Looking Good? Appearance Preferences and Robot Personality Inferences at Zero Acquaintance

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Abstract

The study presented in this paper explored the relationships between participant personality, perceived robot personality and preferences for particular robot appearances. The participants (N=77) watched 3 videos of a HRI situation in which the appearance of the robot was altered to appear more or less anthropomorphic. Participant personality was assessed using the Big Five Domain Scale, while Robot Personality was measured using 5 items based on the traits from the Big Five Model. The results reveal that low Emotional Stability and Extraversion scores are related to preferences for mechanical robot appearances. Results for perceived robot personality suggest that participants clearly differentiated between the different robots on the dimensions of Extraversion, Agreeableness and Intelligence, but did not differentiate strongly between them on the Emotional Stability dimension.

Index Terms – Human robot interaction, video trials, social robotics, personality, robot personality, anthropomorphism, robot appearance

Introduction:

The focus of this particular study is twofold. Firstly to investigate the role of participant personality in relation to preferences for the anthropomorphism of robot appearance, secondly to investigate the role of robot appearance in the attribution of personality traits to the robot.

Appearance does matter:

In the development of most products marketed to the public, appearance is seen as an important factor, where both the intrinsic reward in using the product as well as decisions on which product to use in the future are derived from the physical appearance of the products in questions (C. DiSalvo & Gemperle, 2003; Jordan, 1998). This phenomenon is also apparent in Human-Computer Interaction (HCI), where the aesthetic value of an interface has been shown to have an impact on the perceived usability of a system (Tractinsky et al., 2000). In the field of Human-Robot Interaction (HRI), appearance has been considered in several studies (Blow et al., 2006; Breazal, 2002; C. F. DiSalvo et al., 2002; Goetz et al., 2003; Robins et al., 2004; S. Woods et al., 2004). Robots are not only wide spread in industry but they are projected to become more and more abundant in social and home settings where their ability to function socially is important. A vital part of this ability is the design of robot appearance as a contributing factor to appropriate social interactions. Since the goal of our research is the creation of a personalised robot companion (Dautenhahn, 2004), it follows that the possibility of individual differences in appearance preferences and their correlates should be investigated.

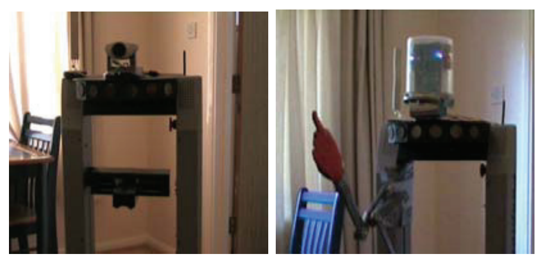

Figure 1. Mechanical (left) and Basic (right) Robot Appearance

Personality:

Big Five Model of Personality:

The personality model we used in this study was the Big Five Model, measured using the Big Five Domain Scale from IPIP (Goldberg, 1999). This model is used extensively in psychological research, which means that results obtained through the use of this model can be compared easily to those of other psychological studies. The Big Five model assumes five basic personality factors (See table 1 for a brief description of correlates for the different factors).

Table 1 Big Five Personality Factors (Adapted from (Matthews et al., 2003)

Emotional Stability	Anxiety, depression, self-consciousness, impulsiveness, vulnerability
Extraversion	Warmth, gregariousness, assertiveness, activity, excitement seeking, positive emotions
Agreeableness	Trust, straightforwardness, altruism, compliance, modesty, tender-mindedness
Conscientiousness	Competence, order, dutifulness, achievement striving, self-discipline, deliberation
Intellect	Imagination, ideas, abstract thought, range of interests

Personality and HRI

HRI researchers have been studying the role of participant personality and different issues in human-robot interactions. Previous studies have shown that there is a relationship between participant personality and proxemics in HRI situations. Proxemics, or the study of interpersonal distances and personal space (Hall, 1966) during interaction, has been of particular interest due to its direct implications for robot navigation planners in human to robot or robot to human approach situations. Walters et al. (Walters et al., 2005) found that participants scoring high in 'Proactiveness' (A personality factor correlating with dimensions of both Extraversion and Psychoticism in the EPI[1] model), did not allow the robot to come to as close a distance as participants with lower scores in this trait.

Syrdal et al. (Syrdal et al., 2006) and Gockley and Matarić (Gockley & Mataric', 2006) both found a proxemic tolerance effect for extraversion, in which extraverts tended to tolerate the robot's presence to larger extent than introverts. Gockley and Matarić also found that extroverts responded better to robots being more 'dominant' in their interactions both in terms of evaluation and task performance. A similar result was found by Tapus and Matarić (Tapus & Mataric´, 2006), showing that when using differing robot behaviours consistent with human personality types along the extraversion – introversion dimension, participants responded better when interacting with robots whose designed 'personality' matched their own.

Perception of Personality

One way of measuring human perception of robot appearance in terms of attribution of human characteristics, focuses on the assessment of robot personality based on appearance. The *anthropomorphic* attribution of personality to non-human entities can be viewed in two separate ways. One way is to view it as a fallacy that obscures the reality of behaviour that does not correspond to human behaviour and thus impedes progress towards understanding and prediction of non-human behaviour (Davis, 1997). The other is to see such attribution as a useful heuristic in describing behaviour in terms that are relatively easily understood by most audiences (Asquith, 1997). In relation to technological artefacts, Nass & Reeves (C. Nass et al., 1995; C. I. Nass et al., 1995; Reeves & Nass, 1996) suggest that this attribution of personality is difficult to avoid. They also state that utilising this phenomenon can be helpful when designing user interfaces and behaviour of such artefacts as it allows for easy and intuitive prediction of system behaviour for the user. This argument is also presented by Duffy (Duffy, 2003). In the domain of HRI, when confronted with entities with unknown behaviour, such as robots, anthropomorphism might thus be used as a guide to cope with the unpredictability of the situation. The implications of such a paradigm is that robot design should endeavour to create robot appearances to which personality attributions are made that correspond to the intended behaviour of the robot as suggested by Goetz et al.(Goetz et al., 2003) For this to be possible, it is necessary to explore the relationship between personality attribution and appearance, in HRI situations. To be able to fully explore this relationship we will first consider how humans rate other humans in terms of personality with limited information before we investigate HRI studies.

In the field of personality and social psychology, studies investigated how successfully participants rate strangers on various personality dimensions at *zero acquaintance,* i.e. contexts in which perceivers are given no opportunity to interact with "strangers" (targets of whom no prior knowledge is available to the subject (Albright et al., 1988)). These studies found that the traits Extraversion, Agreeableness and Conscientiousness seem to allow for the most successful rating of strangers, with Emotional Stability and Openness to Experience the most difficult to rate (Albright et al., 1988; Borkenau & Liebler, 1992). This effect is exhibited even in situations where there is no interaction between participants and even when rating is done purely on the basis of emails (Gill et al., 2006). This body of research also revealed that Extraversion ratings are highly correlated with the physical attractiveness ratings of the person being rated. Of particular interest for our experiment is the Borkenau & Liebler study (Borkenau & Liebler, 1992) where participants rated strangers according to the Big Five personality traits after having only either seen still photos or videos of the strangers.

If one purely extrapolates the results from Human-Human studies on personality attributions to HRI one would expect that Extraversion, Conscientiousness and Agreeableness will be the personality traits with the largest systematic variance in participant ratings due to cues arising from appearance and behaviour, i.e. that these are the traits where people's ratings will change the most according to differences in between robots.

[1] EPI – The Eysenck Personality Inventory, uses a model assuming three underlying dimensions of personality: Extraversion, Neuroticism and Psychoticism(Matthews et al., 2003).

Research on the attribution of personality to robots does to some extent support this extrapolation. Kiesler and Goetz (Kiesler & Goetz, 2002) reported that participants found it easier to rate the robot on the extraversion dimension, while finding Emotional Stability and Openness to experience the most difficult dimensions in which to rate the robot.

Note, this study, along with our previous study (Woods et al., 2005) also investigated the issue of participant projecting their personality traits unto the robot. Woods et al found that this was not the case. This will, however, not be the focus of this paper, as our primary interest is in the relationship between designed appearance and perceived robot personality.

Expectations and Research Questions:

As there have been no conclusive findings from previous studies on participant personality and evaluation of HRI situations, this aspect of our investigation is exploratory in nature. Previous research on perceived robot personality and general trait inference studies do suggest that Extraversion, Conscientiousness and Agreeableness would be the traits with the largest differences. We also expect that these differences will depend on the appearance preferences, with higher ratings on these traits for the preferred robot appearances. The specific research questions investigated were:

1) Did a common pattern emerge towards preferences for any of the robot appearance styles?
2) Did people distinguish between the different robot appearance styles in terms of personality characteristics?
3) Are there any observable trends between different subject personality types and preferences for different robot appearance styles?

Method:

Participants:

The study had 77 participants (71 males and 6 females, 18 to 52 years of age). The mean age of the participants was 25.12 (SD=9.2) and the median age was 24. The participants were students or staff at the University of Hertfordshire from various disciplines.

Situation:

The participants were shown a video in which a robot approached a person in a home environment in order draw his attention using sound and gestures. The scenario designed for these particular trials took place in a 'real' home (The University of Hertfordshire *Robot House*) to increase believability and ecological validity of the trials. Note, in previous studies we showed the validity of video trials compared to live trials, suitable for HRI scenarios such as the one reported in this paper, i.e. with little direct, physical interactions between robot and subjects (Woods et al., 2006). Subjects were provided with the following instructions at the outset of the trial:

> "To help us refine human-robot interactions, we need to know exactly what people prefer or actively dislike. This trial aims to explore some important aspects of human preferences toward different robot appearances and behaviour styles. A robot companion within the home would need to know how to attract a person's attention for different situations, and what people's preferences are. You will view some videotaped clips that depict a scenario where a person is busy at home, when the doorbell rings. The robot companion goes to answer the door and lets the person in, and then needs to let the person at home know that they have a visitor. The video clips will show the robot with three different appearance styles, and the ability to use different cues (e.g. lights, noises, voices) to attract your attention, in the hope of initiating an interaction with you. We would like you to watch each video clip carefully and imagine that you are the person interacting with the robot. We would like you to tell us about your preferences by completing the questionnaire at the end of the clips."

The participants were shown three versions of the video clip. In each version the robot's appearance as well as gesture and sound cues were varied. The first appearance (see Fig 1: Left), labeled 'mechanical appearance' was a standard PeopleBot™ (ActivMedia Robotics) with a camera but no specific anthropomorphic features. In the HRI scenario it communicated, i.e. indicated its presence, using beeps and movements of its gripper. The second appearance (see Fig 1: Right), labeled 'basic appearance' was modified by our research team to feature a simple

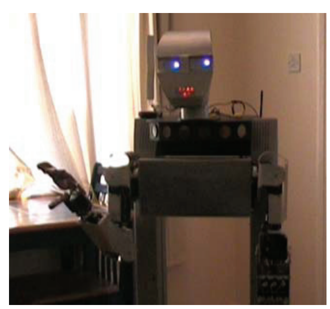

Figure 2. Humanoid Robot Appearance

mechanical head, i.e. a translucent round 'head' with two glowing lights for 'eyes' with circuitry clearly visible. It communicated using a mechanical voice and a simple arm. The third appearance (see Fig 2), labeled 'humanoid appearance' was modified to feature a detailed humanoid head with glowing elliptical eyes, nose and mouth, painted in silver. It communicated using a human voice and a human-like arm for gestures. Gesture and sound cues were chosen by the research team in order to match the overall robot appearance (basic, mechanical, humanoid).

Measurements:

The participants' academic background, computer proficiency, prior exposure to robots and other demographic details were assessed using questionnaires. Participant Personality was measured using the IPIP (Goldberg, 1999) see table 2 below for sample items with both extremes for this scale:

Table 2 Sample Items from the Big Five Domain Scale

Emotional Stability	I am relaxed most of the time. I get stressed easily.
Extraversion	I am the life of the party. I am quiet around strangers.
Agreeableness	I sympathise with others' feelings. I feel little concern for others.
Conscientiousness	I am always prepared. I leave my belongings around.
Intellect	I use difficult words. I am not interested in abstract ideas.

Perceived Robot personality was measured using the following items. Note that a general intelligence item was substituted for the Intellect/Openness to Experience dimension:

Table 3 Robot personality items

Emotional Stability	How relaxed and content, or stressed and easily upset was the robot?
Extraversion	How extravert/introvert was the robot?.
Agreeableness	How interested/disinterested in people was the robot?
Conscientiousness	how organised & committed or disorganised/uncommitted was the robot?
Intellect	how intelligent or unintelligent was the robot during its tasks?

Results

General Preferences:

Most preferred appearance:

The frequencies of responses to the question regarding the most preferred appearance can be found in table 4 below, see also Figure 3. 'Missing' refers to participants who did not indicate any one particular appearance as most preferred. The differences between expected and observed frequencies were significant (χ^2 (2) = 36.189, p<.001), whereby the humanoid appearance is the most commonly preferred.

Table 4 Frequencies of most preferred robot appearance

Robot Type	Frequency	Percentage
Mechanical	14	18.2%
Basic	11	14.3%
Humanoid	49	63.6%
Missing	3	3.9%
Total	77	100%

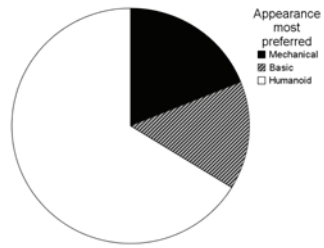

Figure 3. Distribution of most preferred robot appearance

Appearance Preferences were also assessed using a 5-point Likert scale. The mean results from this evaluation can be found in table 5 below and in Figure 4.

The mean difference were assessed with an ANOVA (F(2)= 21.46, p<.001) which found a significant main effect for robot appearance. Post hoc tests found significant differences between all three robot appearances. This suggests that the participants as a whole preferred the humanoid appearance to the basic Appearance and both appearances to the mechanical appearance.

Table 5 Mean Appearance Preference Scores

Robot Type	Mean Preference Score	SD	N
Mechanical	2.47	1.039	76
Basic	2.95	.992	76
Humanoid	3.59	1.098	76

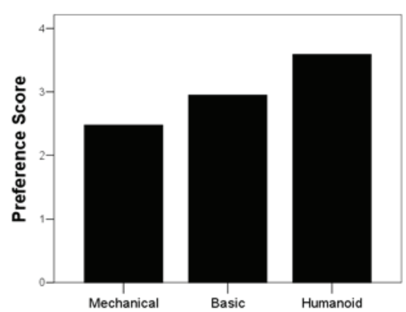

Figure 4. Mean Appearance Preference Scores

Correlations were then run between the preferences indicated for each robot appearance and the personality traits. A significant result was found between Extraversion and Mechanical Appearance preferences (r=-.263,p=.022) and Emotional Stability and Mechanical Appearance preferences (r=-.313,p=.007). These two correlations suggest that participants scoring low in extraversion prefer the mechanical appearance to a greater degree than other participants.

The mean assigned scores for the different personality traits according to appearance can be found in table 6 and figure 5 below:

Table 6 Mean scores for perceived robot traits

Personality Trait	Mechanical Robot	Basic Robot	Humanoid Robot
Emotional Stability	3.22	3.33	3.57
Extraversion	2.35	3.08	3.72
Agreeableness	2.47	3.22	3.64
Conscientiousness	3.23	3.45	3.75
Intellect	2.89	3.24	3.67

Results suggest that for all the traits, the mechanical robot scored the lowest overall, followed by the basic and then the humanoid robot. The relationships between the personality traits and robot appearances were assessed by running a series of ANOVAs.

- For extraversion there was a significant main effect for appearance ($F(1.79)=51.62, p<.001$). Posthoc tests found that there were significant differences between all three robot appearances ($p<.005$).
- For Agreeableness there was a significant main effect for appearance ($F(1.79)=37.80, p<.001$). Posthoc tests found that there were significant differences between all three robot appearances ($p<.005$).
- For Conscientiousness there was a significant main effect for appearance ($F(1.67)=9.855, p<.001$). Posthoc tests found significant differences between the humanoid appearance and the two other appearances ($p<.005$).
- For Emotional Stability there was a significant main effect for appearance ($F(1.75)= 4.014, p<.05$). Posthoc tests found no significant differences between the conditions.
- For Intellect there was a significant main effect for appearance ($F(1.77)=21.87, p<.001$). Posthoc tests found significant differences between all three appearances ($p<.05$).

Discussion:

Personality and appearance preferences:

The most salient results were the negative correlations that were found between appearance preferences for the mechanical appearance and the two personality traits, extraversion and emotional stability, in which participants scoring low on these traits preferred the mechanical appearance to a larger extent than other participants. This would suggest a preference for robots without anthropomorphic features in these participants. This could be seen as a general disposition to prefer a robot

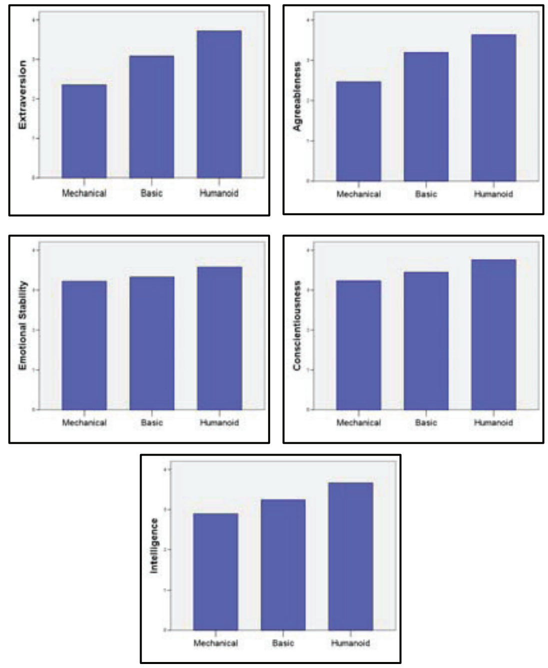

Figure 5. Mean scores for perceived robot traits

companion that does not require interactions that are as social in nature as what would be expected of the more anthropomorphic appearances. The use of speech by the basic and humanoid robot may have had a strong impact on this. As introverts and individuals scoring low on emotional stability would find social interactions more stressful than other individuals (Matthews et al., 2003), this could lead to the conclusion that some users may find a less explicitly anthropomorphic means of interacting with a robot companion more suitable than more extrovert and emotionally stable users.

These results can also be taken in support of Tapus and Matarić'(Tapus & Mataric´, 2006) notion of matching robot personality with that of the user as the mechanical appearance was rated the least extrovert of the three robot appearances. This suggests that participants preferred robots whose attributed personality traits matched their own along the extraversion-introversion dimension.

Attribution of Robot Personality:

These results suggest that the processes of assigning personality traits to a robot have similarities with that of assigning the same traits to other humans.

Firstly, what we appear to see is an overall 'halo effect' (in which a positive rating on one dimension leads to higher scores on other dimensions (Asch, 1946) where liking for the particular robot appearance led to a higher rating for all its personality traits (which consisted of items that would be seen as good and desirable by most participants). This effect can be considered to account for the overall differences between the robots as the ratings for personality traits corresponded with the overall ratings for robot appearance preferences. Also, it accounts for the role of appearance preferences as predictors for perceived robot personality.

Secondly, the above effect is greatest for the Extraversion, Agreeableness and Intellect, while it is weaker for Conscientiousness and Emotional stability. This does, to some extent correspond with the findings of Kiesler & Goetz, (Kiesler & Goetz, 2002) who found that participants' mental models for robots were richer for the personality trait of Extraversion and less so for Emotional stability. Also, as the item used to measure Agreeableness was directly related to social behaviour, the large effect size for this trait may reflect a similar phenomenon to that proposed by Kiesler and Goetz as well. As our study did not give a 'not applicable' option for the trait ratings (in order to encourage the subjects to make decisions), richness of a mental model would here be indicated in the ability of the participants to differentiate between the robot appearances for a particular personality dimensions, reflected in the variances.

It should be noted that the findings also correspond with the studies on human-human ratings of strangers in that the differences for Extraversion, Conscientiousness and Agreeableness were greater than that for Emotional Stability, which fits well with the notion of Emotional Stability being the most difficult trait to accurately rate strangers (Albright et al., 1988; Borkenau & Liebler, 1992). This combined with the halo effect, points to a similar mechanism for assigning a robot personality as that for assigning personality to another human being. This also accounts for the perceived intelligence of the robot. The impact of the halo effect on perceived intelligence is well documented in the literature (Zebrowitz et al., 2002), and so it is a strong possibility that this effect may also impact on perception of robot intelligence.

Shortcomings of the study:

While for scenarios with little interaction between robot and subjects video trials have shown to be a valid method compared to live trials(S. Woods et al., 2006), other scenarios involving more interaction in live situations might provide different results. Also, subjects were exposed to the robots only briefly, and as such results from repeated and prolonged interactions may differ from what was shown in this study. We do contend, however that the initial impression and evaluation of a robot companion is important in HRI. In many instances, individuals will interact with robots in situations that are limited in both time and scope, such as in museums, hospitals or if visiting homes that own robot companions. We do recognise the need for longitudinal studies that examine how impressions and evaluations of social robots change over time. For such an undertaking, establishing baselines at zero acquaintance, as this paper does, is important to accurately track these changes.

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