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The most human bot: Female gendering increases humanness perceptions of bots and acceptance of AI

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Abstract

Companies have repeatedly launched Artificial Intelligence (AI) products such as intelligent chatbots and robots with female names, voices, and bodies. Previous research posits that people intuitively favor female over male bots, mainly because female bots are judged as warmer and more likely to experience emotions. We present five online studies, including four preregistered, with a total sample of over 3,000 participants that go beyond this longstanding perception of femininity. Because warmth and experience (but not competence) are seen as fundamental qualities to be a full human but are lacking in machines, we argue that people prefer female bots because they are perceived as more human than male bots. Using implicit, subtle, and blatant scales of humanness, our results consistently show that women (Studies 1A and 1B), female bots (Studies 2 and 3), and female chatbots (Study 4) are perceived as more human than their male counterparts when compared with non-human entities (animals and machines). Study 4 investigates explicitly the acceptance of gendered algorithms operated by AI chatbots in a health context. We found that the female chatbot is preferred over the male chatbot because it is perceived as more human and more likely to consider our unique needs. These results highlight the ethical quandary faced by AI designers and policymakers: Women are said to be transformed into objects in AI, but injecting women's humanity into AI objects makes these objects seem more human and acceptable.

KEYWORDS
algorithm aversion, artificial intelligence, gender, gendered AI, humanness, machine ethics, robot, stereotypes, trust, uniqueness

1 | INTRODUCTION

Consumers tend to trust Artificial Intelligence (AI) less than human intelligence in specific domains (Berkeley et al., 2015; Bigman & Gray, 2018; Hidalgo et al., 2020). For example, in a health context, consumers are reluctant to use healthcare services provided by AI (Longoni et al., 2019). This aversion to delegating decisions to AI extends to other contexts, such as self-driving cars (Bigman & Gray, 2020; Gill, 2020) but also in consumer settings such as in retail stores, restaurants, hotels, or consumers' homes (Bigman & Gray, 2018; Castelo et al., 2019).

One solution for AI companies to increase acceptance of their algorithm solutions has been to anthropomorphize and gender their bot interface with feminine features. This is evidenced by the proliferation of female robots, such as Sophia (Hanson Robotics), female chatbots such as Amelia (IPSoft), and the popularity of female virtual assistants such as Siri (Apple), Alexa (Amazon), and Cortana (Microsoft).

Assigning a female gender to these AI bot interfaces appears to stem from consumers' expectations about their personalities. Previous research in human–robot interaction has shown that people tend to assign more communal qualities to female bots, including characteristics such as warmth, friendliness, and a higher capacity to experience emotions (Eyssel & Hegel, 2012; Gustavsson, 2005; Otterbacher & Talias, 2017; Stroessner & Benitez, 2019), consistent with the stereotypes generally assigned to women (Eagly & Steffen, 1984; Ebert et al., 2014). But why are people drawn to these characteristics in AI?

If we want to curb the massive use of female gendering in AI, accused of promoting women's objectification (UNESCO, 2019), we need to understand the deep roots of this phenomenon better. In this article, we suggest that research on what makes people human (Ghafurian et al., 2019; H. M. Gray et al., 2007), can provide a new and more nuanced perspective into why feminization is systematically used in AI. More specifically, we draw on theories of humanization and dehumanization (Enock et al., 2020; Haslam et al., 2013; Kteily et al., 2015; Leyens et al., 2000; Over, 2020) to explore consumers' perception of the humanness of male and female AI. Because warmth and experience (but not competence) are seen as fundamental to humans but fundamentally lacking in machines (K. Gray & Wegner, 2012), we argue that women are used in AI objects to humanize these objects.

The current research extends previous findings by examining the perceived humanness of female and male bots using both implicit and explicit, as well as subtle and blatant measures of perceived humanness, compared to both animals and machines. While previous studies have examined social perceptions of bots' personality (e.g., warm, friendly), the present work examines perceptions of the human character of these non-human entities, depending on whether they are presented as male or female. Specifically, we provide an alternative perspective focusing on what really makes something human as a building block in explaining why female features are prominent in AI settings. As such, our findings go beyond previous conceptualizations, which have typically attributed the over-reliance of women in AI settings to their greater perceived warmth (Stroessner & Benitez, 2019), or gender occupational congruency and societal gender norms (Bryant et al., 2020; Tay et al., 2014).

This new perspective contributes to research on warmth and trust in AI (Glikson & Woolley, 2020; Kim et al., 2019; Kramer et al., 2018; Traeger et al., 2020) and, more generally, to the understanding of users' social experiences with AI (Novak & Hoffman, 2019, Puntoni et al., 2020) by identifying a new psychological mechanism that drives consumers to prefer female machines and female AI. Our research also contributes to the growing stream of literature on the efficacy of gendered marketing (Borau & Bonnefon, 2020; Pinna, 2020; van den Hende & Mugge, 2014) and the ethical dilemma of gendered AI and gendered robots (Alesich & Rigby, 2017).

2 | CONCEPTUAL BACKGROUND

This section first reviews how people prefer machines that convey humanness and feelings before reviewing what makes us human. Next, we argue that injecting women's humanness into robots can increase robots' perceived humanness and boost consumers' acceptance of AI.

2.1 | People prefer machines that convey humanness

Research suggests that social machines should resemble humans and be granted human mental capacities to increase acceptance and ease social conversations with humans (Ruijten et al., 2019). Despite the deceptive nature of this strategy (Epley, 2018; Zawieska, 2015), the use of anthropomorphic (humanlike) design (cf. Epley et al., 2007; Fink, 2012) helps in building successful human–robot relationships and increasing positive responses towards robots (Damiano & Dumouchel, 2018; Waytz et al., 2014). Specifically, anthropomorphic design increases credibility, trust and is associated with more favorable attitudes towards robots (Airenti, 2015; Ghafurian et al., 2019; Natarajan & Gombolay, 2020). Researchers have also stressed the importance of humans' higher perceived capacity (vs. robots) to treat people uniquely when interacting with them (Longoni et al., 2019). In the studies by Longoni et al. (2019), humans were perceived as more able than robots to account for people's unique characteristics and circumstances. Thus, improving the humanlikeness of robots should increase the perception that robots can treat people individually and distinctively, thereby improving AI acceptance.

2.2 | People prefer machines that convey feelings

We tend to categorize people based on competence, agency, warmth, and experience. Competence–Agency (rationality) and Warmth–Experience (feelings) are considered the two fundamental dimensions of social judgment (Fiske et al., 2007; Judd et al., 2005; Martin & Slepian, 2020). Competence–Agency refers to the intellectual trait dimension, such as competence, intelligence, and efficiency; whereas Warmth–Experience refers to the emotional trait dimension such as warmth, kindness, and empathy (Abele et al., 2008; Judd et al., 2005).

People's social categorization on the dimensions of competence and warmth applies to nonsocial entities such as machines (Eyssel & Hegel, 2012; Stroessner & Benitez, 2019). Though machines are usually created to be competent in a specific task, they sometimes also need to convey emotions (e.g., during a service encounter in a retail store or at a webshop). However, while humans are frequently seen as both competent and warm, robots often succeed in conveying competence but struggle in conveying warmth (Bigman & Gray, 2018; H. M. Gray et al., 2007; K. Gray & Wegner, 2012). This is an issue for AI companies, as people prefer robots with perceived feelings (Yam et al., 2020).

2.3 | Feelings are at the core of what makes us human compared to machines

To understand what makes us uniquely human (UH), psychologists have tried to understand how we differ from animals and machines. Though we differ from animals in intelligence and civilization, we differ from machines in warmth and emotionality (Yzerbyt & Klein, 2019). As a result, emotional aspects such as warmth and experience are commonly conceptualized as essential human skills compared to machines

(H. M. Gray et al., 2007; K. Gray & Wegner, 2012). Indeed, machines can now surpass humans in logical intelligence (e.g., in mathematics or chess) but have a very hard time reproducing human emotional intelligence because machines do not experience emotions (Bigman & Gray, 2018). Some scholars even argue that warmth and friendliness, in the form of cooperative–communicative abilities, are probably unique features of human intelligence and key factors in the success of our species (Hare, 2017); and that experiencing authentic emotions is required to have a fully human mind (Bigman & Gray, 2018). In sum, warmth and experience, more than competence and rationality, seem to be Uniquely Human traits that distinguish humans from machines. Table 1 summarizes the different conceptualizations and measures of humanness compared to animals and machines that are used in the present research. These measures have been applied to study how people perceive the humanness of different individuals from various ethnicities and religions, but also people of different genders, such as women being compared to both animals and machines (Morris et al., 2018).

2.4 | Female gendering increases humanness of machines and acceptance of AI

Anthropomorphic design is achieved by including human-like characteristics that robots do not have (Ruijten et al., 2019). As anthropomorphism is a process of seeing human qualities in non-human objects, it is possible to humanize robots by giving them human features. For example, verbal and nonverbal communication (Bruce et al., 2002; Eyssel et al., 2010), movements (Wang et al., 2006), and embodiment (Fischer et al., 2012) can all increase a robot's perceived humanness. Assigning a gender to a robot can also increase its perceived humanness (Bryant et al., 2020; Eyssel et al., 2012), but the differential impact of female versus male gendering on perceived humanness has largely been overlooked.

One stream of research on the role of gender in human–robot interaction (Crowelly et al., 2009; Eyssel & Hegel, 2012; Siegel et al., 2009; Ye et al., 2019) has focused on the boundary conditions of the preference for a female over a male robot (such as the user's gender, or the type of task performed by the robot).

Another stream of research on the role of gender in human–robot interaction has focused on the gender stereotypes assigned to robots. Women tend to be judged as having a good human nature (HN) (e.g., warm, friendly, and trusting) and the capacity to experience emotions (e.g., empathy, compassion, and tenderness) (Eagly & Steffen, 1984; Ebert et al., 2014). As a matter of fact, while hostile sexism considers women inferior to men or even subhuman (Salmen & Dhont, 2020),[1] benevolent sexism considers women as creatures of goodness and emotional sensitivity, even if not always perceived as intelligent or competent (Ebert et al., 2014; Glick et al., 2000). This is what some researchers name "ambivalent sexism," which considers women as superior to men in the domain of feelings, but as inferior in other domains (Glick et al., 2000). Because gender stereotypes are even applied to non-human agents (Tay et al., 2014), many studies show that people prefer female over male robots because they are better at conveying warmth, friendliness, and the capacity to experience emotions (Eyssel & Hegel, 2012; Gustavsson, 2005; Otterbacher & Talias, 2017; Stroessner & Benitez, 2019).

However, research within this overarching paradigm has overlooked the underlying psychological mechanism of perceived *humanness* of gendered bots, which could help to explain further *why* female bots are typically preferred over male bots, beyond the warmth–experience effect. Thus, though gendering increases the perceived humanness of robots, and female gendering increases warmth and experience, no studies to our knowledge have explored whether female gendering can increase the perceived humanness of robots and acceptance of AI more than male gendering.

In this research, we argue that women are "transformed" into robots more than men because women are perceived as more human. This higher humanness stems from the perceived higher capacity of women to communicate warmth and to experience emotions, capacities that are fundamental to be a full human, but that are totally lacking in machines (K. Gray & Wegner, 2012). For AI companies, an objective in doing so would be to inject some human essence into lifeless, inanimate objects and algorithms. As a result, we posit that specifically assigning a female gender to robots can help AI designers go one step further in increasing the perceived humanness of robots by endowing them with a perceived complete human mind, able to perform computational tasks, *and* experience authentic emotions.

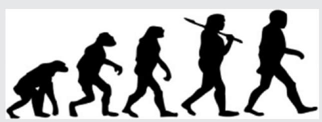
In what follows, we go beyond the warmth–experience findings demonstrated in previous related research and examine how people perceive the *humanness* of men and women as well as male and female robots. We do so by using both implicit and explicit (subtle and blatant) measures of humanness to eventually test whether the perceived humanness of bots increases the perceived uniqueness of treatment from bots, leading to amplified acceptance levels of AI.

3 | OVERVIEW OF STUDIES

We tested our predictions in five studies (see Table 2). Studies 1A and 1B were preregistered and used a within-subjects design to examine whether women are indeed perceived as more human than men, overall and compared to non-human entities (i.e., animals and robots). Study 2 was also preregistered and used an Implicit Association Test (IAT; Greenwald et al., 1998) to investigate whether female bots are associated with the concept of "human" rather than "machine" more so than male bots. Study 3 used a between-subjects design to test whether female robots are perceived as more human than their male counterparts using subtle humanness measures. This study also tested whether the perceived humanness of bots mediates the effect of the robot's gender on the perceived uniqueness of treatment from bots, as well as on participants' attitudes towards the bots. Finally, Study 4 was preregistered and extended Study 3 in a real AI context using blatant humanness measures.

[1]Throughout human history, women have been considered second in creation, as the weaker sex, and without the human rights granted to men.

TABLE 1 What makes us human? Measures of humanness and dehumanization to measure the perceived humanness of humans and bots

Implicit, Subtle, or Blatant	Measures	Dimensions and items of human qualities: Compared to animals: Competence and civilization	Dimensions and items of human qualities: Compared to machines: Warmth and experience	Studies
Implicit dehumanization	**IImplicit Association Test**		*Human*: Person; people; humanity; nature; soul *Machine:* Thing; robots; program; mechanism; computer	Study 2
Subtle dehumanization	**Competent, Warm, Moral Model** (Heflick et al., 2011).	*Human uniqueness dimension* Competence	*Human nature dimension* Warmth/morality	Study 1A Study 3 Study 4
Subtle dehumanization	**Dual model of dehumanization** (Haslam & Loughnan, 2014; Haslam, 2006; Loughnan & Haslam, 2007)	*Uniquely Human (UH)* UH traits extend beyond competence (e.g. civility and refinement) Broadminded/humble/organized/polite/thorough Cold/conservative/hard-hearted/rude/shallow	*Human Nature (HN)* HN extends beyond warmth (e.g., openness) Curious/Friendly/fun-loving/sociable/trusting Aggressive/distractible/impatient/jealous/nervous	Study 1A Study 3
Subtle dehumanization	**Infrahumanization model** (Leyens et al., 2000; adapted by Kteily et al., 2015)	*Infrahumanization Primary* Joy/pleasure/excitement Sadness/pain/rage	*Infrahumanization Secondary* Compassion/tenderness/hope Bitterness/regret/shame	Study 1A
Blatant dehumanization	**Like animals/like Robots** (Bastian et al., 2013)	I feel like men/women lack self-restraint, like animals	I feel like men/women are mechanical and cold, like robots	Study 1A Study 4
Blatant dehumanization	**Graphic diagram of the Ascent of Men** (Animalistic: Kteily et al., 2015) (Mechanistic: Created for these studies)	*Animalisic dehumanization* Scale of the ascent of men/women 	*Mechanistic dehumanization* Adapted scale of the ascent of men/women 	Study 1B Study 4

All Studies recruited participants through an online panel (Prolific). Studies 1 and 2 recruited participants in both the United Kingdom and the United States, and Studies 3 and 4 in the United States only. Participants in all studies indicated their gender, age, parenthood and stated their narcissistic tendencies as well as their adherence to gender stereotypes. These measures were included to increase the internal validity of the studies, as research has documented that age, gender, and parenthood increase gender stereotypes (Endendijk et al., 2018; Siyanova-Chanturia et al., 2015) and that narcissism and adherence to gender stereotypes increase people's propensity to dehumanize women (Gaunt, 2013; Lachowicz-Tabaczek et al., 2019; Viki & Abrams, 2003). Therefore, all analyses included these variables as covariates. Note that our results on humanness hold with the exclusion of these covariates. Studies 3 and 4 also included consumers' optimism towards technology (Parasuraman & Colby, 2015) as these studies were applied to an AI context. All analyses were conducted in R. An attention check was included at the end of the surveys: Participants were explicitly instructed to click on option A (autonomous vehicles) and not on option B (virtual assistants) nor option C (artificial intelligence). Those who did not answer correctly were discarded from further analyses. All data, material, and preregistrations are available on the OSF page linked to the current project (https://osf.io/amcqk/?view_only=a814a8befffa4b9ea8f2e1063fa84ce9).

4 | STUDY 1B: EVIDENCE OF SUBTLE AND BLATANT WOMAN–HUMAN LINKS

Studies 1A and 1B tested whether women are perceived as more human than men (see Supporting Information Appendix 1 for details). In Study 1A, 500 individuals were asked to make inferences about men and women's personality traits, in general, using a within-subjects design. Humanness was assessed using the dual model of dehumanization (Haslam & Loughnan, 2014; Haslam, 2006), the Infrahumanization model (Leyens et al., 2000; adapted by Kteily et al., 2015), an explicit variation of

TABLE 2 Overview of the empirical research and main results

Objectives	Variables	Design, material, and Sample	Results
Studies 1A and 1B test whether people perceive women as more human than men, with subtle measures of humanness (1A) and blatant measures of humanness (1B). *Target:* Humans.	*Manipulation*: Gender of humans *Dependent variables*: 1A: Dual Model of dehumanization; infrahumanization model; animalistic and mechanistic dehumanization; competent, warm, moral model 1B: "The ascent of men" from animal/robot to human	*Research design*: Within-subject design *Stimuli*: None *Respondents*: 1A: *N* = 500 (252 men) 1B: *N* = 1,004 (503 men) *Preregistered*	1A: Women are perceived as more human than men on all the variables, except on the two negative dimensions of the Uniquely Human and Human Nature variables. 1B: Women are perceived as more human than men compared with both animals and robots
Study 2 tests whether people make implicit inferences about the humanness of robots depending on their gender. *Target:* Robots	*Attribute names:* Female bots (Female bot; Miss bot; Lady bot; She bot; Woman bot). Male bots (Male bot; Mr bot; Sir bot; He bot; Man bot). *Target Names:* Human (person; people; humanity; nature; soul). Machine (thing; robots; program; mechanism; computer)	*Research design*: Implicit Association Test (IAT) *Stimuli*: Words *Respondents*: *N* = 199 (100 men) *Preregistered*	Implicit mental association between the concepts of female robots and humanness.
Study 3 tests whether people make explicit inferences about the humanness of robots depending on their gender and whether the gender of robots has an indirect effect on the perceived uniqueness of treatment from bots and attitudes toward the bots through their perceived humanness. *Target:* Robots	*Manipulations*: Gender of robots *Dependent variables*: Dual model of dehumanization; Competent, warm, moral model; Uniqueness of treatment from bots; Attitude toward the bots; Trust, credibility	*Research design*: Between-subject experiment. *Stimuli*: Pictures of robots, chatbots, and humanoids *Respondents* *N* = 899 (450 men) *Not preregistered*	Female bots are preferred over male bots because they are perceived as "better" human and more prone to consider our unique needs.
Study 4 investigated further the effect of robot's gender on the perceived humanness of bots, perceived uniqueness of treatment from bots, and acceptance of AI in a real context. *Target:* Chatbots operated by AI	*Manipulations*: Gender of chatbots *Dependent variables*: "The ascent of men" from animal/robot to human; Competent, warm, moral model; Uniqueness of treatment from bots; Attitude toward the bots; Trust, credibility	*Research design*: Between-subject experiment. *Stimuli*: Scenario + picture of chatbots *Respondents*: *N* = 595 (303 men) *Preregistered*	In the context of health care, female chatbots operated by AI are preferred over male chatbots because they are perceived as more human and more prone to consider our unique needs.

animalistic and mechanistic dehumanization (Bastian et al., 2013), and the competent, warmth, and moral dimension model (Heflick et al., 2011)—See Table 1 for the details of the different scales. Note that in this study, we analyzed positive and negative dimensions of humanness separately because research indicates that positive qualities are more unique to humans than negative qualities are. For example, research on infra-humanization (Viki & Abrams, 2003) indicates that positive secondary emotions are more unique to human beings than other emotions. These results are in line with the idea that friendliness and cooperation (more than incivility and competition) are unique features of humans (Hare, 2017).

As predicted, we found that women were perceived as more human than men on all the variables, except on the two *negative* dimensions of the Uniquely Human and Human Nature variables (see Figure 1): Uniquely $\text{Human}_{\text{positive}}$: $t(499) = 19.8$, $p < 0.001$; Human $\text{Nature}_{\text{Positive}}$: $t(499) = 10.2$, $p < 0.001$; $\text{InfraPrimary}_{\text{Positive}}$: $t(499) = 5.8$, $p < 0.001$; $\text{InfraPrimary}_{\text{Negative}}$: $t(499) = 2.4$, $p = 0.02$; $\text{InfraSecondary}_{\text{Positive}}$: $t(499) = 21.6$, $p < 0.001$; $\text{InfraSecondary}_{\text{Negative}}$: $t(499) = 9.6$, $p < 0.001$; CompentenceWarmthMoral: $t(499) = 14.7$, $p < 0.001$; LikeAnimals: $t(499) = -14.4$, $p < 0.001$; LikeRobots: $t(499) = -10.1$, $p < 0.001$; Uniquely $\text{Human}_{\text{Negative}}$: $t(499) = 19.8$, $p < 0.001$; Human $\text{Nature}_{\text{Negative}}$: $t(499) = 10.2$, $p < 0.001$.

Though Study 1A used subtle measures of dehumanization, Study 1B rather relied on blatant measures. A total of 1004 individuals were exposed to two different scales of "the ascent of man" (see Table 1 and Supporting Information Appendix 2). The first one pictured the original diagram of the evolution of man from ape to human (Kteily et al., 2015), which measures blatant animalistic dehumanization. The second one pictured an adaptation of this scale with a diagram showing the evolution of man from robot to human, which measures blatant mechanistic dehumanization.[2] As predicted, women were perceived as more human than men compared to both animals, $t(1003) = 12.7$, $p < 0.001$ and robots, $t(1003) = 10.1$, $p < 0.001$ (see Figure 2).

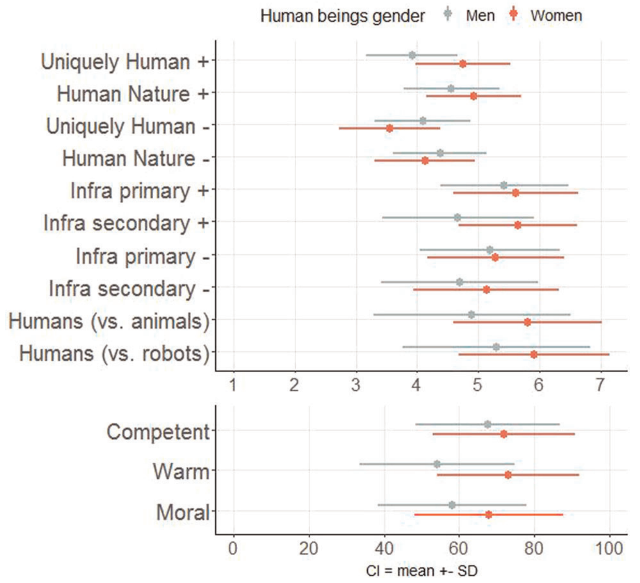


FIGURE 1 Inferences about men and women (Study 1A) [Color figure can be viewed at wileyonlinelibrary.com]

5 | STUDY 2: EVIDENCE OF AN IMPLICIT FEMALE BOT–HUMAN LINK

Study 2 aimed to test whether people make implicit inferences about the humanness of robots depending on their gender, as they do for individuals. Similar to Studies 1A and 1B, this study was preregistered.

5.1 | METHOD

We ran an IAT to assess the existence of an implicit cognitive association between the concepts of "female robots" and "human" as well as "female robots" and "machine"; and between "male robots" and "human" as well as "male robots" and "machine." The IAT is a widely used test (Bar-Anan & Nosek, 2014), where participants try to categorize pairs of words as quickly as possible. On average, paired words are more (vs. less) quickly categorized when they match (vs. mismatch) participants' subjective mental representations. The use of IAT can successfully prevent typical social desirability effects by measuring more automatic responses (Berry, 2015).

After excluding one participant who failed the attention check and further exclusion of five participants who were dropped from the analyses due to excessive speed when performing the IAT test, the final sample consisted of 199 individuals ($M_{age} = 33$ years, $SD = 16$; 100 men).[3]

First, participants performed the IAT (Greenwald et al., 1998). The task was programmed and presented online by using the IAT generator (Carpenter et al., 2019). This program creates a four-block interactive IAT that fully counterbalances left/right starting positions of targets (words related to female or male bots) and categories (words related to humans or machines). Each participant completed the four blocks of trials. In each trial, the target stimulus was displayed in the center of the screen and category labels were displayed in the upper right and left corners of the screen. See Table 1 for the details of the items. Participants were instructed to press the E key as fast as possible when the word belonged to the category on the left, and the I key when it belonged to the category on the right. If an error was made, a red X appeared, and participants could correct errors by hitting the other key. According to our theorizing, the blocks where the category labels "female robots" and "human" are on the same side and "male robots" and "machine" on the other side should be more congruent with participants'

[2]Each of these scales were created in two different gender versions (ape/robot to man and ape/robot to woman) to avoid any biases due to the gender of the featured human being on the "ascent of man" scale. Participants were randomly exposed to either the female or the male version of these scales. Results are still significant when controlling for the gender version of the diagrams/scales (female drawing or male drawing).

[3]By default, participants are dropped if over 10% of trials are less than 300 ms. (cf. Greenwald et al., 2003).

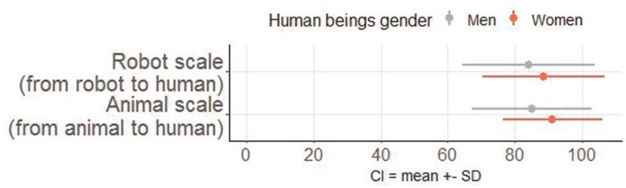


FIGURE 2 Inferences about men and women (Study 1B) [Color figure can be viewed at wileyonlinelibrary.com]

implicit associations than the blocks where "female robots" and "machine" are on the same side and "male robots" and "human" on the other side. Faster correct responses in the congruent block than in the incongruent one would indicate that participants more strongly associate human-related words to female bots and machine-related words to male bots.

As the dependent variable, we used the IAT D-score, which is based on latencies to classify the words that appear in the center of the screen into one of the two target categories in the upper right or left side of the screen. This score is created by dividing differences between the mean response latencies of congruent and incongruent blocks by the standard deviation of all latencies in the blocks.

After doing the IAT, participants filled out a set of self-report measures. Specifically, they indicated their gender, age, parenthood situation, and they were asked to rate their personality using a measure of narcissism that consisted of a 16-item scale with binary choices between two different statements (Ames et al., 2006) and their propensity to adhere to gender stereotypes (Mills et al., 2012). Adherence to gender stereotypes was measured by asking respondents to indicate the extent to which they believe fourteen different tasks required from a couple should be done by the man, the woman, or both. The proportion of tasks ascribed to only one partner forms the adherence measure, such that a proportion closer to 1 indicates a stronger adherence to gender stereotypes (see lists all the items, with descriptive statistics and Cronbach's α scores for the scales).

5.2 | RESULTS

The IAT D score was automatically computed by the IAT generator program (Carpenter et al., 2019). The reliability of the IAT was supported by a good split-half internal consistency with Spearman-Brown correction ($r = 0.81$; Bosson et al., 2000). The mean IAT D-score was 0.29 ($SD = 0.41$), which is significantly different from 0, $t(199) = 10.17$, $p < 0.001$, Cohen's $d = 0.72$. This positive IAT D-score indicates that participants were faster to categorize words in congruent versus incongruent trials. Thus, consistent with our prediction, female (vs. male) bots were more strongly cognitively associated with humanness. Moreover, there was a significant difference in IAT D-score between male and female participants, $F(1, 199) = 22.6$, $p < 0.001$, such that women were more inclined than men to associate the concepts of female bots and humanness cognitively. Still, even among men, the mean IAT D-score was 0.12 ($SD = 0.41$), which is significantly different from 0, $t(103) = 2.90$, $p = 0.005$, Cohen's $d = 0.28$).

5.3 | DISCUSSION

Study 2 provides evidence of the mental association between the concepts of female robots and humanness, in line with the stereotype of perceiving women as more human than men found in Studies 1A and 1B. This result confirms that gender stereotypes about humans apply to nonhuman entities (Tay et al., 2014). Study 3 extends the findings hitherto reported using explicit humanness measures and further examines the consequences of perceived humanness of female bots on inferred uniqueness of treatment from and acceptance of bots.

6 | STUDY 3: FEMALE GENDERING OF BOTS INCREASES SUBTLE HUMANNESS PERCEPTIONS AND ATTITUDES TOWARDS BOTS

The primary purpose of Study 3 was to use explicit measures to test whether people make inferences about the humanness of female and male robots. This study also sought to better pinpoint what makes female robots more human than their male counterparts. Finally, Study 3 aimed to assess whether robots' gender has an indirect effect on the inferred uniqueness of treatment from bots and attitudes toward the bots through their perceived humanness.

6.1 | METHOD

After excluding five participants who failed the attention check, the final sample consisted of 899 individuals ($M_{age} = 35$ years, $SD = 12$; 450 men). Participants were asked to make inferences about personality traits of male and female robots represented in pictures. Participants were randomly allocated to one of six groups, following a 2 (Gender: Male robots, female robots) × 3 (Robot type: Robots, humanoids, and chatbots) between-subjects design (see Supporting Information Appendix 3 for the sets of male and female robots). Note that we only varied the types of robots out of a generalization concern but that we do not expect any interaction effects between gender manipulation and the type of robots on perceived humanness. A pretest conducted among 50 individuals confirmed that the female robots were perceived as more feminine than the male robots (see Supporting Information Appendix 4). The human appearance of the robots was measured, with chatbots perceived as more humanlike than humanoids and humanoids perceived as more humanlike than robots. Importantly, these scores did not significantly differ across gender. Also, all our results hold when we control for robot type as a covariate.

After being exposed to the set of male or female robots, participants answered questions about the robots' perceived humanness through two of the models of humanness used in Study 1: the Dual Model of Dehumanization with the Human Nature and Uniquely Human measures (Haslam & Loughnan, 2014; Haslam, 2006) and the Competent, Warm, Moral model with three items, each item capturing one of the three subdimensions (Heflick et al., 2011). Perceived uniqueness of treatment from bots was assessed by adapting the uniqueness neglect scale from Longoni et al. (2019). Specifically, we asked participants to which extent they thought that these robots would be able to address their unique needs using a 3-item scale (e.g., *These robots will be able to recognize the uniqueness of my issues*). Participants also indicated their overall attitude towards the robots they were exposed to using a 3-item scale (i.e., good, positive, favorable). Finally, two additional measures were added in the questionnaire for exploratory purposes: A 5-item scale to measure trust towards these robots, adapted from Heerink et al. (2010) (e.g., *I would trust these robots if they gave me advice*) and a 5-item scale to measure the perceived believability of these robots, adapted from Andrist et al. (2015) (e.g., *If I had to interact with these robots, I imagine that they would be believable*).

As in Studies 1–2, participants indicated at the end of the questionnaire their gender, age, parenthood situation and rated their level of narcissism and propensity to adhere to gender stereotypes with the same measures used in the previous studies. In addition, they indicated their optimism towards technology in general (e.g., *New technologies contribute to a better quality of life*) using a 4-item subdimension from the technology readiness index (Parasuraman & Colby, 2015). Supporting Information Appendix 5 lists all the items, with descriptive statistics and Cronbach's α scores for the scales.

FIGURE 3 Inferences about male and female robots (Study 3) [Color figure can be viewed at wileyonlinelibrary.com]

6.2 | RESULTS

Our first main hypothesis was that female robots would be perceived as more human than male robots. As shown in Figure 3, the results for robots are in line with those found in Studies 1A and 1B for humans. Specifically, female bots are perceived as more human than male bots on all the variables, except two. Female bots are perceived as more human on the *positive* dimensions of the Uniquely Human and Human Nature variables, as well as on the Competence, Warmth, and Moral variable. On the contrary, male bots are perceived as more human than female bots only on the two *negative* dimensions of the Uniquely Human and Human Nature variables.

A series of regressions further confirmed this pattern of results. Uniquely $\text{Human}_{\text{Positive}}$, Human $\text{Nature}_{\text{Positive}}$, Uniquely $\text{Human}_{\text{Negative}}$, Human $\text{Nature}_{\text{Negative}}$, and the Competence, Warmth, and Moral variables were entered as outcome variables; the robots' gender (male vs. female) was entered as the predictor; and participants' gender, age, narcissism, propensity to adhere to gender stereotypes, and optimism towards technology were entered as covariates (Table 3). These analyses confirmed that female bots registered higher scores than male bots on the Uniquely $\text{Human}_{\text{Positive}}$ variable, $t(891) = 3.7$, $p < 0.001$ and on the Human $\text{Nature}_{\text{Positive}}$ variable, $t(891) = 5.4$, $p < 0.001$. However, male bots registered higher scores than female bots on the Uniquely $\text{Human}_{\text{Negative}}$ variable, $t(891) = -4.8$, $p < 0.001$, as well as the Human $\text{Nature}_{\text{Negative}}$ variable, $t(891) = -4.7$, $p < 0.001$. Female bots also registered higher scores on the Competence, Warmth, Moral variable, $t(891) = 2.9$, $p = 0.004$, but this significant difference was driven by significantly higher scores obtained for female robots specifically on the Warmth dimension, $t(891) = 4.3$, $p < 0.001$, though the Competent and Moral dimensions did not differ significantly between the male and female bots, Competent: $t(891) = 1.4$, $p = 0.17$; Moral: $t(891) = 1.06$, $p = 0.29$. Note that these analyses also detected some main effects of three covariates, such that older participants tended to humanize bots less, whereas those scoring higher on adherence to gender stereotypes and technology optimism tended to humanize bots more. However, we did not find any interactions between the robots' gender and participants' gender or between the robots' gender and participants' adherence to gender stereotypes on perceived humanness of female and male bots. Therefore, these variables are unlikely to act as boundary conditions for our results.

Another series of regressions provided additional evidence for higher perceived humanness of female bots and a general positive inclination towards the female bots. We ran two regression models with the uniqueness of treatment and overall attitudes towards the bots as the outcome variables, the robots' gender (male vs. female) as the predictor; and our usual covariates (Table 3). Again, we found that female bots performed significantly better than male bots on these two variables: Uniqueness of treatment, $t(891) = 2.2$, $p = 0.03$ and overall attitude towards the bots, $t(891) = 2.2$, $p = 0.03$. We also ran the same regressions with our exploratory measures as outcome variables (i.e., trust and credibility). Female bots registered higher scores on these two variables as well: Trust, $t(891) = 2.2$, $p = 0.03$ and credibility, $t(891) = 2.5$, $p = 0.01$.

Our second main hypothesis was that the perceived humanness of bots would positively mediate the effect of the robots' gender on the perceived uniqueness of treatment from bots and ultimately impact attitudes towards the bots in a consistent positive way.

TABLE 3 Perceived subtle humanness of robots depending on their gender, with age, parenthood, narcissism, gender stereotypes, and optimism toward technology as covariates (Study 3)

	Dependent variable:										
	$UH_{Positif}$	$HN_{Positif}$	$UH_{Negatif}$	$HN_{Negatif}$	Competent	Warm	Moral	Trust	Credibility	Uniqueness	Attitude
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Robots: Female	0.24***	0.35***	−0.31***	−0.30***	0.09	0.28***	0.07	0.14*	0.16*	0.14*	0.14*
	(0.06)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Resp gender: Women	0.01	0.005	−0.04	−0.12	0.14*	0.02	0.01	−0.12	−0.02	−0.25***	−0.18**
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)
Age	−0.12**	−0.07*	−0.01	−0.09*	−0.07	−0.08*	−0.13***	−0.09*	−0.07*	−0.03	−0.12**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Children	0.12	0.15	−0.25**	0.02	0.13	0.18*	0.17*	0.15	0.07	0.20**	0.17*
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Narcissism	−0.01	−0.04	−0.08*	−0.15***	0.01	0.01	0.01	0.005	0.04	−0.06	−0.003
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Gender Stereotypes	0.13***	0.13***	0.04	0.04	0.11***	0.13***	0.14***	0.11**	0.11**	0.08*	0.10**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Tech Optimism	0.14***	0.14***	−0.08*	−0.07*	0.17***	0.15***	0.13***	0.24***	0.24***	0.15***	0.18***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Constant	−0.16**	−0.23***	0.26***	0.21**	−0.16*	−0.21***	−0.10	−0.06	−0.10	−0.02	−0.04
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Observations	899	899	899	899	899	899	899	899	899	899	899

Note: Unstandardized regression coefficients with standard errors in brackets.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

We computed an aggregate index of positive humanness by averaging the ratings of the positive dimensions of Uniquely Human and Human Nature based on the strong positive correlations between these two variables ($r = 0.63$). We ran a serial mediation model to investigate this sequential indirect effect (PROCESS Model 6; Hayes, 2013), with our usual variables as covariates. This analysis did not detect a direct significant effect of the robots' gender on attitudes towards the robots ($B = -0.05$, SE = 0.09; CI [−0.27; 0.17]), nor an indirect effect of the robots' gender on attitudes toward the bots through the uniqueness of treatment ($B = 0.01$, SE = 0.05; CI [−0.12; 0.09]). However, the indirect effect of the robots' gender on attitudes toward the bots through perceived humanness was positive and significant ($B = 0.03$, SE = 0.05; CI [0.15; 0.36]), as well as the sequential indirect effect of the robots' gender on attitude toward the bots through perceived humanness and, in turn, perceived uniqueness of treatment ($B = 0.01$, SE = 0.03; CI [0.08; 0.20]).[4] We also ran the exact same sequential mediation model with the variable "Warmth" instead of the aggregate "Human" variable. The results were identical to the ones obtained with the human scales with a significant positive sequential effect ($B = 0.11$, SE = 0.03; CI [0.05; 0.17]). Note also that the sequential mediation with the variable "competent" was not significant ($B = 0.22$, SE = 0.05; CI [−0.02; 0.07]), confirming that warmth, but not competence, mediated the effect between the robots' gender and perceived uniqueness of treatment and acceptance of the bots.

In sum, these results show that the positive effect of female gendering on attitudes toward the bots operates, at least partially, through their perceived subtle humanness and perceived uniqueness of treatment. In other words, female bots tend to be preferred over male bots because they are perceived as more human and more prone to consider our unique needs.

6.3 | DISCUSSION

Using explicit yet subtle humanness measures, Study 3 provides further evidence that female bots are perceived as more human than male bots. Moreover, it appears that female robots are perceived to be "better" entities: They are ascribed more positive but less negative qualities that

[4]The sequential indirect effect is also significant when we compute an aggregate index of positive humanness by averaging the ratings of the positive dimensions of UH and HN, as well as the Competent-Warm-Moral variable.

are Uniquely Human, while also being perceived as warmer. Importantly, female gendering's positive effect on inferred uniqueness of treatment from bots and acceptance of bots is largely driven by robots' perceived humanness. However, one question remains whether participants were simply expressing more favorable views towards female AI because of social desirability as a form of benevolent sexism, rather than perceiving female (vs. male) features as more human in AI settings. Indeed, in Study 3, female bots were perceived as more human on the positive dimensions of humanness, but not the negative ones. This could be due to people ascribing positive traits to female bots—without perceiving female bots as more human. Although Study 2 partially appears to have ruled out this alternative account by using words related to humanness (and not positive qualities), Study 4 was designed to address this concern more explicitly by using blatant measures of humanness, which do not refer to positive or negative qualities.

7 | STUDY 4: FEMALE GENDERING INCREASES BLATANT HUMANNESS PERCEPTIONS OF BOTS AND ACCEPTANCE OF AI

Study 4 investigated the effect of female's gendering on the perceived humanness of bots and the uniqueness of treatment from bots. This final preregistered study differs from Study 3 in two important ways: It examined the acceptance of algorithms operated by AI in a real context (a health decision delivered by a chatbot) and used blatant rather than subtle measures of humanness.

7.1 | METHOD

After excluding nine cases due to missing data and eleven additional participants who failed the attention check, the final sample consisted of 595 individuals (M_{age} = 34 years, SD = 11; 303 men). Participants were randomly allocated to either the female or the male chatbot condition. The two chatbots had identical facial expressions, physical attractiveness, and approximate age. For the female chatbot, we used Amelia's image, the current market-leading cognitive AI solution (https://www.amelia.com, 2020). For the male chatbot, we used Sam's image, a chatbot created by IBM for the United Nations Environment Programme (Clemente, 2020) (see Supporting Information Appendix 6 for the sets of stimuli that were photoshopped to control for the background). We renamed the two chatbots Oliver and Olivia, to ensure that their first names would not influence evaluations of the chatbots. Participants were asked to read the following text: "Imagine that you have symptoms of the Coronavirus and you contact the hospital. The hospital will collect data related to your health, but the diagnosis and the corresponding recommendation (i.e., whether or not to go to intensive care) will be made by Olivia/Oliver. Olivia/Oliver is operated by Artificial Intelligence. She/He will evaluate the results of your examination and use an algorithm to compare your case with hundreds of patients who have had the same symptoms as you."

After reading this introduction accompanied with the picture of the male or female chatbot, participants answered questions about the chatbot's perceived humanness. First, they were asked to rate how mechanical and cold they perceived the chatbot to be, after which they rated the perceived humanness of the female or male chatbot compared to animals and machines, with the same graphic measures used in Study 1B that capture both blatant mechanistic dehumanization and animalistic dehumanization. Specifically, participants were exposed to the two different scales of "the ascent of man" (see Table 1): One picturing the original diagram of the evolution of man from ape to human (blatant animalistic dehumanization, Kteily et al., 2015), and the second one, specifically created for the purpose of the present research, depicting the evolution of man from robot to human (blatant mechanistic dehumanization). Participants then used a continuous slider from 0 (least "evolved") to 100 (most "evolved") to rate how evolved they perceived the chatbot to be. They also rated the chatbot in terms of Competence, Warmth, and Morality (Heflick et al., 2011). Finally, participants indicated their level of trust, credibility, uniqueness of treatment, and overall attitudes towards the chatbot, and responded to the same measures used as covariates in the previous studies. Supporting Information Appendix 7 lists all the items, with descriptive statistics and Cronbach's α scores for the scales.

7.2 | RESULTS

As shown in Figure 4, the female chatbot was perceived as more human than the male chatbot on both the animal–human scale, and the robot–human scale. The female chatbot was also perceived as warmer and more moral and elicited more trust, credibility, perceived uniqueness of treatment, and positive attitudes. However, the female chatbot was not perceived as less mechanical or cold nor as more competent than the male chatbot.

A series of regressions further confirmed this pattern of results (see Table 4). The variables Mechanical, Moral, Warm, Competent, the Scale Animal–Human and Robot–Human, Trust, Credibility, Uniqueness of Treatment, and Attitudes were entered as the outcome variables; the chatbot's gender (male vs. female) was entered as the predictor; with participants' gender, age, narcissism, propensity to adhere to gender stereotypes, and optimism towards technology acting as covariates. These analyses confirmed that the female chatbot registered higher scores than the male chatbot on all the variables except on Mechanical, $t(587) = -0.959$, $p = 0.33$) and Competent, $t(587) = 0.94$, $p = 0.35$; Moral, $t(587) = 1.8$, $p = 0.06$, Warm, $t(587) = 3.2$, $p = 0.002$), Animal–Human, $t(587) = 3.2$, $p = 0.001$, Robot–Human, $t(587) = 2.3$, $p = 0.02$, Trust, $t(587) = 2.9$, $p = .0.003$, Credibility, $t(587) = 3.4$, $p < 0.001$, Uniqueness of Treatment, $t(587) = 2.7$, $p = 0.007$, and Attitudes, $t(587) = 2.5$, $p = 0.01$. Note that the analyses also showed a strong effect of technology optimism: Those who embrace technology were significantly more positive towards chatbots, whereas narcissists, women, and older individuals, overall, were more negative. We did not find any interaction effect between the chatbot's gender and participants' gender on perceived humanness of the female or male chatbot; nor between the chatbot's

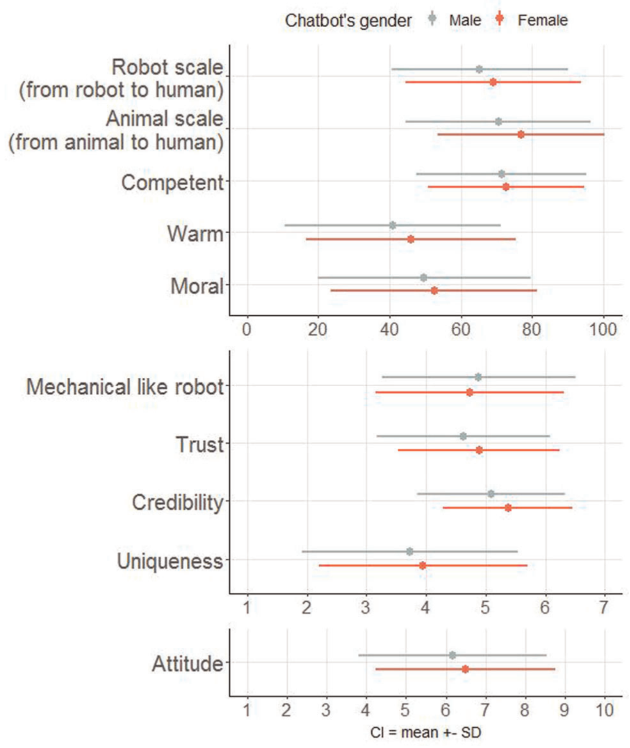


FIGURE 4 Inferences about male and female chatbots (Study 4) [Color figure can be viewed at wileyonlinelibrary.com]

gender and participants' adherence to stereotypes on perceived humanness of the female or male chatbot.

Next, we checked whether the chatbots' perceived humanness positively mediated the effect of the bot's gender on the perceived uniqueness of treatment from bots and ultimately influenced attitudes towards AI. We computed an aggregate index of the animal to human scale and the robot to human scale. We then ran a serial mediation model (PROCESS Model 6; Hayes, 2013), with our usual variables as covariates. In line with the results found in Study 3, this analysis did not detect a direct significant effect of the robots' gender on attitudes towards the chatbot ($B = 0.04$, $SE = 0.12$; CI [−0.20; 0.28]), nor an indirect effect of the chatbot's gender on attitudes towards the bot through the uniqueness of treatment ($B = 0.14$, $SE = 0.08$; CI [−0.02; 0.29]). However, the indirect effect of the bot's gender on attitudes towards the bot through perceived humanness was positive and significant ($B = 0.14$, $SE = 0.05$; CI [0.05; 0.24]), as well as the sequential indirect effect of the bot's gender on attitudes towards the bot through perceived humanness and, in turn, perceived uniqueness of treatment ($B = 0.09$, $SE = 0.03$; CI [0.03; 0.15]).[2] We also ran the exact same sequential mediation with the variable "Warm" instead of the aggregate "Human" variable. The results were similar to those obtained for the Human scales, with a significant positive sequential effect ($B = 0.13$, $SE = 0.04$; CI [0.05; 0.23]). Note also that the sequential mediation with the variable "competent" was not significant ($B = 0.23$, $SE = 0.06$; CI [−0.03; 0.07]), confirming that warmth, but not competence, mediated the effect between the robots' gender and perceived uniqueness of treatment and acceptance of the chatbot.

7.3 | DISCUSSION

Relying on a preregistered procedure, the results from Study 4 show that the positive effect of female gendering on attitudes towards bots operates, at least partially, through perceived humanness. Replicating the findings from Study 3, female bots were preferred over their male counterparts because they were perceived as more human and more likely to consider our unique needs. In line with the findings from Study 2, the results of Study 4 also help in ruling out the alternative account that female bots are not necessarily perceived as more human, but just as having more positive attributes because of social desirability concerns. Specifically, by using blatant measures of humanness (without any reference to positive human qualities), Study 4 ruled out this alternative explanation.

8 | GENERAL DISCUSSION

Almost all virtual AI products in the market today, including virtual assistants and chatbots, come with female features. Although there is broad consensus that AI should not be exclusively female, it is still unclear why AI tools tend to be feminized. Drawing on theories of humanization and dehumanization, we argued that because warmth and experience (but not competence and efficiency) are seen as human key characteristics that are lacking in machines, women might be used in AI bots to humanize these machines. Five large-scale studies (four preregistered) with a total sample of over 3,000 participants provide converging evidence for our theorizing: (i) women are perceived as more human than men, overall and compared to non-human entities (animals and machines); (ii) female bots are endowed with more positive human qualities than male bots and are perceived as more human than male bots, compared to both animals and machines; and (iii) the inferred humanness of female bots increases perceived uniqueness of treatment from them, leading to more favorable attitudes towards AI solutions. Our findings hold in multiple preregistered studies, conducted in different contexts, and irrespective of the specific humanness measures and paradigms used (e.g., IAT, subtle measures, blatant measures), thereby indicating considerable robustness, replicability, and generalizability of our results across study paradigms and settings.

Although we found that women and female robots are perceived as more human on most of the subtle and all the blatant measures of humanness, we also found that men and male robots are perceived as more human on the *negative* dimensions of the subtle measures of humanness (such as Human Nature and Uniquely Human dimensions). That is, men and male bots were thought to possess *fewer positive* human attributes than women and female bots but were thought to possess *more negative* human attributes.

Taken together, our results indicate that female robots are not only endowed with more positive human qualities than male robots, they are also perceived as more human and are expected to be more prone to consider our unique needs. These findings may point to a new possible explanation of why female bots are favored over their male counterparts, with people preferring female intelligent

TABLE 4 Perceived blatant humanness of robots depending on their gender, with age, parenthood, narcissism, gender stereotypes, and optimism toward technology as covariates (Study 4)

	Dependent variable:									
	Mechanical	ScaleAnimalHuman	ScaleRobotHuman	Competent	Warm	Moral	Trust	Credibility	Uniqueness	Attitude
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
AI: Female	−0.12	6.30**	4.49*	1.66	6.59**	3.99	0.30**	0.28***	0.32**	0.41*
	(0.13)	(1.97)	(1.93)	(1.78)	(2.08)	(2.19)	(0.10)	(0.08)	(0.12)	(0.16)
Age	0.03***	−0.41***	−0.11	−0.09	−0.41***	−0.36**	−0.01	−0.01	−0.01*	−0.02**
	(0.01)	(0.10)	(0.10)	(0.09)	(0.11)	(0.11)	(0.01)	(0.004)	(0.01)	(0.01)
Resp gender: Women	0.06	0.53	1.45	−5.50**	−7.59***	−6.70**	−0.38***	−0.16	−0.61***	−0.84***
	(0.13)	(2.03)	(1.99)	(1.83)	(2.15)	(2.26)	(0.10)	(0.09)	(0.12)	(0.17)
Children	−0.40*	7.52**	7.21**	1.74	14.73***	7.99**	0.06	0.07	0.56***	0.58**
	(0.16)	(2.40)	(2.35)	(2.17)	(2.54)	(2.67)	(0.12)	(0.10)	(0.15)	(0.20)
Narcissism	0.33	−12.15*	−20.08***	−13.01**	−35.95***	−29.77***	−1.10***	−0.60**	−2.26***	−2.19***
	(0.32)	(4.89)	(4.79)	(4.43)	(5.18)	(5.44)	(0.25)	(0.21)	(0.30)	(0.40)
Gender Stereotypes	0.25	−3.26	2.95	−3.26	10.86**	10.39**	0.04	−0.18	0.52*	−0.14
	(0.23)	(3.50)	(3.43)	(3.17)	(3.71)	(3.89)	(0.18)	(0.15)	(0.21)	(0.29)
Tech Optimism	−0.25**	5.90***	5.67***	7.84***	6.89***	6.85***	0.77***	0.70***	0.67***	1.11***
	(0.09)	(1.30)	(1.28)	(1.18)	(1.38)	(1.45)	(0.07)	(0.06)	(0.08)	(0.11)
Constant	4.40***	76.09***	66.75***	63.51***	63.70***	63.97***	2.96***	3.15***	3.98***	5.39***
	(0.87)	(13.32)	(13.05)	(12.06)	(14.11)	(14.82)	(0.68)	(0.57)	(0.81)	(1.09)
Observations	595	595	595	595	595	595	595	595	595	595

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

machines because such machines are more strongly associated with humanness.

8.1 | Theoretical contribution to the feminine–warmth effect and trust in AI

Much research has been devoted to the justification of the overuse of female gendering in robotics and AI. It is commonly assumed that women are stereotypically ascribed traits related to warmth and that this stereotype also holds true for female-gendered robots (Stroessner & Benitez, 2019). This female bot–warmth association increases the congruency of female gendering with the role of service provider (Eyssel & Hegel, 2012), and is in line with gender norms about women (Tay et al., 2014). Nevertheless, our work offers an additional, complementary explanation for female bots' general preference in AI contexts. Specifically, research on humanization and dehumanization postulates that the capacity to convey warmth and experience emotions constitutes a unique feature of humans compared to machines, more so than competence and efficiency. Given that warmth (but not competence) is fundamentally lacking in machines (K. Gray & Wegner, 2012), we argued and found that people prefer female over male bots because they are perceived as more human compared to machines, and consumers seem to prefer humanlike machines.

Our research also extends previous findings by showing that female bots are seen as more humans than male bots compared to both machines *and* animals, using implicit and explicit as well as subtle and blatant measures of humanization.

Finally, our findings related to the negative perceptions of the humanness of men and male bots contribute to the literature on the role of harmfulness in dehumanization (Swiderska & Küster, 2020). If men and male bots are judged more negatively than women and female bots, they might be perceived as more harmful. Research has shown that entities that are perceived as harmful are less likely to be attributed mental states and are less entitled to moral standing (Piazza et al., 2014). Logically, entities that are perceived as harmless or even benevolent should be more likely to be attributed mental states and deemed more worthy of moral standing.

In sum, our conceptualization goes beyond the typical explanations given in prior research by suggesting that female AI bots' consumer preferences can be understood through their higher perceived humanness. This could explain why consumers tend to view female AI as more trustworthy (Siegel et al., 2009), why they tend to prefer female AI (Gustavsson, 2005); and, ultimately, why AI designers may favor female features in AI (Zdenek, 2007).[5][6][7]

[5]It is important to note, though, that our results are restricted to people's *perceptions* of female humans and bots, and not necessarily AI designers' beliefs and motives. As a result, we cannot speak about AI designers' motivations in the gendering of AI.

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8.2 | Theoretical contribution to the perceived uniqueness neglect from AI

Our results indicate that female bots' perceived humanness increases their assumed capacity to treat people uniquely; a skill usually deemed to be at the very heart of humanness (Longoni et al., 2019). To explain why we perceive that machines are unable to treat people uniquely, Longoni et al. (2019) refer to our belief that machines lack cognitive flexibility. The authors argue that machines tend to be perceived as rigid and inflexible, contrary to humans who are capable of openness and creativity. Our research suggests that it is also the inability of machines to feel emotions like humans do that could be at the root of the uniqueness neglect effect.

8.3 | Methodological contribution

Our research proposes a new scale to measure blatant mechanistic (de)humanization. The novel ascent dehumanization scale developed by Kteily et al. (2015) pictures the original drawing of the evolution of man from ape to human and allows to capture only blatant *animalistic* dehumanization (i.e., overt and direct denial of humanness compared to animals). To the best of our knowledge, there is no such scale to measure blatant *mechanistic* dehumanization. Therefore, we adapted the ascent of man scale by picturing man's evolution from robot to human (instead of ape to human) to capture the concept of blatant mechanistic dehumanization (i.e., overt and direct denial of humanness compared to robots). This single-item scale offers scholars a new way of easily capturing the robot–human continuum.

8.4 | Managerial contributions

Our findings indicate that companies providing AI services and other robotic solutions may benefit from embodying them with female features. Feminizing such tools makes consumers perceive them as more human in a positive way. Due to this amplified ascription of humanness, consumers infer that these tools will be more prone to consider their unique needs, leading to higher overall acceptance of the feminized (vs. masculinized) versions of such services and solutions. Companies and brands could finetune the use of gendered AI depending on the image they want to project. The increased perceived humanness of female AI can be particularly well-suited for certain brands already playing the humanizing card in their communication and distribution strategies (Otterbring & Lu, 2018; Söderlund, 2016), and certain types of services, where it is better to blur the dichotomy between a bot and a human interlocutor (e.g., health care).

In a healthcare context, our results help identifying factors that could break down the barriers in the adoption of medical AI among

[7]The authors declare no sources of conflict of interest.

consumers. Study 4 suggests that female gendering of a healthcare chatbot can decrease consumers' beliefs that medical AI cannot account for the unique facets of their situation during, for example, the current COVID-19 pandemic. Thus, in increasing perceived humanness, the female gendering of medical AI can decrease the perception that the medical services provided by AI are standardized and not calibrated to consumers' specific conditions, thereby reducing the neglect effect (Longoni et al., 2019).

Considering the uncanny valley hypothesis, though, there may be some ceiling effects in conveying humanness. The uncanny valley hypothesis predicts that an entity appearing almost human will risk eliciting repulsion among consumers (Kim et al., 2019; Mori et al., 2012). For example, Castelo et al. (2018) found that high levels of warmth decreased attitudes towards robots, probably because of uncanniness feelings. Therefore, we recommend that AI companies pretest their virtual tools before putting them in the market to verify that they have been assigned the appropriate amount of artificial humanness.

8.5 | Ethical contribution

Despite the potential positive impact of female AI, this practice has been accused of sexism due to the reinforcement of gender stereotypes and contribute to women's social alienation (Brahnam & de Angeli, 2012; Bullock, 2016; Puntoni et al., 2020). For example, UNESCO (2019) warns that this practice could trap women in traditional female gender roles (such as maids or personal assistants) and increase the risk of treating women as objects or instruments whose primary purpose is to fulfill consumers' needs. As a result, AI designers and policymakers face an ethical dilemma: The female gendering of AI is likely to increase the perceived humanness and adoption of AI tools, but also risks, in turn, to reinforce or even propagate harmful gender stereotypes. Interestingly, women are said to be objectified (i.e., transformed into objects) in AI, but injecting women's humanness into AI objects makes these objects seem more human, which, in turn, may result in the objectification of women in real life. Consequently, policymakers are facing a tradeoff: Should they promote the usage of female features to humanize robots, even if it comes at the expense of dehumanizing women? The development of gender-neutral voices could be a way to move away from the anthropomorphizing principle in AI design and stop the perpetuation of harmful stereotypes (Hadi et al., 2020; Puntoni et al., 2020).

8.6 | Limitations and future research

The present research has certain limitations. Our results related to the perceived humanness of AI are restricted to bots (robots, humanoids, and chatbots), are hypothetical (participants were not interacting with these bots), and specific to a single type of task and context (i.e., utilitarian decision-making in the health context of COVID-19 in Study 4). Therefore, to generalize our results, future research should examine other forms of AI (such as virtual intelligent assistants and avatars), investigate real human–robot interactions (such as communicating with a real robot or chatting online with a chatbot), and include different types of tasks and attribute trade-offs such as utilitarian or hedonic (Longoni & Cian, 2020) because AI may be perceived as more competent than humans in the utilitarian realm than in the hedonic realm (e.g., booking a flight, providing emotional support). With regard to the latter point, the type of tasks performed by robots could potentially influence the perceived humanness and acceptance of bots, as people may favor male robots for tasks requiring rational intelligence, and female robots for tasks requiring emotional intelligence (Eyssel & Hegel, 2012; Sweeney, 2014).

8.7 | CONCLUSION

The present research takes an important first step in uncovering the impact that gendered attributes have on consumers' acceptance of AI tools. Using implicit, subtle, and blatant measures of humanness, our results consistently showed that female bots are perceived as more human than male bots compared to both animals and machines. As a result, feminizing AI could constitute a way to inject a unique human essence into such lifeless, inanimate tools. This perceived humanness of female bots increases the perceived uniqueness of treatment from them, leading to higher acceptance of AI. Taken together, our findings extend the feminine–warmth effect by including the human character and the blatant humanness of female AI bots. These results highlight the ethical quandary faced by AI designers and policymakers and the need to reflect on the social costs we are willing to pay to improve our interactions with machines.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available on OSF (https://osf.io/amcqk/?view_only=a814a8befffa4b9ea8f2e1063fa84ce9).

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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