an introvert personality and 10 having an extrovert personality.

V. RESULTS

A manipulation check confirmed that people perceived the extrovert robot (M=4.92, SD=0.70) as more extrovert than the introvert robot (M=4.40, SD=0.85) ($t(43)=-2.230$, $p<0.05$). However, no statistically significant interaction effects were found between the robot's behaviors and the task contexts for perceived intelligence, likeability, or social credibility. Instead, a main effect for social credibility was found. Both robots were trusted, but, the introverted robot was rated significantly less credible (M=4.70, SD=0.66) than the extroverted robot (M=5.29, SD=.64) ($F(1, 41)=8.95$, $p<0.05$) in both tasks; thus rejecting H1.

In each condition, the robot would tell which painting was its favorite. In the extrovert conditions this was more explicit and prominent (in the beginning of the interaction) than in the introvert conditions. In the questionnaire, participants were asked to recall which painting the robot favored. More participants in the cleaning condition recalled the robot's favorite painting correctly (Table 2). We believe this to be due to the fact that the tour guide robot gave a lot of information, whereas the cleaning robot did not say a lot except for its task and favorite painting.

TABLE II. COMPLIANCE TO THE ROBOT'S FAVORITE PAINTING SUGGESTION

	Introvert robot	Extrovert robot
Correct Recall of the Robot's Favorite Painting		
Cleaning condition	10 (90.9%)	11 (78.6%)
Tour guide condition	5 (50.0%)	6 (60.0%)
Match between Robot and Participant's Favorite Painting		
Cleaning condition	1 (9.1%)	3 (21.4%)
Tour guide condition	5 (50.0%)	4 (40.0%)

At the end of the interaction, each participant was asked which painting was his/her favorite. The robot already had told the participant which painting it liked the most. Thus, a match could be seen as compliance with what the participants believed to be the robot's favorite painting (see Table 2). The percentage of matches was significantly affected by the task of the robot: participants in the tour guide condition matched their choice more often than

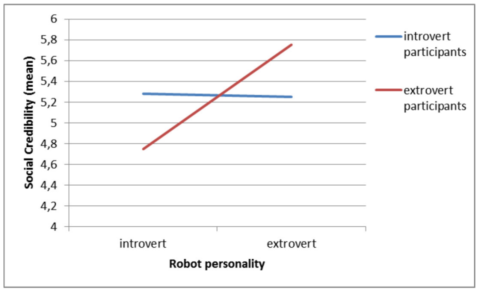

Figure 2. Social credibility (trust) in the tour guide condition

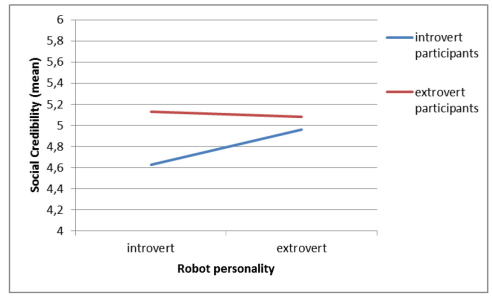

Figure 3. Social credibility (trust) in the cleaning condition

participants in the cleaning condition (*U*=150.0, Z=-2.719, *p*<0.01, 2-tailed). This finding supports H2.

In the post-experiment questionnaire, participants were asked which RIASEC job type they thought the robot they just saw could do. Participants believed the extrovert robot was more suited (M=2.63, SD=1.74) for an artistic job than the introvert robot (M=1.67, SD=1.20) (*t*(43)=-2.174, *p*<0.05).

A. *Participant personality and trust*

An interesting non-significant (*F(1,25)=8.10, p=0.31*) trend was found related to the debate on the similarity attraction versus complementary attraction theory. In the tour guide condition, extroverted people trusted the extroverted robot (M=5.75) more than the introverted robot (M=4.75). The introverted participants, however, rated the introverted (M=5.28, SD=0.34) and extroverted robot (M=5.25, SD=0.89) equally trustworthy. Thus, there is a tendency towards a similarity attraction effect that is only supported by the extroverted participants (Figure 2).

In the cleaning condition, however, introverted participants trusted the extrovert robot (M=4.96, SD=0.08) slightly more than the introvert robot (M=4.63, SD=0.76). The extroverted participants rated the introverted robot (M=5.13, SD=1.06) equally high as the extroverted (M=5.08, SD=0.67). So there is some indication for a complementary attraction effect, however, it is only slightly supported by the introvert participants (Figure 3).

VI. Discussion & Conclusion

We did not find sufficient evidence for the matching hypothesis, nor evidence for either the similarity attraction or complementary attraction theory. In contrast, the data suggests that attraction rules for robot personalities and behaviors depend on the task context. We expected that people would hold such stereotypical expectations of robots in particular jobs that they would prefer an introverted robot as cleaner and an extroverted robot as museum guide. However, the trend we found may indicate that for some task contexts the similarity attraction rule holds while for others the complementary attraction theory may apply. This suggests that people's preferences for robot's personalities may be much more complex than initially found. Rather than preferring a robot with a personality similar to the own, we may want this for a robot working on tasks that are connected to specific stereotypes. Therefore, future work should not only assess whether a certain personality would be suited for a certain task, but if the participant has stereotypical thoughts on the associated personality.

If task actually has an effect, this will have a major impact on adapting robot behaviors to users' personalities. Household robots would need to adapt their behaviors differently from museum guide robots, robots that pick up trays in hospitals, office robots and so on.

Our study did reveal that participants in the tour guide conditions complied more with the art preference of the robot, in contrast with the cleaning condition. Perhaps participants found the tour guide robot more as an authority on art compared with a cleaning robot and they were more likely to comply to the guide's taste. This could also indicate that role expectations indeed influence people's behaviors leading to more or less compliance in particular task settings. However, due to the small sample size the observed effect could very well be a coincidence.

The current study was a first exploration of the task context in identifying effective robot personalities and behaviors. The limitations of the current study need to be addressed in future research. One of the limitations can be found in how the robot personality was manipulated. Participants in the cleaning condition had to physically remove an obstacle out of the way in order for the robot to continue cleaning. In case of the tour guide, no physical action of the participant was requested. Also, participants were not selected based on their personality. From our entire sample 45% of the participants did not have a strong extroverted or introverted personality and were therefore excluded from the personality matching part of our study. This limits the statistical power of the results. For a future study, selection based on personality could be helpful. While we are aware of gender differences in perceived personality we chose not to explore this factor because of obvious disparity within the sample.

Based upon previous HRI research and social psychological literature this study has attempted to answer questions regarding "socially normative behavior" for robots, in this case social robot's personality trait attribution. In our experiment we did not find results confirming our first hypothesis; we did not find that participants preferred the extraverted guide and the introverted cleaner robot. We did find out that participants found the robot more trustworthy depending on the setting, either displaying a similarity- or a complementary-personality to their own. This suggests that the similarity- and complementary attraction theories do not capture the complexity that is involved in the perception of a robot's personality in the context of its role. It could very well be that people have the tendency to identify more or less with certain roles and that this influences whether they respond to a robot based on the similarity- or complementary attraction theory.

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