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# Robots should be seen and not heard…sometimes: Anthropomorphism and AI service robot interactions

*Dr Kate Letheren[1], Professor Jolanda Jetten[2], Professor Jonathan Roberts[3], Associate Professor Jared Donovan[4]*

*[1]School of Advertising, Marketing and Public Relations | Centre for Behavioural Economics, Society and Technology, Queensland University of Technology.*
*[2]School of Psychology, University of Queensland.*
*[3]School of Electrical Engineering and Robotics, Queensland University of Technology.*
*[4]School of Design, Queensland University of Technology.*

**Abstract**
There is a growing need to understand how consumers will interact with Artificially Intelligent (AI) domestic service robots, which are currently entering consumer homes at increasing rates, yet without a theoretical understanding of the consumer preferences influencing interaction roles such robots may play within the home. Guided by anthropomorphism theory, this research explores how different levels of robot humanness and social interaction opportunities affect consumers' liking for service robots. A review of the extant literature is conducted, yielding three hypotheses that are tested via 953 responses to an online scenario-based experiment. Findings indicate that while consumers prefer higher levels of humanness and moderate-to-high levels of social interaction opportunity, only some participants liked robots more when dialogue (high-interaction opportunity) was offered. Resulting from this work is the proposed Humanized-AI Social Interactivity Framework (HASIF). The framework extends previous studies in marketing and consumer behavior literature by offering an increased understanding of how households will choose to interact with service robots in domestic environments based on humanness and social interaction. Guidelines for practitioners and two overarching themes for future research emerge from this work. This paper contributes to an increased understanding of potential interactions with service robots in domestic environments.

**Keywords** Artificial Intelligence (AI), service robots, social interaction opportunities, liking, Anthropomorphism, consumer psychology

**Paper Type** Research Paper

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## 1. Background and Introduction

Humans already interact conversationally with AI. Currently, most conversations are based on discrete, utilitarian interactions such as providing directions to a GPS or asking Siri about the weather (one notable exception being AI mental-health support chat-bots) as AI technologies are generally more suited to these transactional service tasks (Huang & Rust, 2021). However, if the technology could enable richer conversation rather than discrete fact-based inquiries, would people be interested in engaging, and perhaps even respond to the AI as they would a friend – for instance, with higher levels of liking for the AI? Indeed, research indicates that conversation can be an essential part of establishing service friendships and relationships (Garzaniti, Pearce, & Stanton, 2011) and that technologies that enable human-like conversation, such as voice-based assistants, tend to be seen as social actors (Pitardi & Marriott, 2021; Whang & Im, 2020).

In addition to being conversational, the AI's success may also depend on its appearance, which functions as an additional and potentially crucial method of delivering human-cues for embodied robots. This pairing of conversational ability and appearance may hold particular relevance for service robots, which are the focus of this paper. Wirtz *et al.* (2018, p.909) define service robots as "…system-based autonomous and adaptable interfaces that interact, communicate and deliver service to an organization's customers." Research notes that AI agents like service robots are judged not only on their behavioral realism but their form realism as well (Miao, Kozlenkova, Wang, Xie, & Palmatier, 2021). In this study, behavioral realism is represented by social interaction opportunity (i.e., the ability to converse), and form realism is captured in human-like appearance. Indeed, this study proposes that behavioral and form realism elements may be symbiotic: that is, that increased social interaction with AI robots may require a tangible social actor to provide visual cues to indicate that conversation is available.

An AI designed to engage in conversation must trigger social cues – which is more easily achieved if it is not only embodied/present but also visually humanized. For instance, studies indicate that physically present robots provide a greater sense of social presence (Nowak & Biocca, 2003), are perceived more positively (Li, 2015), and are shown more empathy (Kwak *et al.*, 2013) than their 'disembodied' counterparts such as virtual AI agents. Once a sense of physical presence is established, visual anthropomorphism is an effective way of providing human cues (Aggarwal & McGill, 2007; Connell, 2013; Labroo, Dhar, & Schwarz, 2008) and potentially triggering human-interaction scripts (Epley, Waytz, & Cacioppo, 2007; Waytz, Gray, Epley, & Wegner, 2010).

This sense of social or physical presence is becoming more important as the roles assigned to robots evolve. Once relegated to the factory floor, the market statistics show that robotics is expected to be one of the most influential technologies over the next five years (Euromonitor International, 2019), with the personal robotics market projected to outpace industrial robotics and reach 35 billion USD in value as early as 2022 (Reuters, 2019). The introduction of service robots is changing roles for employees and customers alike (Larivière *et al.,* 2017), and robots will take on a range of diverse roles based on their capabilities and intelligence levels (Davenport, Guha, Grewal, & Bressgott, 2020). Importantly, there is an upward trend in service robots intended for the consumer household environment (International Federation of Robotics, 2017). This context presents new and exciting challenges for service marketing researchers and practitioners (Wirtz *et al.,* 2018), as service "employees" in the form of humanized robots completing a service will be operating across digital, physical, and social realms (Bolton *et al.,* 2018) within the home. Whereas previously only affluent consumers could afford permanent in-home service employees (e.g., live-in nannies, personal trainers, chefs, housekeepers), the service robot industry's growth will make this service experience a reality for increasing numbers of consumers.

However, service robots cannot be assumed to be the same as human service employees. It remains unclear how consumers wish to interact with service robots and how the interaction context may alter these preferences. For instance, a study from Letheren, Russell-Bennett, Mulcahy and McAndrew (2019) finds that consumers prefer to assign clearly defined social 'roles' like intern or manager to their technology, while Savela, Turja, and Oksanen (2018) found that what humans expect of robots depends on the context. For instance, in medical settings, robots are thought to be able to monitor patients but not provide companionship, while in military settings, robots are deemed useful for rescue but not surveillance missions. Like interaction roles, interaction style also varies by context, with humans sometimes preferring 'relatable' robots exhibiting biases (Biswas & Murray, 2017) and rejecting robots that attempt to persuade them, as they experience a negative response to this perceived manipulation (Ghazali, Ham, Barakova, & Markopoulos, 2019).

While human expectations and requirements for interactions with robots can be complex, they nevertheless bear investigation and understanding, as being comfortable with interaction is a crucial determinant of how much a service experience is enjoyed and utilized (van Pinxteren, Wetzels, Rüger, Pluymaekers, & Wetzels, 2019). Recent work indicates that one path for future research is an understanding of the emotional and relational elements of the service experience (Wirtz *et al.,* 2018), hence in this research we focus on two central variables to better understand social interactions with AI robots: social interaction opportunity (i.e., AI conversational ability), and human-like appearance.

This paper first discusses the elements of robot humanness that help us understand human-robot social interactions, specifically the construct of anthropomorphism, the possibility of liking robots (a form of positive social engagement), and the unique challenges offered by the domestic environment. The literature review develops three research hypotheses examining the influence of humanness (H1) and social interaction opportunities

(H2) on robot liking, as well as examining potential interactions between these two focal variables (H3). The hypotheses are examined in a study described in the method and results sections. Finally, a discussion of contributions and future research directions is presented.

## 2. Literature review

### *2.1 Anthropomorphism and human-like interactions*

Fundamental to our interactions with service robots, given these robots are designed to interact with customers in a service setting (Wirtz *et al.*, 2018), is anthropomorphism. Anthropomorphism refers to the extent to which people attribute human characteristics to a non-human agent (Epley *et al.*, 2007). According to the Epley et al's (2007) theory of anthropomorphism, the likelihood of anthropomorphism is determined by Sociality motivation (need for social connection),Eeffectance motivation (need for control/to avoid uncertainty) and Elicited agent Knowledge (applying anthropocentric knowledge structures to non-humans) – hence, the theory is entitled the SEEK theory of anthropomorphism (Epley *et al.*, 2007). When anthropomorphism occurs – often subconsciously within moments of 'meeting' a non-human agent – the consumers' mindset shifts, recognizing that the service is not being delivered by a some*thing* but rather by a some*one,* with those agents seen as being human-like also being more likely to be treated as humans (Epley *et al.*, 2007). This mindset shift is fundamentally important to any social interactions between the human and non-human, and can even help consumers make sense of unpredictable or unfamiliar agents or situations and hence satisfy effectance motivation (Waytz *et al.*, 2010; Yang, Aggarwal, & McGill, 2020). Indeed, one of the areas where anthropomorphism often occurs is when people are interacting with technology (Epley, Akalis, Waytz, & Cacioppo, 2008), as people attempt to familiarize themselves with increasingly novel technologies; for example, the Microsoft Paperclip of early Windows PCs, or Siri on Apple iPhones. Humanized technology is even seen as better able to competently fulfill its intended functions (Waytz, Heafner, & Epley, 2014).

The process of anthropomorphism is of interest to researchers in psychology, marketing, robotics, and related disciplines. From a marketing point of view, the outcomes of anthropomorphism make it attractive as a strategy supporting brand relationships, endorser perceptions, and service technologies – for instance, a greater feeling of connectedness and protectiveness towards a non-human agent (Tam *et al.*, 2013), less willingness to replace or negatively judge an anthropomorphized agent (Chandler & Schwarz, 2010), increased social presence (Gardner & Knowles, 2008), altered behavioral preferences (Aggarwal & McGill, 2012; Chartrand *et al.*, 2008), more trust (Waytz *et al.*, 2014), or attributions of brand personality and brand liking (Delbaere *et al.*, 2011).

In the psychology field, infrahumanization research examines how attributing uniquely human characteristics to an agent can result in their admission to the 'ingroup' (as opposed to the dehumanized outgroup, whose members risk harm and dislike from the ingroup) (Haslam & Loughnan, 2014; Vaes, Leyens, Paladino, & Miranda, 2012). Hence, anthropomorphism holds relevance for psychology researchers in understanding how relationships will be formed with technological agents like robots.

Similarly, in robotics, understanding the mechanisms underlying successful interaction between humans and robots takes on increased importance for research, development and design. This is perhaps best encapsulated in the uncanny valley effect, whereby human appearance or characteristics in the design of a robot (anthropomorphism) has a direct influence on a robots likeability and perceived eeriness, with the 'almost human' falling into the uncanny valley and being perceived as creepy (Kim, Schmitt, & Thalmann, 2019; Murphy, Gretzel, & Pesonen, 2019; Walters, Syrdal, Dautenhahn, te Boekhorst, & Koay, 2008). Further, blending psychology and robotics is recent work from Schmitt (2020), which introduces the term speciesism to describe the differential treatment received by AI and robotics from humans who perceive the human species as superior and notes the potentially deleterious effects on robot service offerings of unchecked speciesism.

However, increased humanness is not always the answer to ensuring better treatment for service robots and enhanced service experiences for consumers – as illustrated in the uncanny valley effect. Indeed, being humanized can increase the risk of *negative* consequences just as much as it increases the chance of *positive* consequences for robot, brand, and consumers. For instance, work from Puzakova and colleagues shows that anthropomorphism can backfire when people feel 'betrayed' by a humanized brand, such as perceiving price increases as more unfair (Kwak, Puzakova, & Rocereto, 2015), or being less forgiving of negative brand publicity (Puzakova, Kwak, & Rocereto, 2013).

Adding to the complexity of anthropomorphism benefits and detriments is the contextual nature of the evaluation. In considering service robots in the home, recent conceptualizations propose that anthropomorphic characteristics are integral to consumer acceptance of robotic service (Murphy, Gretzel, & Hofacker, 2019). The fact that a service robot would be physically and visually present in the home may also affect responses. Past studies have found that greater empathy is shown towards embodied rather than disembodied robots (Kwak *et al.*, 2013) and that greater telepresence is perceived in slightly anthropomorphic visually represented avatars than non-visually represented avatars, or avatars where visual anthropomorphism is too high (Nowak & Biocca, 2003) – hence highlighting the importance of presence. Regarding how a robot may be styled, research shows that consumers tend to prefer images that look more like they do, such as through greater physical humanization (Connell, 2013), though not so humanized as to trigger the uncanny valley effect.

*2.2 Social interaction opportunities and the value of liking*

This paper applies three levels of social interaction opportunity (low, medium, and high), partly reflecting service contact levels which range from low (e.g., internet banking) to medium (e.g., dry cleaning) to high (e.g., haircut) (Lovelock *et al.*, 2014). For instance, a robot may work *for* consumers while they are away (low social interaction opportunity), work *with* humans when they are close by (medium social interaction opportunity), or actively *interact with* humans via conversation while working close by (high social interaction opportunity). Such social interaction opportunities are an important determinant of service satisfaction and positive consumer experiences (Srivastava & Kaul, 2014). Currently, little is known about the level of social interaction opportunities consumers may desire with service robots or whether this preference varies by the degree of anthropomorphism present in the robot design and characteristics.

Recent work on connected-homes with social robots has yielded important insights, showing that consumers using a connected-home (i.e., a home containing numerous "smart devices" that connect consumers to services facilitated by the internet) for the first time will tend to treat the experience as an interpersonal interaction, for instance by addressing the home in day-to-day language (Holthaus *et al.,* 2016). Other work also finds that consumers prefer a friendly interaction style rather than a purely functional 'engineer like' style when interacting with the Internet of Things (Wu, Chen, & Dou, 2017). While not examining embodied robots, these studies nevertheless illustrate that expectations may exist for service robots to interact in a human-like and even social manner.

The question then emerges of whether service robots will – or should – have an ability to interact socially with consumers, as human service employees do (e.g., displaying social niceties like small talk, showing empathy, remembering the customer/their preferences). For practitioners, knowing how customers are feeling via AI-driven sentiment analysis can lead to successful brand outcomes (Zhou, 2018). One of the first steps to creating the 'commercial friendships' seen in services is to *like* the service provider, a key social bonding component (Wilson, 1995). Liking is an important antecedent to service evaluations (Jayanti & Whipple, 2008), service relationships and commitment (Mavondo & Rodrigo, 2001), and behavioral loyalty (Abosag, Baker, Hall, Voulgari, & Zheng, 2017). Though in the case of the current study, as the experiment would be the first exposure that participants had to the robot scenario, it was deemed that variables that indicated a more developed relationship – such as affective commitment and behavioral loyalty – were not appropriate to this stage.

For the current study liking was selected as the main dependent variable in order to provide insight into this initial stage in relationship formation and role expectations. This variable is also particularly appropriate in the context of anthropomorphism in light of the social overtones of liking. Indeed, liking is a central outcome within the uncanny valley theory (Gray & Wegner, 2012; Kim *et al.*, 2019; Mathur & Reichling, 2016). In line with previous research finding that consumers were more likely to rely on human features such as "warmth" and less on features such as product quality when faced with a humanized product (Chandler & Schwarz, 2010), the current research proposes that liking – an affective service outcome expected more for when interacting with humans than with technology – is an outcome of anthropomorphism (Epley *et al.*, 2007) and hence has relevance in this context. This is supported by previous work in robotics and anthropomorphism (Rau, Li, & Li, 2010; Zanatto, Patacchiola, Goslin, & Cangelosi, 2019).

### *2.3 Interacting with service robots in a domestic environment*

Marketing researchers draw attention to the need to understand how consumers will interact with service robots and how the context of interaction may influence outcomes (Hollebeek, Andreassen, & Sprott, 2018). The elderly and aging are one group that are already interacting with service robots in a novel context; that is, a domestic service environment. Research is investigating the relational experience that occurs alongside the functional experience for the elderly engaging with service robots in an aged care setting (Čaić, Odekerken-Schröder, & Mahr, 2018). Further, robotic and other smart technologies are of interest for 'aging in place' within the domestic environment (Arcelus, Jones, Goubran, & Knoefel, 2007; Portet, Vacher, Golanski, Roux, & Meillon, 2013), where engagement tends to be positive (Demiris, Hensel, Skubic, & Rantz, 2008). While pragmatic concerns make the elderly a necessary early adopter group of service robotics and smart technologies, the application to other groups is apparent: such as where the combination of functional and social interactions enhances the overall service experience (consider support in large households' daily running, lone-person households, or households where caring roles are needed). However, it remains unclear whether increased social interaction opportunities offered by the domestic environment will lead to an actual desire for said opportunities amongst household members and if so, at what level.

Services literature indicates the presence of varying contact-levels (which function similarly to social interaction opportunities), depending in part on the level of simultaneity inherent in a service (that is, the degree to which the service provider and customer need to be present at the time the service is provided). Those services requiring higher levels of personal care (e.g., hairdressing) are more likely to be delivered and consumed at the same time, as opposed to those services requiring lower levels of personal care (e.g., lawn mowing). Some high personal care services also have a high potential for social interaction in addition to the minimum level of instrumental outcomes. For instance, when considering the novel situation of a service robot working in a domestic environment, something like cooking for the human customers holds both instrumental value and potentially social interaction value as well. This is in keeping with the customer experience framework proposed by Gentile and colleagues, who note that different services offer different service experience dimensions - in the example above, a cooking robot relates primarily to the pragmatic and relational elements of service experience (Gentile, Spiller, & Noci, 2007). Recent research proposes a hierarchy of robot capabilities where basic functionality must be displayed before social capabilities (Murphy, Gretzel, & Hofacker, 2019). Hence, while pragmatic experience offers a minimum threshold for a successful service experience (that is, does the service deliver what is promised), additional dimensions of service experience must be considered, with social or relational experience often a key consideration for high personal care services.

It is proposed that increased social interaction opportunities between consumers and domestic service robots lead to a greater chance for consumers to humanize the robot and even form commercial "friendships" with service robots. However, researchers currently have little understanding of whether consumers truly desire such social interaction opportunities in this context or how consumers will choose to interact with service robots in their homes. This consumer choice to interact with service robots in the domestic setting – or indeed, the choice to *like* the service robot - is an interesting one, though not easily explained. Recent studies have shown that how consumers feel about interacting with service robots can be influenced by numerous factors including the service context (Park, Tung, & Lee, 2021), perceived usefulness of the robot (Murphy, Gretzel, & Hofacker, 2019), preference for a human service worker (Yun, Lee, & Kim, 2021), privacy concerns, trust in AI technology (Park *et al*., 2021) and even how relatable the robot seems (Biswas & Murray, 2017).

Understanding social-relational experience has been highlighted by other authors as necessary in the context of service robots (Wirtz *et al*., 2018), especially as interactions have a strong influence on service experience enjoyment (van Pinxteren, Wetzels, Rüger, Pluymaekers, & Wetzels, 2019). In this paper we extend knowledge of consumer interaction preferences by focusing on emotional/relational experience, and in particular on the extent to which the emotional/relational experience is connected with liking. Two direct-effect hypotheses are proposed to examine the possible social-relational experience of this unique service context, the influence of robot humanness, and opportunities for social interaction on robot liking:

> ***H1****: "Higher levels of humanness in a service robot will increase consumer liking for service robots."*

> ***H2****: "Exposure to higher levels of social interaction opportunity will increase consumer liking for service robots."*

Additionally, we examine whether these two factors – robot humanness and opportunity for social interaction – may interact. Past research shows that human appearance (Connell, 2013) and social interaction cues (Holthaus *et al.,* 2016) can act as potential triggers for anthropomorphism. Hence it is expected that social interaction opportunity and human appearance will each act as human cues in this study, increasing the likelihood of affective evaluations associated with anthropomorphism having occurred (Epley *et al.*, 2007) – in this case, liking for the robot. Therefore, the following interaction hypothesis is proposed:

> **H3***: "Exposure to both high levels of humanness and high levels of social interaction opportunity will increase consumer liking for service robots."*

The three hypotheses were examined via an experimental study that allowed for manipulating these two key variables. Notably, the experiments' context was a domestic scenario, reflecting the literature gap surrounding consumer-robot service interactions in the home.

## 3. Method

### *3.1 Research design*

An experiment was designed to manipulate the human-like appearance and social interaction opportunities for service robots. The conditions were manipulated through scenarios and images, following the approach taken by similar studies examining consumer responses to service robots in an experiment (Jörling, Böhm, & Paluch, 2019; Mende, Scott, van Doorn, Grewal, & Shanks, 2019). The use of scenarios remains common in social science research due to the relative difficulty in gaining access to physical robots for field experiments (Mende *et al.*, 2019). The scenarios involved a robot cooking a meal for the consumer but ranged from low social interaction opportunity (the robot cooks while the consumer is at work) to medium social interaction opportunity (the robot and human cook together) to high social interaction opportunity (the robot conversationally interacts with the human while they cook together). While the robots in the images were gendered – either by name for the mechanical and humanoid types or by name and appearance for the android type – the conditions were collapsed into nine categories for analysis as gender held no statistically significant effect.

As part of the 3x3 experimental format, participants viewed a condition including a visual rendering of one of three robot types created for this study by an industrial designer, each representing a different space on the continuum of humanness/anthropomorphism (mechanical, robotic, android; see Figure 1) and one of three social interaction opportunities (high, medium, low; see Appendix 1). While there is diversity of terms present in the extant literature, the current study uses 'mechanical' to refer to robots with few/no intentional humanized features which visually appear as 'machines'; humanoid to refer to robots with both intentional human-like and machine-like visual qualities; and android to refer to robots with a substantial and intentional human-like appearance (i.e., mechanical = more machine-like than human-like; humanoid = both machine-like and human-like, and android = more human-like than machine-like). These combinations created the nine conditions used for analysis. Participants then completed a short questionnaire of demographics and attitude items, including liking for the robot.

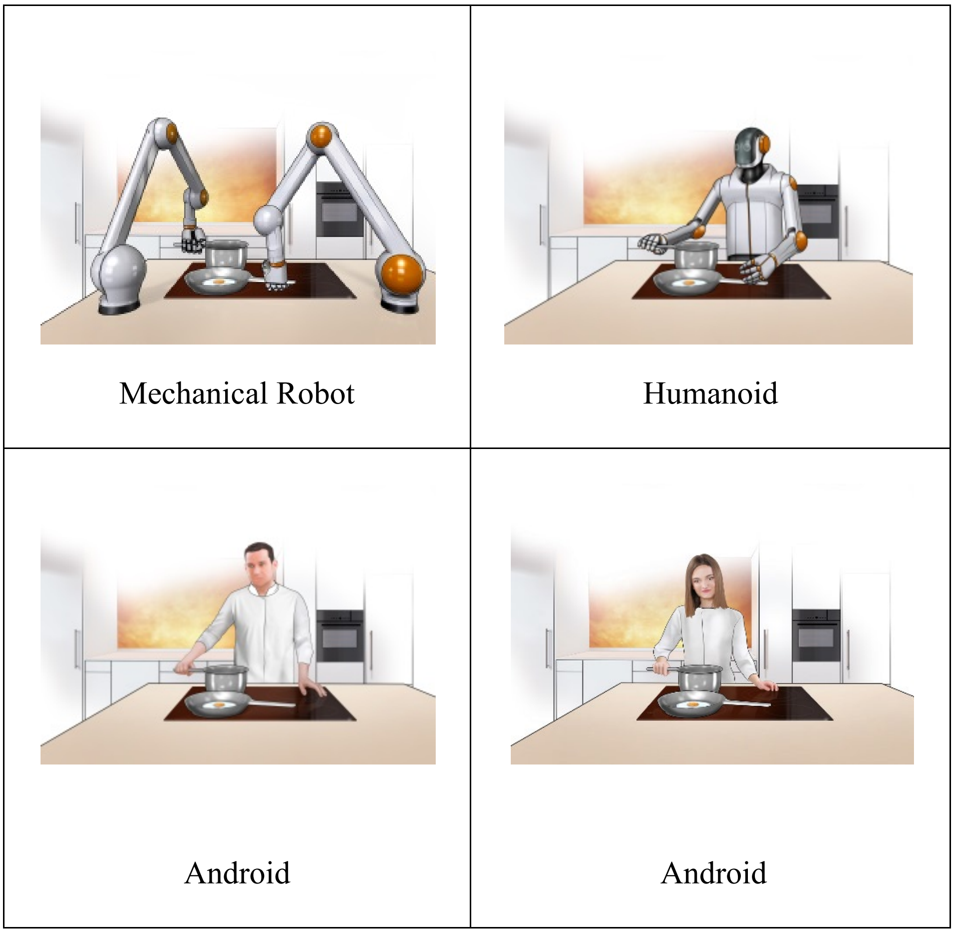


**Fig. 1.** Stimuli options – mechanical, humanoid, male android, female android

*3.2 Measures*

All measures used in the current research have been used in validated studies. The main dependent variable of liking was measured using Reysen’s (2005) 11-item likeability scale measured on a 1–7 Likert scale (original $\alpha = .90$, current study $\alpha = .92$). This scale was particularly relevant to the social context of this study, as the items on this particular scale are more social and could be asked equally of a human service worker or a humanized service robot. While liking functions as the only dependent variable for this study, perceived compatibility of the robot with the consumers' lifestyle, and intention to purchase the robot were also measured to re-establish the practical relevance of liking in the context of the current dataset. Intention to purchase was measured using Sundar and Kalyanaraman's (2004) scale, $\alpha = .86$ (original) $\alpha = .88$ (current study), and perceived compatibility was measured using Rijsdijk, Hultink and Diamantopoulos' (2007) compatibility scale, $\alpha = 0.87$ (original) $\alpha = .97$ (current study). Scale items for these three scales are provided in Appendix 2. Correlation analyses revealed a strong, positive relationship between liking and compatibility ($r = 0.576$, $p = .000$), and liking and intention to purchase ($r = 0.581$, $p = .000$). See also Table 1.

**Table 1**
*Descriptive Statistics and Correlations for Study Variables*

| Variable | *n* | *M* | *SD* | 1 | 2 | 3 |
|---|---|---|---|---|---|---|
| 1. Liking | 956 | 3.47 | 1.31 | — | | |
| 2. Compatibility | 956 | 3.78 | 1.95 | $.57^{**}$ | — | |
| 3. Purchase Intention | 956 | 4.09 | 1.76 | $.58^{**}$ | $.76^{**}$ | — |

$^{**}p < .01$.

*3.3 Sample and recruitment*

Data were collected using an online survey format, administered via Mechanical Turk's market research facility (MTurk), following the method applied by recent papers reporting online social science experiments (King & Auschaitrakul, 2020; Su, Kunkel, & Ye, 2020). The current study aimed for a sample size of at least 900 people, in keeping with established guidelines for experiments that recommend a minimum of 30 people be attained per sub-group (Roscoe, 1975), and with the assumption that data cleaning would be necessary, 50 people per sub-group were sought. The sample size was also partially determined by financial considerations. Following dataset cleansing, data from 953 resident adults in the United States were used for analysis. Respondents were 50% male, and ages ranged from 18–24 to 75+, with a mean age category of 25–34 years. Care was taken to ensure the wage paid to workers was ethical, being 0.80 USD for approximately 5 minutes to complete the experiment. This is above minimum wage and at the higher end of the average rates paid for this type of task (i.e., 0.60-0.80USD at the time of data collection).

MTurk samples have been previously found to demonstrate high levels of attention to research tasks (Hauser, 2016), yield comparable or even superior results to traditional online panels or student samples (Kees, Berry, Burton, & Sheehan, 2017), and produce similar levels of internal and external validity as those conducted in physical labs or the field (Horton, Rand, & Zeckhauser, 2011).

## 4. Findings

A two-way analysis of variance (ANOVA) was conducted to examine the findings for H1 and H2 and found significant positive effects of both humanness (H1) and social interaction opportunity (H2) on participant score for liking. Specifically, robot humanness (represented in the type of service robot) significantly influences participant liking scores, $F(2,947) = 19.30$, $p = .000$. In addition, post-hoc analyses indicated that each level of humanness was significantly different from the others, with androids (M = 3.79, SD = 1.293) being better liked than humanoids (M= 3.47, SD = 1.290) or mechanical robots (M=3.16, SD = 1.295). Interestingly, the overall evaluation of robots was quite low on the 7-point scale (see Table 2).

**Table 2**
*Means, Standard Deviations, and Analyses of Variance for Three Levels of Humanness on Liking Scores*

| Measure | Mechanical | | Humanoid | | Android | | $F$(2,947) | $\eta_p^2$ |
|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | | |
| Liking | 3.16 | 1.29 | 3.47 | 1.29 | 3.79 | 1.29 | 19.30$^{***}$ | .039 |

$^{***}p < .001$.

Further, the level of social interaction opportunity also significantly influenced participant liking scores, $F(2,947) = 12.88$, $p = .000$. Post-hoc analyses indicated that while robots in both the high social interaction opportunity condition (M= 3.69, SD = 1.255) and the medium social interaction opportunity condition (M=3.54) were significantly more liked than the low social interaction opportunity condition (M=3.20, SD = 1.385), evaluation of the robots in the high and medium social interaction opportunity conditions was not significantly different. This finding potentially indicates that while consumers prefer higher levels of *opportunity* for social interaction with their service robots, this does not necessarily translate into a need for more active social interaction, such as through conversation (see Table 3).

**Table 3**
*Means, Standard Deviations, and Analyses of Variance for Three Levels of Social Interaction Opportunity on Liking Scores*

| Measure | Low | | Medium | | High | | $F$(2,947) | $\eta_p^2$ |
|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | | |
| Liking | 3.20 | 1.38 | 3.54 | 1.25 | 3.69 | 1.25 | 12.88$^{***}$ | .026 |

$^{***}p < .001$.

The interaction effect conceptualized for H3 was tested via this same two-way ANOVA with the level of humanness and level of social interaction opportunity as independent variables and liking as the dependent variable. Findings showed support for the significant direct effects found for H1 and H2, but the interaction effect proved non-significant, $F(4,947) = .379$, $p = .824$. Figure 2 presents a visual representation of this finding.

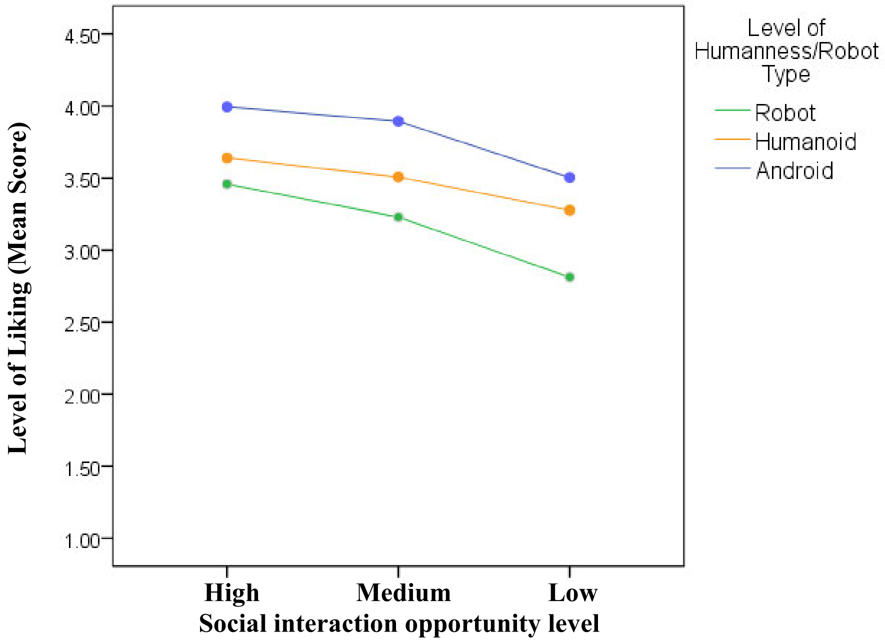


**Fig. 2.** Interaction between social interaction opportunity level and humanness level

## 5. Discussion

This research's direct result is the proposed Humanized-AI Social Interactivity Framework (HASIF), presented in Figure 3. This framework combines extant literature and study findings to put forward three dimensions influencing successful social interactions with humanized service technologies by showing how attempting to influence elicited agent knowledge (Epley *et al.,* 2007) via realism of form and behavior (dimensions within control of the developer/marketer) is only part of the picture, with consumer choice offering a potential explanation for liking a robot more when social interaction is (or is not) available.

The first dimension (D1) is the presence of salient human cues, as supported by the preference for visibly human-like service robots in this study (bottom right). Second, the opportunity to interact (D2), as represented in this study by proximity and the ability to engage in human scripts such as conversation (bottom left), is supported by the preference for medium to high-level contact. Both of these dimensions are informed by Epley et al's (2007) theory of anthropomorphism which guides the current study – put plainly, one is about looking human (D1) and the other about being able to converse in a human-like way (D2). These two dimensions represent both form and behavioral realism (Miao *et al*., 2021), and importantly, are two ways of increasing the accessibility of anthropocentric knowledge structures associated with elicited agent knowledge. Third is the addition of the 'Consumer choice of interaction level' (D3) dimension (top middle). This addition is a direct result of considering why social interaction opportunity and higher humanness each led to higher liking in this study but did not always lead to a preference for human-like interaction in the form of conversation (as indirectly indicated by higher or lower levels of liking for robots that did/did not offer social interaction opportunities). Each of these dimensions will be discussed in turn throughout the remainder of this section.

*5.1 Dimension 1 (D1): Salient Human Cues via Anthropomorphism*

First, as participants liked the humanised robots in this study (D1) more, the findings support previous anthropomorphism research on factors influencing liking for other agents (Delbaere *et al.*, 2011). Specifically, the research supported the similarity-attraction hypothesis (Byrne *et al.*, 1967) but contradicted the uncanny valley effect's expectations (Walters *et al.*, 2008;

Masahiro, 1970). That is, the research found participants tended to like those who were more human – hence more similar to themselves – while the uncanny valley would have anticipated that the most human-like robot would fall into the valley. This is interesting because it supposes that the uncanny valley effect may not always apply to all human-like robots, though further research is required to confirm this supposition and establish why this might be the case.

Interestingly, while greater visual humanization resulted in higher levels of liking in this study, it did not result in a greater desire for humanization involving other senses – that is, the audible social interaction of human-like conversation ability. As discussed, past research indicates that anthropomorphism can lead to more connectedness (Tam *et al.*, 2013), less judgement (Chandler & Schwarz, 2010), increased social presence (Gardner & Knowles, 2008), altered behavioral preferences (Aggarwal & McGill, 2012; Chartrand *et al.*, 2008), and more trust (Waytz *et al.*, 2014), but literature does not yet indicate whether consumers will necessarily seek to converse with a non-human agent actively. Research from the field of human computer interaction shows that actually hearing the voice of a machine increases the likelihood of anthropomorphism occurring (Lee & Nass, 2004) and hence may be another important human cue to make salient. Therefore, while participants in the current study responded well to the robots with more human-like appearance, additional salient human cues – such as the ability to actually hear the robot – may also be relevant. As technologies advance and begin to offer opportunities for social interaction, anthropomorphism literature needs to continue to examine how consumers might move from 'silent, positive evaluations' to 'engaged, positive interactions.' This leads directly to D2, which deals with opportunities for interaction.

*5.2 Dimension 2 (D2): Opportunity for Interaction via Proximity and Ability*

D2 suggests that for consumers to perceive an opportunity to interact, robots should have proximity to humans as well as a clear ability to interact. The findings of this study provide insights into the growing body of research on social interactions and voice-based technologies (Hu, Lu, & Gong, 2021; Pitardi & Marriott, 2021; Whang & Im, 2020), revealing a preference for medium or high levels of *opportunity* for social contact as represented by robots who were nearby humans and potentially able to hold a conversation (D2), but no significant preference for active social interaction with robots in the form of conversation. Placing this finding within previous literature, it is proposed that within this study, some participants saw the robots as human-like enough to merit ingroup status and the potential for interactions this can bring (Vaes *et al*., 2012; Vaes, Paladino, Castelli, Leyens, & Giovanazzi, 2003), while some did not. While voice-based technologies can be seen as social actors (Pitardi & Marriott, 2021; Whang & Im, 2020), this does not guarantee that consumers will want to converse with the perceived social actor. The field of infrahumanization research (Haslam & Loughnan, 2014; Vaes *et al.,* 2012) may guide future research in determining what it means to be not just 'like me' and hence worthy of respect, but also 'like us' and so worthy of interaction. One potential explanation lies with the uncanny valley, with research finding that it is not necessarily the sense of agency that most unsettles consumers, but rather the ability of a robot to feel and sense (Gray & Wegner, 2012) – and feeling and sensing may both become more salient to the consumer if conversing with the robot. Alternatively, given that research finds trust in machines is difficult to establish and requires both functional and social elements (Pitardi & Marriott, 2021), the single exposure offered in this study may simply have been too brief for some consumers to establish a sense of social connection necessary for additional evaluations to occur – such as a preference for social interaction.

Overall, it is clear that there is more to examine in understanding the social interaction preferences of consumers interacting with service robots in the home, and that the ability of the human to maintain agency over their social interaction choices (or lack thereof) will likely remain important.

### *5.3 Dimension 3 (D3): Consumer Choice of Interaction Level*

Finally, the dimension of consumer choice of interaction level (D3) has been added to the model to guide our examination into why some consumers like robots they can socially interact with, and other consumers do not. The central tenet of this dimension is simply that if different interaction levels are offered, consumers must be able to choose a level at which they are comfortable interacting if there are to be positive evaluations of the service robot. Previously services have been defined as having inherent contact-levels (Lovelock, 1980), which reflect the service's abilities and characteristics, and this research extended this idea to encapsulate *opportunity* for, but not pre-determined levels of, social interaction. Based on our findings, we now suggest this additional dimension (consumer choice of interaction level) should apply to social interaction opportunities when considering the unique nature of services offered by emerging technologies like robots. The addition of this dimension aligns with previous research which indicates that consumers prefer to choose how their robots interact with them (Schiffhauer *et al.,* 2016), and which finds that the social cues offered by the robot itself can help to support this critical sense of consumer freedom (Ghazali *et al.,* 2019). Previous research also notes that the intensity level sought from any service interaction experience can differ (Hollebeek *et al.*, 2016), further supporting the consumer's need to choose whether and how to interact with service robots within this domestic context.

The choice to interact with an AI robot is a significant choice for consumers that comes with potentially long-reaching effects, as once they choose to interact with an AI they may even come to delegate some of their other choices to the AI (Klaus & Zaichkowsky, 2021). Further, trust is often an important element influencing the choice to interact with AI or robots (Pitardi & Marriott, 2021; Sanders, Kaplan, Koch, Schwartz, & Hancock, 2019), and trust in robots can take time to develop (Ullrich, Butz, & Diefenbach, 2021). Hence the elusive dimension of consumer choice of interaction level may be partially based on temporal factors (as noted in the limitations section).

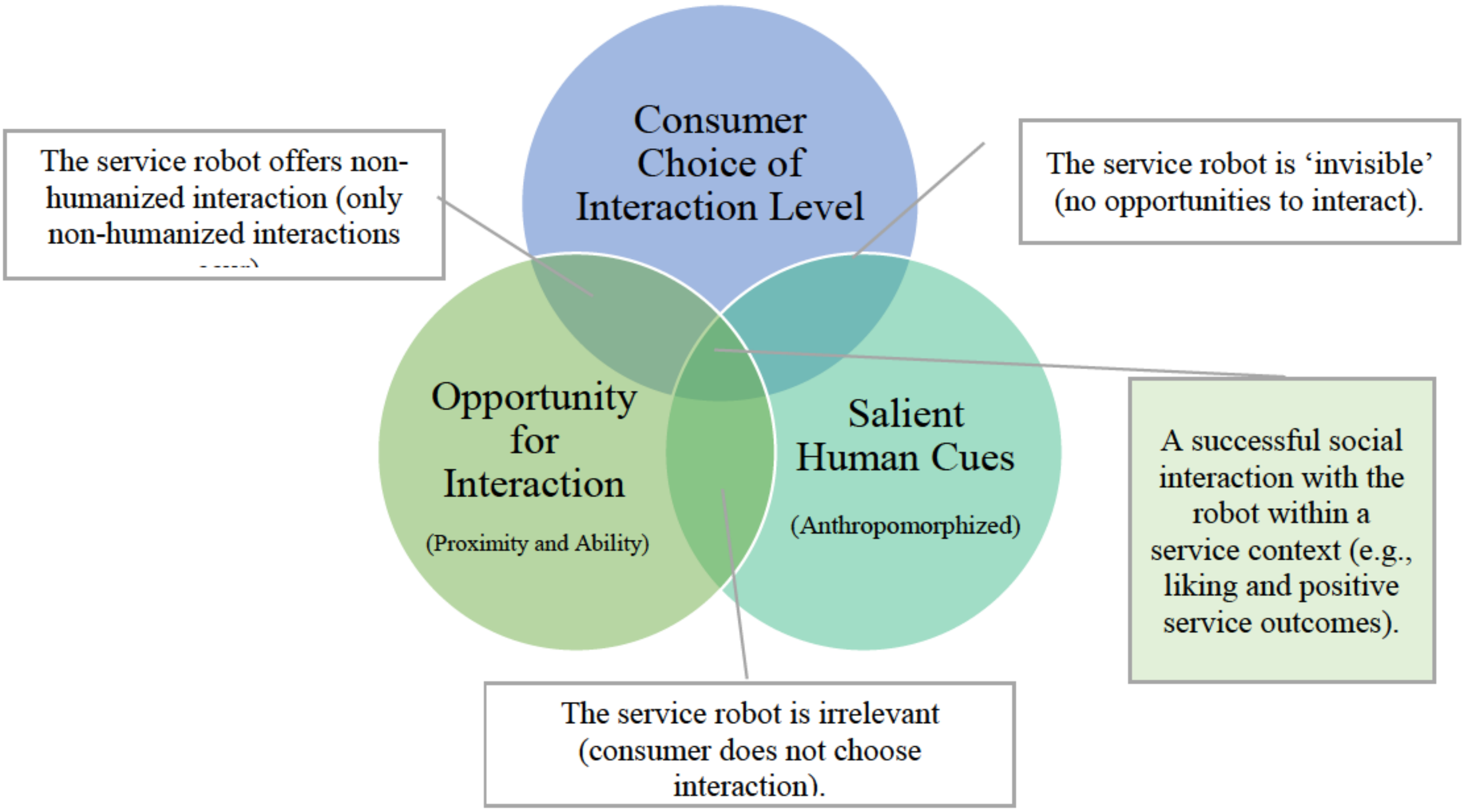


**Fig. 3.** Proposed Humanized-AI Social Interactivity Framework (HASIF) with explanatory notes for service robot technology

**6. Conclusion**

This research supports and extends an emerging body of literature that examines robotic service experience in a domestic environment. It has also explored how the level of humanness and opportunities for social interaction increase consumer liking of service robots. This section concludes the paper with a summary of implications for theory and practice and suggested streams for future research.

### *6.1 Implications*

This study examined how social interaction opportunity and human-like appearance influenced consumer liking for domestic service robots. In so doing, it answers the call to extend our knowledge of interactions between emerging technologies like service robots and consumers in novel service environments (e.g., Hollebeek *et al*., 2018). It is one of the first studies to explore potential social and relational human-robot interactions in this private space, whereas robots are generally considered more associated with transactional services (Huang & Rust, 2021) and utilitarian outcomes (Longoni & Cian, 2020). This research contributes to both marketing and consumer behavior research not by examining this new context, but by providing initial data showing that social interaction scripts in this context may not always work as anticipated based on the evidence of past literature. That is, just because social interactions are designed into robots does not mean that consumers will choose to engage. This implication is best encapsulated in the newly proposed HASIF model (Figure 3) discussed in the previous section. This study has also tested two ways of increasing the accessibility of anthropocentric knowledge structures associated with elicited agent knowledge (Epley *et al.,* 2007) and examining affective outcomes.

From a practitioner's perspective, it is integral to provide or support all HASIF dimensions, given that missing one dimension could lead to an unsuccessful service interaction (see also Figure 3). As discussed with regards to the uncanny valley (Gray & Wegner, 2012; Kim *et al*., 2019; Murphy *et al*., 2019), practitioners have the power to design and program the characteristics of service robots, allowing direct input into the level of interaction abilities. Further, from a marketing communications point of view, practitioners must communicate with consumers to ensure consumers are aware of opportunities to interact (as well as benefits associated with this feature). Finally, while the consumer must make the final choice of whether and how to interact (Schiffhauer *et al.,* 2016), practitioners can support this dimension through careful design of social cues and features that support consumer freedom (Ghazali *et al*., 2019).

*6.2 Limitations and Future Research*

The main limitation of the current work is that the HASIF is proposed as an outcome of the current findings only and has not yet been fully tested in its own right as a standalone framework. We suggest this may be done by examining the impact the three dimensions have on liking and humanization and ingroup membership (Haslam & Loughnan, 2014; Vaes *et al*., 2012). In particular, consumer choice bears further investigation. Further, we also propose two streams for future research that build on the proposed HASIF framework and extend past the current study's limitations. These streams are:

*Different scripts activated by human cues (D1) and opportunity (D2):*

This research has operated under the assumption that human cues lead to the activation of human scripts (Epley *et al*., 2007). However, it is not necessarily the case that these human scripts will always involve social interaction, just as in human-human interactions, the proximity and conversational ability of another human being does not always trigger a 'social interaction' script. Hence, future research should examine which scripts are triggered by the dimensions of the HASIF. Further, research may also examine which scripts are activated under longitudinal or field study contexts, given that the uncanny valley effect can diminish with repeated interactions (Złotowski *et al*., 2015), that physically present robots tend to be perceived more positively (Li, 2015), and that hearing a machine's voice influences anthropomorphism (Lee & Nass, 2004). If a sense of trust is required, this may also take time to further develop (Pitardi & Marriott, 2021). Finally, different types of human cues may be tested, as research that finds human voice (Eyssel *et al.,* 2012), movement patterns (Chidambaram *et al.*, 2012), touch (Chen *et al.*, 2011), and social cues (van Pinxteren *et al.,* 2019), are all important for human-robot interaction.

*The influence of the paradox of the authentic and the artificial on D3:*

Finally, one of the domestic environment's unique features as a setting for an AI service experience is that the home is arguably the most authentic, private space to which a person belongs. This authenticity is contrasted with the inherently artificial nature of AI, creating a misalignment paradox: how can authentic (social, service) experiences occur when one of the actors is innately artificial? This paradox may provide further explanation of D3 – given that this consumer choice emerged from consideration of the findings rather than being sought, it bears further testing and examination. In this study, the choice of reaction was tested (liking) but the choice of robot was not directly tested. Consumer choice research indicates that choices are context-dependent and vary based on the goals of the consumer (Bettman, Luce, & Payne, 1998). Hence, we suggest future studies might offer consumers a direct choice of different robotic and non-robotic options (i.e., artificial and authentic options) to examine this choice. Further, as decision complexity increases, so too does the likelihood that consumers will engage with heuristics (Bettman et al., 1998), meaning that the motivations underlying their choices may not be clear to researchers or even to consumers themselves in some cases. We therefore recommend qualitative research to form a part of future research programs.

Future work might examine ways in which this paradox can be resolved: for instance, whether specific spaces within the home are less authentic and hence a better ‘fit’, or whether the robot itself can be made more authentic. Research already indicates that authenticity in humanized technologies is important, as seen in human preferences for relatable robots (Biswas & Murray, 2017) that do not attempt persuasion (Ghazali *et al.,* 2019). Recent work examining actors in another form of parasocial relationship (i.e., celebrities) reveals six elements of authenticity: accuracy, connectedness, integrity, legitimacy, originality, and proficiency (Nunes, Ordanini, & Giambastiani, 2021). Most of these elements will be difficult or impossible for an AI to recreate – for instance, being seen as autonomous and intrinsically motivated. Therefore, it remains to be seen how this paradox may be resolved for our most artificial creations, entering the most authentic spaces of consumers.

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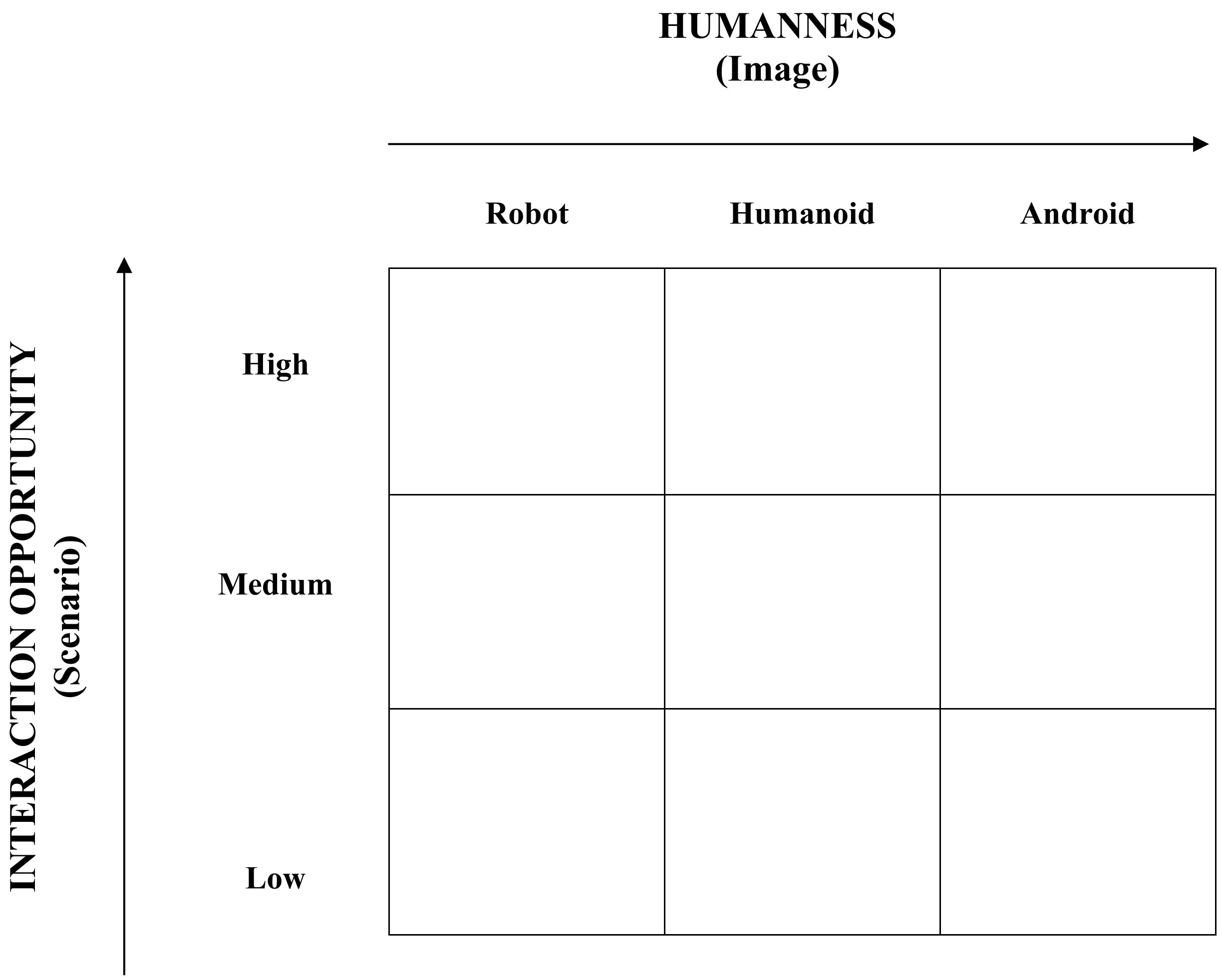
**Appendix 1: Experimental design and scenario wording**



**Scenarios**

*Alpha Cooking Company's R&D department has developed a working prototype of a cooking robot that is capable of operating in a home kitchen environment but is seeking customer feedback on the styling that should be used for this robot. Please read the product description below and then spend a moment considering the design (we will ask you questions about this on the following pages).*

<u>**Scenario One**: (Low social interaction opportunity)</u>

*Alpha Cooking Company is launching a new range of smart home robots. The first robot to be released in this range is a cooking robot that can cook meals while you are out of the house. You will be able to give the robot instructions on what to cook and for how long, and the robot will check that you have added the appropriate ingredients. The robot will send you a text message 30 minutes before the meal is ready, and you can also call the robot throughout the day for updates on the meal. The research and development team has proposed the following design for this robot, tentatively named Daniel/Danielle.*

***OR***

<u>**Scenario Two**: (Medium social interaction opportunity)</u>

*Alpha Cooking Company is launching a new range of smart home robots. The first robot to be released in this range is a cooking robot that will cook meals with you when you are home. The robot will be your own assistant chef and can help you to prepare any number of dishes. Cooking can now be more relaxing with a cooking robot's assistance. Once the meal is cooking, the robot will watch it for you, and you can ask the robot for updates whenever you like. They will call you when your meal is ready. The research and development team has proposed the following design for this robot, tentatively named Daniel/Danielle.*

***OR***

<u>**Scenario Three**: (High social interaction opportunity)</u>

*Alpha Cooking Company is launching a new range of smart home robots. The first robot to be released in this range is a cooking robot that will cook meals with you when you are home. The robot will be your own kitchen companion and can help you to prepare any number of dishes. While you prepare the meal, the robot will talk with you, and ask you how your day was. Cooking can now be more relaxing with a cooking robot's companionship. Once the meal is cooking, the robot will watch it for you, and you can ask the robot for updates whenever you like. They will call you when your meal is ready. The research and development team has proposed the following design for this robot, tentatively named Daniel/Danielle.*

*Please spend some time considering this design, and then move to the next page to answer questions about it.*

## Appendix 2: Scale items for Liking, Intention to Purchase, and Compatibility

**Intention to Purchase**, *α = .86 (original) α = .88 (current study)*

Once released…

- How likely would you be to buy a cooking robot with the design you saw?
- How likely would you be to try the robot with the design you saw?
- How likely would you be to visit the associated website for the robot with the design you saw?

Citation: Sundar, S. S., & Kalyanaraman, S. (2004). Arousal, memory, and impression-formation effects of animation speed in web advertising. *Journal of Advertising*, *33*(1), 7-17.

**Likeability,** α = .90 *(original) α = .92 (current study)*

Please indicate your level of agreement with the following statements about the robot you saw in the scenario:

- This robot is friendly
- This robot is likeable.
- This robot is warm.
- This robot is approachable.
- I would ask this robot for advice.
- I would like this robot as a co-worker.
- I would like this robot as a roommate.
- I would like to be friends with this robot.
- This robot is physically attractive.
- This robot is similar to me.
- This robot is knowledgeable.

Citation: Reysen, S. (2005). Construction of a new scale: The Reysen likability scale. *Social Behavior and Personality: an international journal*, 33(2), 201-208.

**Compatibility,** α = 0.87 *(original) α = .97 (current study)*

This robot…

- fits into my way of living.
- fits the way I do things.
- suits me well.

Citation: Rijsdijk, S. A., Hultink, E. J., & Diamantopoulos, A. (2007). Product intelligence: its conceptualization, measurement and impact on consumer satisfaction. *Journal of the Academy of Marketing Science*, *35*(3), 340-356.