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Authentic Impediments: The Influence of Identity Threat, Cultivated Perceptions, and Personality on Robophobia

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Abstract

Considering possible impediments to authentic interactions with machines, this study explores contributors to *robophobia* from the potential dual influence of technological features and individual traits. Through a 2 × 2 × 3 online experiment, a robot's physical human-likeness, gender, and status were manipulated and individual differences in robot beliefs and personality traits were measured. The effects of robot traits on phobia were nonsignificant. Overall, subjective beliefs about what robots are, cultivated by media portrayals, whether they threaten human identity, are moral, and have agency were the strongest predictors of robophobia. Those with higher internal locus of control and neuroticism, and lower perceived technology competence, showed more robophobia. Implications for the sociotechnical aspects of robots' integration in work and society are discussed.

Keywords: robophobia, social robots, artificial intelligence, agency, identity

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Introduction

Social robots come in many shapes and sizes, variably approximating human appearance. Some, like Hanson Robotics' Sophia, attempt to appear as human-like as the technology allows, with artificial skin, female features, and feminine outfits that strategically hide Sophia's wires and rolling base. Others, like SoftBank's Pepper, maintain a mechanistic look, with an all-white plastic exterior and a touch screen for a chest. These design choices suggest differing ontological aims for social robots: Sophia imitates humans as closely as possible in order to facilitate a more seamless "co-existence" with people, whereas Pepper stands apart in an immutable "robot" category.

The efficacy of either approach may also be variable and highly contingent on individual differences in expectations and beliefs about robots (A. Edwards et al., 2019), as well as beliefs about human identity (Ferrari et al., 2016; Zlotowski et al., 2017). One of the value propositions that social robots offer is real engagement with their human interactants, such that they could fill in for their human counterparts in retail, care, and education spaces, as a few examples (Pedersen et al., 2018; Rasouli et al., 2022). To achieve this, people should feel like they are experiencing an authentic interaction. What "authenticity" means, though, can vary; the term has been used to denote originality, indicate a veritable reconstruction or reproduction, and describe the revelation of a deep truth (Van Leeuwen, 2001). Because of this conceptual fuzziness, Van Leeuwen (2001) emphasizes the situated, relative, and subjective nature of authenticity, as a question not of external reality but of who perceives something as authentic, and who does not.

Within the computer-mediated communication (CMC) paradigm, authenticity is emphasized in the ways people perform their identities on platforms (Abidin, 2018; Van Driel & Dumitrica, 2021). Authenticity in mass-CMC relates to the source, message, and interaction that influence beliefs in, feelings about, and behavior change from media messages (Lee, 2020). Within the human-machine communication (HMC) paradigm, questions shift from authenticity *through* a mediated channel (toward another human receiver) to authentic interactions and relations *with* a machine (Guzman & Lewis, 2020). Here, questions arise not only about the human's identity but also about the identity of the machine alone and in relation to its human interactant. For example, engaging with social robots as interaction partners may hinge on both the social robot's plausibility as a human-like interactant and the human interactant's receptivity to such engagement.

Therefore, this study explores perceptions of social robots from the potential dual influence of technological features and individual traits. People's phobia of robots (*robophobia*) is examined and considered conceptually as a potential hindrance to meaningful, authentic interactions. Using an online experimental design, this study analyzes whether a robot's physical human-like appearance, gender, and status affect people's robophobia, and the extent to which people's cultivated perceptions of robots from media, attitudes of robot's threat to human uniqueness, and individual differences in efficacy and anxiety influence these attitudes.

Literature Review

Robophobia

Phobia around technology has been narrowly conceptualized as fear and anxiety toward computers and more broadly conceived to capture people's orientation to technology generally (Khasawneh, 2018a; Osiceanu, 2015). A commonality across definitions is that such phobia is characterized by avoidance, paranoia, fear, and anxiety, which can manifest behaviorally, emotionally, and attitudinally (Osiceanu, 2015). In turn, technophobia is an important factor in people's adaption to new technologies (Khasawneh, 2018a, 2018b; Lan et al., 2022). Those with computerphobia have more negative attitudes toward computers (Rosen et al., 1993), which in turn leads to computer avoidance (Mcilroy et al., 2007). From the lens of technology acceptance (Davis, 1989), technophobia is a significant antecedent to attitudes about how easy and useful a technology is (Khasawneh, 2018b).

In thinking about robophobia, there are similarities with and deviations from computer- and technophobia. To start, computers are a tool employed by people to help them achieve their own goals. While the introduction of computers and their ancillary systems in the workplace required employee re-skilling and upskilling, and rendered certain tasks obsolete, computers still required human operators. Robots, though also conveyed as tools and helpers, can act with varying degrees of autonomy. With less need for direct human intervention or involvement, robots pose more existential threat than computers, which lack robots' increasingly autonomous, intelligent, and embodied capabilities (Sinha et al., 2020).

Research has shown that similar technophobic dynamics to computer resistance is at play with robots. People with more negative attitudes toward robots are more likely to avoid human-robot communication (Nomura et al., 2008). Technophobia had a powerful and negative influence on intentions to use robots in a hospitality context (Sinha et al., 2020). Importantly, technophobia not only negatively predicted use intentions, but also usurped anthropomorphism's positive effect on use intention (Sinha et al., 2020). This suggests the importance of considering differences in how individuals approach technology alongside its features.

Indeed, for decades, we have seen evidence that socio-emotional relating with machines may have less to do with its technical capabilities and more to do with the human interactant (Vanman & Kappas, 2019). Rudimentary computer programs like ELIZA (Weizenbaum, 1966) and the Tamogotchi (Vanman & Kappas, 2019) could elicit human emotion and attachment, which Turkle (2007) explicated by people's projection of their own attributions and desires, in order to bridge the gap between an artifact's actual (rudimentary) capabilities and people's (complex) emotions. More recently, though, these "relational artifacts" (Turkle, 2007) imitate human behavior and appearance in increasingly sophisticated ways, as illustrated by robots like Sophia and Pepper.

Thus, robophobia may be variably influenced by the technology's traits and differences across people in how they approach technology. An important question is the extent to which robophobia stems from its static, human-like features or people's individual experiences and subjective beliefs, which are multifaceted. The remaining literature review discusses each of these components in turn.

Robots' Features

Physical Human-Likeness and the Uncanny Valley

Considerations about the possible influence that a robot's human-like appearance has on attitudes toward it extends back decades to Mori et al.'s (2012) uncanny valley hypothesis. Mori posited that people feel more affinity toward nonhuman entities that appear more human-like up to a certain point of humanness; once something approaches human-likeness but is not actually human, people drop into the "uncanny valley," wherein affinity is replaced with feelings of eeriness and unease (Mori, 1970, in Mori et al., 2012; Wang et al., 2015). Importantly, Mori (1970, in Mori et al., 2012) did not test this hypothesis empirically, and subsequent research has not unequivocally demonstrated a clear, curvilinear relationship in the uncanny phenomenon (Rosenthal-von der Pütten et al., 2014). For example, MacDorman (2006) found an uncanny valley occurred in response to images of an entity morphing from mechanical to human-like, but the same pattern was not replicated with videos portraying mechanical to human-like subjects. In another study using video stimuli, Riek and colleagues (2009) found that people empathized more with robots that appeared more human when they were being mistreated.

On the other hand, studies have found that, when faced with more human-like robots, people can feel increased unease (Palomäki et al., 2018) and more threat to their identity (Ferrari et al., 2016; Yogeeswaran et al., 2016). This study does not aim to directly test the uncanny valley hypothesis, which would require a greater range of stimuli than the present manipulation entails (MacDorman, 2006; Palomäki et al., 2018; Rosenthal-von der Pütten et al., 2014). The "uncanny phenomenon" (Wang et al., 2015), however, does inform how people might respond to a robot that appears mechanical compared to one that is more human-like, and supports the prediction that:

H1: The more human-like robot will elicit more robophobia.

Gender and Stereotypes

The research on how robot gender affects people's response to it does not show a clear-cut preference for one gender over another. Studies have shown that people tend to apply existing gender stereotypes to robots (Bernotat et al., 2021; Eyssel & Hegel, 2012). When not explicitly gendered, people tend to default to a male attribution (Beraldo et al., 2018; Bernotat et al., 2021). Stereotypes can also influence robot acceptance and anthropomorphism, in that both increased when robot gender was more congruent with the task at hand (Kuchenbrandt et al., 2014; Tay et al., 2014).

In terms of more phobia-adjacent measures such as likability and trustworthiness, the results are mixed. Although they are liked more than male robots, female robots are viewed as less trustworthy (Kraus et al., 2018). Male robots are also perceived as more useful than (Beraldo et al., 2018) and generally favored (Jung et al., 2016) over female robots. Still other studies have not found any evidence of gender differences in how much people perceived competence in (Bryant et al., 2020), felt comfortable with (Rogers et al., 2020), or trusted (Ghazali et al., 2018) robots. Given these mixed findings, this study asks:

RQ1: Are there differences in how much robophobia is elicited by a male vs. female robot?

Status and Power

In addition to robots' physical human traits, the human *context* in which they operate may affect how people perceive and interact with them, which is reflected by recent research in this realm (e.g., Bernotat et al., 2021; Bryant et al., 2020; Kraus et al., 2018; Rogers et al., 2020). Context could refer to the domain in which the robot operates, such as security or care settings (Tay et al., 2014; Taipale & Fortunati, 2018), as well as to the robot's status relative to its human interactants (Y. Kim & Mutlu, 2014). This study focuses on status in order to explore how a robot's agency may influence phobia of it. Research shows that generally people prefer for a robot to engage in work that is more rote and assistive (Dautenhahn et al., 2005; Takayama et al., 2008). When relying on a robot to complete a task, people are more critical of one in a supervisory compared to subordinate capacity (Hinds et al., 2004). Interestingly, when examining both physical (near vs. far) and power (high vs. low status) distance, Y. Kim and Mutlu (2014) found that people preferred the higher-status robot to remain physically closer than the lower-status robot, perhaps due to a wariness about the robot with more power. Robots demonstrating more autonomy also elicit less empathy (Kwak et al., 2013) and more feelings of eeriness (Appel et al., 2020). These findings suggest that people may be more phobic of robots with a higher status (e.g., supervisor) than them:

> **H2:** A higher-status robot will elicit more robophobia than an equivalent- or lower-status robot.

Humans' Features

Perceptions of Robots' Identity Threat and Morality

When robots appear more anthropomorphic (Ferrari et al., 2016) or autonomous (Zlotowski et al., 2017), they are perceived as more threatening. Threat perceptions may not just stem from robots' traits, however. If viewed as a separate ontological entity, people may categorically classify robots as "other" (A. Edwards, 2018; Vanman & Kappas, 2019). According to intergroup threat theory (Stephan et al., 2008), outgroup members are perceived to pose heightened threat, which leads to ingroup members holding more negative attitudes toward them (Stephan et al., 2008; Zlotowski et al., 2017). Outgroup bias is caused by ingroup members' fear and uncertainty toward unfamiliar "others" (Kawakami et al., 2017). This dynamic has been demonstrated in threat perceptions of machines, which amplify negative attitudes about usage (Huang et al., 2021). People may differ in how much they view robots as outgroup members, which would influence the extent to which they perceive them as threatening (Vanman & Kappas, 2019; Yogeeswaran et al., 2016). Therefore, this study predicts that:

> **H3:** Perceived identity threat is related to greater robophobia.

Although robots can elicit feelings of threat, they can also be regarded as entities deserving of moral treatment (Banks, 2019; Waytz et al., 2010). Banks (2019, 2021) has identified two dimensions of robots' morality: their ability to reason (morality dimension) and the extent to which they lack agency and intentionality (dependency dimension). In her validation of the scale, Banks (2019) found that robots' perceived morality was related to positive feelings about the robots' goodwill and trustworthiness, as well as willingness to interact more intimately with it and have more relational certainty toward it. Examining moral behaviors, Banks (2021) found that judgments are relatively agent agnostic, though the robot agent (compared to the human agent) was given more credit or blame for upholding or violating moral foundations. This (small) interaction effect suggests that heuristics about a robot's mind or morality may influence judgments about their (im)moral behavior (Banks, 2021).

Viewing a robot with empathy extends from individual differences in anthropomorphic tendencies (Darling, 2015), which are also related to the extent to which robots are seen as entities with moral worth (Waytz et al., 2010). When presented as more autonomous (Stein & Ohler, 2017) or more human-like (Ceh & Vanman, 2018), robots simultaneously elicited more empathy *and* more feelings of threat. Thus, when innate human traits are ascribed to robots, they may activate both affinity and hostility, making it unclear whether moral perceptions of a robot would influence negative attitudes toward it. Seeing robots as moral accords with more affinity toward it (Banks, 2019), but a unique human trait could also elicit feelings of animus (Vanman & Kappas, 2019). Therefore, this study explores whether perceived morality affects robophobia.

> **RQ2a-b:** Is a robot's perceived (a) morality and (b) dependency related to robophobia?

Robot Experience in Real Life and on the Screen

The literature on technophobia demonstrates how increased exposure to and experience with a technology can reduce people's apprehension about it (Anthony et al., 2000). Similarly, affinity toward robots may be developed with increased real-life interactions and experience with them (Lan et al., 2022; Nomura & Horii, 2020). When exposed to a robot in their classroom over 2 months, elementary school children came to view it as a member of their group (Kanda et al., 2007). Importantly, though, this dynamic occurred among children who were initially open to interacting with it; some children in the classroom rejected its presence early on (Kanda et al., 2007). Thus, real-life experience with a robot may already hinge on a lack of robophobia, which may have a self-reinforcing effect in that further contact reduces phobia more. Therefore, this study posits that:

> **H4:** More real-life experience with robots relates to less robophobia.

In the absence of real-life experience, people may rely on media portrayals to frame their understanding. Media exposure cultivates certain attitudes toward (Sundar et al., 2016) or mental models (Banks, 2020) of robots. When they could better recall robots from films, people showed less anxiety about robots generally (Sundar et al., 2016). When people felt sympathy toward recalled robot characters, they were more likely to view robots positively (Banks, 2020). Conversely, when people had cultivated negative perceptions of robots from media exposure they subsequently held more negative attitudes (Horstmann & Krämer, 2019). Given these differential effects of positive and negative views, this study captures them separately and predicts that:

H5a: Positive mediated view of robots relates to less robophobia.

H5b: Negative mediated view of robots relates to greater robophobia.

Personality Traits

People's attitudes about technology are not solely determined by their prior experience with it (Anthony et al., 2000). Matthews and colleagues (2021) argue that individual differences in etic (i.e., universal, generalizable) traits are critical for understanding human-machine interactions, now and in the future. Given the uncertain, increasingly complex, and rapidly advancing nature of intelligent and autonomous technology, people's acceptance cannot necessarily hinge on sophisticated knowledge about its use (Matthews et al., 2021). Therefore, in addition to robot-specific experience and beliefs (what Matthews et al., 2021 refer to as "emic" traits), individuals' traits related to efficacy and personality are explored. As an interactive, agentic technology, social robots are a departure from prior conceptions of "use" for technical tools; thus, people's own sense of agency and control may be challenged in the face of machine agency (Mays et al., 2021). Research on the influence of efficacy in technology adoption typically finds that general efficacy and domain efficacy positively relate to adoption (Hsia et al., 2014). In attitudes toward AI, however, people with a greater sense of control of their lives were *less* comfortable with the technology (Mays et al., 2021). Conversely, those with more technological competence (domain efficacy) were more comfortable with AI. As a technology with similar attributes to AI (e.g., more autonomy and agency), attitudes toward robots may show a similar divergence in influence of general and domain efficacy. Therefore, this study predicts that:

H6: Higher internal locus of control is related to greater robophobia.

H7: Higher perceived technology competence is related to less robophobia.

Of the Big Five personality traits, neuroticism in particular—which is characterized by tendencies toward anxiety and emotional instability (Eysenck et al., 1985)—shows a positive relationship with technophobia (Anthony et al., 2000) and computer anxiety (Osiceanu, 2015), as well as fear of and less comfort with AI (Mays et al., 2021; Sindermann et al., 2022). This pattern appears to extend to robots, as those higher in neuroticism are less comfortable with them (Robert, 2018), hold more negative attitudes toward them (Müller & Richert, 2018), and are more sensitive to their uncanniness (eeriness and lack of warmth) (MacDorman & Entezari, 2015). While this study does not evaluate uncanniness directly, robophobia and the uncanny are conceptually similar in that both relate to fear and anxiety (MacDorman & Entezari, 2015). Neuroticism is a particularly salient trait to examine because of its relationship to uncertainty intolerance (Matthews et al., 2021). As an emergent technology with plenty of unknowns about their advancement and social integration, social robots induce a great deal of uncertainty. Additionally, those higher in neuroticism experience more sensitivity to social threat (Matthews et al., 2021). Research on attitudes toward outgroups suggests that if robots are perceived as more threatening, then people will feel more anxiety and negativity toward them (Riek et al., 2006, in Vanman & Kappas, 2019). Given these findings, it is predicted that:

H8: Higher neuroticism is related to greater robophobia.

Method

Design and Participants

In order to examine the factors that influence robophobia, a between-subjects online experiment (2 × 2 × 3) was conducted. Human-like robot traits were considered through a visual + vignette manipulation. Participants (*N* = 1,020)[1] were randomly shown one robot that was either male or female, either humanoid (more mechanical appearing) or android (more human appearing), and described as an agentic, intelligent entity (per Zlotowksi et al., 2017) that was an assistant, coworker, or supervisor.

Age and gender quotas based on US census demographics were established for each condition. In the overall sample, 52.5% of the participants were female and the mean age was 44.01 years (*SD* = 17.30). After being shown the stimulus—robot image (see Figures 1–4) and description (see Table 1)—participants were instructed to imagine the robot in the scenario when responding to a measure of robophobia. After completing that measure, participants answered other self-report measures for the independent variables.

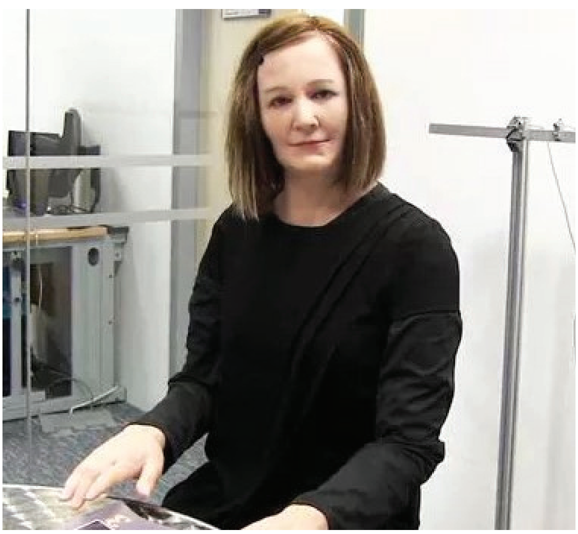

FIGURE 1 Android Female Robot, "Nadine"

FIGURE 2 Android Male Robot, "Geminoid"

1. Sample size was determined based on available funding and an estimation of 100 participants/condition. The resulting sample size (*N* = 1020) is smaller after removing straight-liners from the data. Using G*Power software, a post-hoc power analysis was conducted for multiple linear regression with 14 predictors, an alpha of .05, and a conservative effect size (f^2 = .02), yielding a statistical power of .85 (Faul et al., 2009).

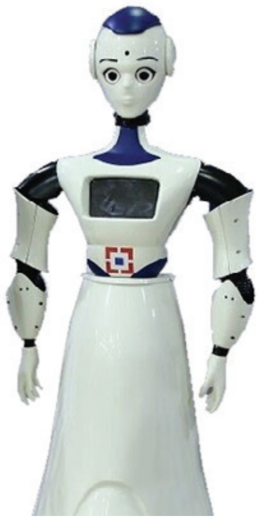

FIGURE 3 Humanoid Female Robot, "Ira"

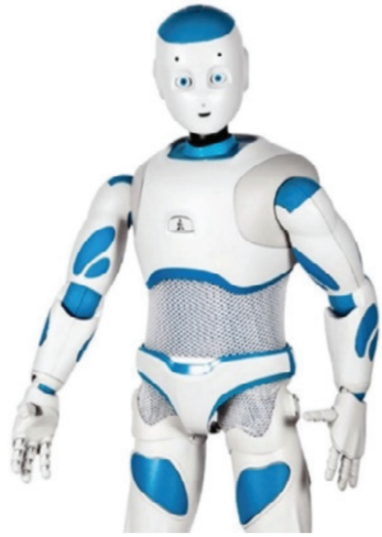

FIGURE 4 Humanoid Male Robot, "Romeo"

TABLE 1 Robot Scenarios Displayed to Manipulate Its Status

	Status description
In all three conditions	Today's robots can already move on their own and perform a variety of tasks like lifting heavy things, cleaning, driving, tutoring, and looking after the elderly. They can also solve puzzles and make decisions on their own. In light of these advances, in the very near future robots might be part of everyday life. One setting where robots may be deployed is **in the workplace**.
Superior	Imagine that this robot has been assigned as your **supervisor at work.** In such a role, [she / he] would assign you tasks and projects, as well as evaluate your performance.
Peer	Imagine that this robot has been assigned as your **coworker at work**. In such a role, [she / he] would be assigned similar tasks to yours, as well as work with you as a partner on group projects.
Subordinate	Imagine that this robot has been assigned as your **personal assistant at work**. In such a role, [she / he] would help you with your tasks and projects, performing duties like answering phones and emails, scheduling meetings, and taking care of other logistics.

Stimulus Material

Prior to the main study, a pilot study was conducted to pre-test the robot image stimuli to ensure they significantly differed in gender and human-likeness, and were not significantly different in threat perceptions. Drawing from the ABOT (Anthropomorphic roBOT; Phillips et al., 2018) database, 21 robots were identified for pre-testing based on ABOT's humanness ratings. Participants ($N = 75$) were asked to rate aspects of the robot images' physical appearance using 9-point semantic differential scales adapted from MacDorman (2006), Bartneck et al. (2009), and Ho and MacDorman (2010). Physical humanness was evaluated on four pairs of items: machine-like vs. human-like; artificial vs. natural; robotic vs. human; human-made vs. human-like. The robot's gender was evaluated using two pairs of items: male vs. female; masculine vs. feminine. In order to control for any other aspects of the robot's appearance that could confound phobia perceptions, four pairs of items gauging threateningness were evaluated: cold vs. warm; threatening vs. friendly; unlikeable vs. likeable; dangerous vs. safe. Gender perception scores were used first to reduce the sample of 21 robots to 4 for further analysis. These four robots' physical humanness and threateningess scores were then compared via paired-samples *t*-tests. The *t*-test results confirmed significant gender differences within the pairs of android ($t = 19.93$, $p < .001$) and humanoid ($t = 7.16$, $p < .001$) robots. Between the android and humanoid pairs there were significant differences in physical humanness (android male–humanoid male: $t = -12.30$, $p < .001$, android male–humanoid female: $t = -11.44$, $p < .001$, android female–humanoid male: $t = -13.38$, $p < .001$, android female–humanoid female: $t = -12.79$, $p < .001$). Threateningness scores were not significantly different across the four robots.

Robot status was manipulated using vignettes based on Zlotowski et al.'s (2017) scenarios (see Table 1). These included the same description of a social robot's capabilities across conditions and varied a workplace scenario to describe the robot as the participant's supervisor (superior status), coworker (peer status), or personal assistant (subordinate status). The robots (Figures 1–4) were combined with a vignette (Table 1) and presented together in one image.

Measurement

Unless otherwise noted, all variables were measured using 7-point, Likert-type scales.

Dependent variable. Following the stimuli, participants were asked to respond to the *robophobia* items: "I would feel very nervous just being around a robot," "I would feel paranoid talking with a robot," "Something bad will happen if robots develop into living beings," "I would feel very nervous just being around a robot," "I would feel uneasy if robots really had emotions," "Robots should never make decisions concerning people," and "Robots would be a bad influence on children." The 6-item scale (strongly disagree—to strongly agree) was adapted from Nomura et al.'s (2008) Negative Attitudes toward Robots Scale (NARS) ($\alpha_{mas} = .88$, $\alpha_{map} = .90$, $\alpha_{maa} = .84$, $\alpha_{mhs} = .90$, $\alpha_{mhp} = .83$, $\alpha_{mha} = .78$, $\alpha_{fas} = .88$, $\alpha_{fap} = .87$, $\alpha_{faa} = .90$, $\alpha_{fhs} = .90$, $\alpha_{fhp} = .87$, $\alpha_{fha} = .89$).[2] The six NARS items were selected because they

2. Cronbach's α is reported for each condition for the dependent variable: m/f = male or female, a/h = android or humanoid, and s/p/a = superior, peer, or assistant.

represented elements of other technophobia scales that gauge people's avoidance, paranoia, fear, and anxiety of the technology in question.

Independent variables. In addition to the robot manipulation and main outcome variable, participants' individual differences related to personal robot experience, robot-human-likeness beliefs, and personal traits were measured. Robot experience was comprised of *real-life exposure* to and *mediated views* of robots, both adapted from Horstmann and Krämer (2019). To measure exposure, participants were asked how often, on a 6-point scale ranging from "Never" to "Very often," they encountered industrial robots, domestic robots like a vacuum cleaner or lawnmower, and social robots that are autonomous and interactive (α = .82, M = 2.70, SD = 1.45). Mediated views were measured with two 3-item scales capturing *positive* (α = .82, M = 5.09, SD = 1.16) and *negative* (α = .87, M = 3.87, SD = 1.51) views. Participants were asked to indicate their agreement with negative (e.g., "Robots are rather against humans") and positive (e.g., "Robots help humans") statements about the relationships between humans and robots in movies or TV shows. Higher values corresponded to stronger negative and stronger positive views.

Three additional robot beliefs were measured to capture subjective impressions of robots' human-like abilities. *Perceived identity threat* (Zlotowski et al., 2017) measures the extent to which participants believe robots threaten human uniqueness. The 4-item scale asked about participants' agreement with items such as "Robots seem to lessen the value of human existence" (α = .76, M = 4.07, SD = 1.51). Perceptions of robots' morality were measured using Banks's (2019) two-dimensional scale that captures both *morality* (six items) and *dependency* (four items). Participants indicated their agreement with moral reasoning statements such as "Robots can have a sense for what is right and wrong" (α = .91, M = 4.07, SD = 1.49) and dependency statements such as "Robots can only do what humans tell them to do" (α = .83, M = 2.63, SD = 1.19).

Finally, personal traits of efficacy and neuroticism were measured. General efficacy was measured with a 5-item *locus of control* scale (Rotter, 1966), which asked participants' agreement to items such as "I do not have enough control over the direction my life is taking." Higher values corresponded to higher internal locus of control (α = .84, M = 3.68, SD = 1.38). Domain efficacy was measured through a 5-item *perceived technology competence* scale (Katz & Halpern, 2014), which captured how much participants enjoy and feel comfortable using technology. Higher values indicated more perceived competence (α = .84, M = 5.47, SD = 1.19). A 9-item *neuroticism* scale was adapted from Eysenck et al. (1985). Participants answered how much they agreed with statements like "I would call myself tense or 'highly strung.'" Higher values corresponded to stronger neuroticism (α = .94, M = 3.92, SD = 1.51).

Results

A hierarchical linear regression was run to explore the relative influence of a robot's technological features (block 1), robot experience/beliefs (block 3), and personal traits (block 4) on robophobia. Demographics were included in the second block as a control. Table 2 displays the regression results; all analyses were conducted using IBM SPSS.

TABLE 2 Technological and Individual Factors That Influence Robophobia

	B (SE)	β
Block 1: Robot traits		
Physical humanness	.06 (.07)	.02
Gender (1 = male, 2 = female)	–.02 (.07)	–.01
Status	–.05 (.04)	–.03
ΔR^2	.30%	
Block 2: Demographics		
Age	.001 (.002)	.02
Gender (1 = male, 2 = female)	.11 (.07)	.04
ΔR^2	1.00%**	
Block 3: Experience w/ robots		
Real-life exposure	–.01 (.03)	–.02
Negative mediated views	.23 (.03)	.25***
Positive mediated views	–.19 (.04)	–.17***
Identity threat	.30 (.03)	.33***
Morality	–.19 (.03)	–.16***
Dependency	.17 (.03)	.19***
ΔR^2	37.3%***	
Block 4: Personal traits		
Locus of control	.09 (.03)	.09**
Perceived technology competence	–.09 (.04)	–.07*
Neuroticism	.09 (.03)	.10**
ΔR^2	2.4%***	
Total adjusted R^2	40.1%	

Notes: $N = 1{,}020$; *$p < .05$; **$p < .01$; ***$p < .001$.

The experimental manipulation of robots' features had no influence on phobic attitudes (H1–2, RQ1). Rather, individual differences in beliefs about robots had the strongest effect, explaining 37% of the variance in robophobia. Those who felt that robots threaten human identity (H3: $\beta = .33$, $p < .001$) and have cultivated negative views from robots' mediated portrayals (H5b: $\beta = .23$, $p < .001$) were more phobic. Conversely, positive mediated views of robots (H5a: $\beta = –.17$, $p < .001$), perceptions of robots as moral (RQ2a: $\beta = –.19$, $p <.001$) and agentic (e.g., lower dependency) (RQ2b: $\beta = .16$, $p < .001$) was related to less robophobia. Contrary to the prediction in H4, real-life exposure to robots had no effect on robophobia. Although demonstrating less influence, personal traits were also related: those who felt more in control of their lives (H6: $\beta = .09$, $p < .01$) and who were higher in neuroticism (H8: $\beta = .10$, $p < .01$) were more phobic, while those with a higher perceived technology competence were less phobic (H7: $\beta = –.09$, $p < .05$).

Discussion

Considering possible impediments to authentic interactions with machines, this study explored contributors to robophobia. Through an online experiment, a robot's physical human-likeness, gender, and status were manipulated and individual differences in robot attitudes and traits were measured. Overall, subjective beliefs about what robots are, cultivated by media portrayals, and whether they threaten human identity, were the strongest predictors of robophobia. Stronger beliefs that robots can be moral and agentic—typically unique human traits—were related to less robophobia. Although the effects were smaller, results showed that stable individual traits (general and domain efficacy and neuroticism) also influenced robophobia, though in different directions. Those who feel more in control of their lives (general efficacy) and who are higher in neuroticism were more robophobic, while those with higher feelings of technological competency were less robophobic.

Importance of Subjective Robot Beliefs and Individual Traits

The study's findings on the strong influence of subjective, cultivated beliefs about robots extends research on the double-sided nature of human-robot interaction that includes both the robot traits as well as individual subjectivities (c.f., MacDorman & Entezari, 2015; Mays & Cummings, 2023; Rosenthal-von der Pütten et al., 2014; Rosenthal-von der Pütten & Weiss, 2015; Waytz et al., 2010). In particular, the more robots were perceived as a threat to unique human identity, the more phobic someone was. This extends intergroup threat findings on how ingroup members perceive those in the outgroup more negatively (Stephan et al., 2008) to robots as an outgroup "other" (A. Edwards, 2018; Vanman & Kappas, 2019; Zlotowski et al., 2017), which increases negative attitudes toward them (Huang et al., 2021).

Given identity threat's amplifying influence on phobia, it is at first blush counterintuitive that perceptions of robots as moral and agentic *lessened* phobia toward them. Some research suggests that ascribing such human-like traits, particularly agency, would increase hostility toward robots (Vanman & Kappas, 2019). However, other research indicates that viewing robots as moral (Banks, 2019), autonomous (Stein & Ohler, 2017), and human-like (Ceh & Vanman, 2018) can increase affinity toward them. This study's findings on perceptions of robots as moral agents supports the latter stance. One possible explanation is that morality is not considered an exclusive human trait; thus, a robot capable of morality does not necessarily violate assumptions of unique human identity. Another explanation could be that phobia *precedes* agentic perceptions. Future work should investigate the directionality of influence, with a mediation analysis or by manipulating machine agency to explore its effects on phobia.

The significant influence of cultivated attitudes on how people engage with and perceive the world is well established and extends far beyond robots (Gerbner & Gross, 1976). In the context of robots, this study reinforces prior research findings on the extent to which media affects attitudes about robots (Banks, 2020; Horstmann & Krämer, 2019; Sundar et al., 2016): a negative mediated attitude was related to higher robophobia and a positive mediated attitude was related to less robophobia. Of note, negative cultivation had a stronger effect on phobia compared to positive cultivation, which may stem from people's negativity bias (Rozin & Royzman, 2001).

The findings also showed an interesting dynamic between domain and general efficacy, wherein those with technological efficacy were less phobic, while those with higher general efficacy were *more* phobic. Considered in tandem with the influence of perceived identity threat, these findings indicate a tension between machine and human agency. Acceptance of older technologies like computers has been positively related to both general and domain efficacy (Hsia et al., 2014); the divergence revealed here provides support for the contention that today's AI-powered technology is a paradigmatic departure from technology as human-wielded tools. More research is needed to explore this potential shift. It may be that there is significant individual variation in people's ontological judgments about social and agentic machines. Promising work has been done recently in using cluster analyses to identify how different groups of people view AI roles, for example (T. Kim et al., 2023). A similar approach could be taken in understanding whether there are different ontological clusters for how people make sense of AI and social robots.

Categorical Judgments of Robots as "Other"?

The different robot traits manipulated in the stimuli had no significant effects on robophobia. While this may be due to the limited nature of the stimuli (expanded upon in the Limitations section, below), it may be explained by a categorical othering of robots that supersedes any nuanced judgments of robots' appearance and context. In a human context, research has shown that people are less capable of individuating faces amongst those in an outgroup (Schroeder et al., 2021). In looking at neural responses to artificial agents, research shows that parts of the brain related to mentalizing reacted "particularly strongly" to human versus nonhuman agents in a "non-linear, step-like function" (Rosenthal-von der Pütten et al., 2019, p. 6567), supporting the idea that categorical nonhuman determinations may trigger a more expansive mental model about what the nonhuman "other" is beyond the physical artifact immediately being confronted. Considering the strong effect of perceived identity threat, as well as cultivated robot attitudes, on robophobia, participants may have categorized all the robots similarly, as "other," which allowed for their preconceptions and cultivated models of robots to prevail. In other words, people may be thinking more categorically rather than discretely when making judgments about a social robot.

It is important to better understand the variation in people's mental models about robots, as well as the extent to which they influence people's approach toward and engagement with robots. There is evidence that technophobia overrides any positive effects of anthropomorphism (Sinha et al., 2020). In that vein, this paper speculates that robophobia is an impediment to authentic interactions with robots. However, what an authentic human-robot interaction entails could vary significantly across people. Some, who may embrace social and agentic robots, would likely perceive a more human-like interaction as more authentic. Others, who may prefer to compartmentalize robots as tools, would probably find a more human-like interaction to be more *in*authentic. In this latter case, robophobia may be mitigated if the "user" had more choice in modifying a robot's sociality setting. More research should be done to understand how different user predispositions influence their preferences for more or less human-like, social interactions with robots.

Limitations and Future Research

There were a number of limitations to this study. The first relates to its reliance on cross-sectional and self-reported data, which may be biased or an inaccurate representation of participants' attitudes and traits. Further, the personality traits measured do not encompass the scope of possible relevant individual differences. Future research should consider the influence of other Big Five personality traits, such as extraversion and openness, which have been found to relate to robot liking (Robert, 2018) and other technophobia measures (Korukanda, 2005). Additionally, the online experimental manipulation was limited in several aspects. It relied on images combined with vignettes—a two-dimensional and static visual—to cue differences among robots, which may not have been a powerful enough stimuli. Studies have found that presenting robots in varying modalities—video, pictures, and in-person—results in different attitudes (Rosenthal-von der Pütten & Weiss, 2015). Future online experiments should employ more dynamic stimuli as well as a range of stimuli to compare the influence of different robot presentations. Building out these comparisons may help elucidate differences in mindful versus mindless reactions toward robots (Rosenthal-von der Pütten & Weiss, 2015). Additionally, every condition contained a relatively human-like robot, with a human-shaped body and face, and the same general description of a social robot as an interactive, agentic entity. These similarities may have overridden any distinctions that followed in the robot's image and description. Further, the robots were presented within the gendered binary of female vs. male. This was done purposefully to emphasize the gender difference, but it would be interesting to examine attitudes toward robots that are not explicitly gendered. It may be that "agender" robots are perceived the most positively because that aligns more with the categorization of robot as "other." Future research should also make stronger distinctions between agentic/non-agentic and social/nonsocial machines and consider those in conjunction with more varied physical instantiations of a robot.

Conclusion

Social robots are an interesting case study for authenticity in HMC because they are manifestly reproductions that are created to evoke socio-emotional responses from people, and whose success in doing so may portend the replacement of humans by their reproductions. It is no wonder that some may resist this proposition. Complete human-robot replacement may be an over-hyped, fear-mongering prediction, but the present development and integration of collaborative robots indicate that at least human-robot coexistence is not too far off. These robots already can be found across a range of sectors such as health care, logistics, agriculture, and defense (Galaz et al., 2021) and are forecasted to be increasingly prevalent in the workforce due to their lucrative potential for improving productivity and efficiency (Frey & Osborne, 2017). Thus, robot adoption, or at least begrudging acceptance, will grow in importance in the future of work (Demir et al., 2019).

Despite claims that such technology will enhance people's lives, the sociotechnical aspects of their integration warrant careful consideration. The power of media in shaping or mitigating robophobia indicates possible avenues for AI- and robot-related literacy interventions to smooth the assimilation of this technology. The positive influence of unique human traits that are tied to people's best interest—such as morality—demonstrates that AI ethics principles like transparency and explainability may be critical for reducing robophobia, helping people see what robots are, rather than imagined threats. Ultimately, though, there are people in power behind the decisions to deploy and expand AI and robotic systems in society. The extent to which individuals feel threatened by robots may fundamentally rely more on their trust that the larger social and economic structures in place are operating with human well-being and thriving as a priority. Thus, it is important to consider not only individual-level interventions for improving HMC dynamics, but also the society-level considerations for how this technology is being designed, integrated, and regulated.

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