Computers in Human Behavior: Artificial Humans 2 (2024) 100079

Contents lists available at ScienceDirect

Computers in Human Behavior: Artificial Humans

journal homepage: www.journals.elsevier.com/computers-in-human-behavior-artificial-humans

Social robots are good for me, but better for other people : The presumed allo-enhancement effect of social robot perceptions

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A R T I C L E I N F O

Keywords:
Social robots
The presumed allo-enhancement effect
Biased perceptions
Attitude ambivalence
Behavioral indicators

A B S T R A C T

This research proposes and investigates *the presumed allo-enhancement effect of social robot perceptions*, a tendency for individuals to view social robots as more beneficial for others than for themselves. We discuss this as a systematic bias in the perception of the utility of social robots. Through two survey studies, we test and replicate self-other perceptual differences, obtain effect sizes of these perceptual differences, and trace the impact of this presumed allo-enhancement effect on individuals' attitudes and behaviors. Analyses revealed strong perceptual differences, where individuals consistently believed social robots to be more enhancing for others than for themselves ($d = -0.69$, $d = -0.62$). These perceptual differences predicted individuals' attitudes and endorsed behaviors towards social robots. By identifying this bias, we offer a new theoretical lens for understanding how people perceive and respond to emergent technologies.

1. Introduction

Social robots are increasingly common, being tasked with jobs ranging from managing security in shopping malls and preparing meals in restaurants, to providing companionship and assistance to individuals around the world. These robots, powered by artificial intelligence, interact with humans based on social rules (Vollmer, Read, Trippas, & Belpaeme, 2018).

As social robots become a part of our social world, it is important to understand how people perceive and respond to these emergent technologies. Large-scale surveys show that people can have reservations about social robots, expressing concerns about their capabilities and urging caution in their adoption (Gnambs & Appel, 2019; Smith & Anderson, 2017). However, a recent review of 97 empirical studies indicates that people may actually hold more positive attitudes toward robots (Naneva, Sarda Gou, Webb, & Prescott, 2020). These mixed findings show that people's perceptions of robots vary.

Qualitative studies show a trend where people believe that social robots are better for others than for themselves. For instance, an interview study found that seniors did not want a social robot for themselves but believed that "social robots are great for young kids and can help them with their homework" (Liu, Shen, & Hancock, 2024). An interview study conducted with American youth revealed a similar theme. One eleven-year-old shared that she does not personally want to use social robots, but believed they "will be more helpful for older people" (Liu & Hancock, 2023). These results suggest there may be systematic tendencies for people to think social robots will be more valuable for others than for themselves.

Social robots offer benefits across demographics. For instance, they can benefit seniors by providing emotional and physical care for aging individuals (Góngora Alonso et al., 2019; Pedersen, Reid, & Aspevig, 2018). They can also support learning processes by scaffolding conversations, sharing educational materials, and building childrens' academic skills, a contribution that has been particularly promising among children with special needs (Belpaeme, Kennedy, Ramachandran, Scassellati, & Tanaka, 2018). However, the acceptance of these benefits depends on whether people perceive social robots as useful to their own lives. This study aims to explore the dynamics of these perceptions and their implications for the adoption of social robots.

What might be the causes and implications of the perception that social robots are better for others than for oneself? This biased way of thinking reflects a new kind of self-other discrepancy that, to our knowledge, has not been investigated in prior work. We define the *presumed allo-enhancement effect of technology perception as a cognitive*

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https://doi.org/10.1016/j.chbah.2024.100079
Received 18 December 2023; Received in revised form 29 June 2024; Accepted 1 July 2024
Available online 2 July 2024

bias wherein individuals perceive certain technologies as being more beneficial or enhancing for other people than for themselves. This perception leads to an overestimation of the positive impact of technology on others compared to one's own experience with the same technology. At a conceptual level, this effect can be understood in relation to the third-person effect (Davison, 1983; Perloff, 2002), a well-known phenomenon where individuals believe that other people are more susceptible to harmful media effects (e.g., televised violence, Paul, Salwen, & Dupagne, 2000), and therefore support more restrictive policies regarding media (e.g., banning certain games, minimizing social media use). Unlike the third-person effect, which focuses on perceptions of harm from media (e.g., the belief that television provides undesirable messages), the presumed allo-enhancement effect looks at the perceived benefits of media and technology (e.g., the belief that social robots provide valuable personal and interpersonal benefits). At its core, effect shows that people are cautious about new "smart" technologies, like social robots, and judge their benefits more favorably for others than for themselves.

Social robots are a good example for studying this effect for several reasons. First, they are a new kind of technology that is intelligent and agentic, driven by advances in artificial intelligence, capable of performing complex tasks (Sundar, 2020). Such multifaceted capabilities can make potential users hesitant, as they may question the robots' abilities and their broader implications. Second, social robots are relatively new compared to older technologies that are well-established in people's everyday lives, making people more likely to avoid them due to their novelty. Thirdly, social robots look and act in ways that make them seem almost human, triggering anthropomorphic tendencies and perceptions of mind (Banks, 2020; Broadbent, 2017). This means that these robots not only exist as electronic devices but also possess characteristics that resemble or mimic human behavior (Kahn Jr et al., 2011). This dual nature makes social robots both fascinating and challenging to understand. According to Stapels and Eyssel (2021), social robots are "exceptional in that users hold strong opinions toward them while simultaneously possessing relatively limited knowledge about, and experience with, them" (p.9).

Though they are new, an extended body of research (see reviews by Broadbent, 2017; Naneva et al., 2020) has examined how people treat and react to social robots (Reeves, Hancock, & Liu, 2020; Reeves & Nass, 1996). A key factor in accepting and adopting social robots is *perceived usefulness.* People tend to embrace technologies they find useful. Our research on the presumed allo-enhancement effect builds on this by examining how perceptions of social robots' utility for oneself, relative to others, influences individuals' experiences.

In this paper, we conducted two studies that provide the first empirical tests of the presumed allo-enhancement effect. First, we measured the differences in how people perceive the utility of social robots for themselves versus others and identified factors that increase these differences. We also looked at how these perceptions influence attitudes and behaviors. Our findings were replicated in a second study. We discuss these findings in the context of how people perceive social technologies and what this means for future engagement with social robots.

1.1. Self-other differences in perceptions of technology

Social technologies are everywhere in our modern lives, so it's natural for people to form beliefs about their role. Psychological research on loci of control emphasizes that people have a fundamental need to understand the dynamics of their relationship to the world around them (Mirowsky & Ross, 2017).

People often see themselves as less influenced by media compared to others (Perloff, 2002). This phenomenon, known as the third-person effect, has two main components: the perpetual effect and the behavioral effect (Perloff, 1999). First, there is a perceptual discrepancy where individuals view themselves as being less susceptible to negative media effects than others, such as viewing themselves as less vulnerable to misinformation than the average individual (Yang & Tian, 2021). The greater this difference in perception, the stronger the third-person effect. Not only do individuals view others as more susceptible to effects they view as socially undesirable (e.g., being influenced by advertisements; Perloff, 2002), but they view themselves as more susceptible to the positive effects of desirable messages (e.g., following guidance about wearing seat-belts, or sunscreen; Gunther & Mundy, 1993). This perceptual effect can lead to influential attitudinal and behavioral responses, such as supporting policies that control media messages.

1.1.1. Perceptual dimensions

Our study is inspired by the third-person effect model but focuses on different phenomena and mechanisms. Instead of focusing on media messages, we examine how people perceive the utility of technology itself. Previous qualitative studies have shown that people tend to see social robots as more useful and better for others than for themselves (Liu & Hancock, 2023). A recent national survey on Americans' attitudes toward artificial intelligence found similar patterns. Respondents rated artificial intelligence as more beneficial to most Americans than to themselves (Bao et al., 2022). Artificial intelligence and social robots share several similarities as advanced technologies. We predict that there will be self vs. other discrepancies in the perceptions of social robots' utility. In this study, we predict that.

H1. Individuals will perceive social robots as having higher utility for others than for themselves.

An important factor influencing how people perceive technology is their level of digital literacy. This concept includes more than basic familiarity with technology; it refers to a multifaceted skill set that includes the knowledge, skills, and abilities to effectively engage with digital spaces (Guess & Munger, 2020; Hargittai, 2005; Sirlin, Epstein, Arechar, & Rand, 2021). Research has shown that digital literacy significantly impacts various aspects of technology use and perceptions, including which specific technologies individuals will adopt, their patterns of use, their perceptions of the potential opportunities and risks associated with technology use, as well as the outcomes resulting from their engagement with these technologies (Hargittai & Walejko, 2008; Livingstone & Helsper, 2010; Livingstone, Mascheroni, & Stoilova, 2023; Van Deursen & Van Dijk, 2011).

In our study, we explore how digital literacy is connected with the perceived utility of social robots. Our rationale is that having digital knowledge and skills could help individuals see how social robots can be useful in different situations, making them more likely to use and benefit from these robots. However, there is another possibility: individuals with high digital literacy might see less personal need for social robots. They might feel that their digital skills reduce their need for assistance from such technologies or that social robots are simply not necessary in their lives.

This study explores whether digital literacy is positively or negatively associated with the perceived utility of social robots for others and how digital literacy might either moderate or magnify the perceptual differences between self and others. We ask.

RQ1: How will digital literacy influence perceptions of social robots' utility for the self, for other people, and perceptual differences between self vs. others?

1.1.2. Behavioral dimensions

The behavioral component of the third-person effect is a major focus in this line of research. It looks at how perceptions affect behaviors. For example, believing that others are more influenced than the self by harmful media content can result in support for stricter media content regulations, engaging in corrective actions, and limiting media use and consumption (Lev-On, 2017; Wei, Lo, & Lu, 2010).

In this research, we explore how the perceptions of social robots' utility for oneself, for others, or the differences between these perceptions, influence how much people support social robots research and investment in social robots industries. Supporting social robot research and investment has been used as a policy outcome indicator and a proxy of behavioral implications in previous research. Studies found that when people feel threatened by social robots, they reduce their willingness to support social robots' research and investment (Yogeeswaran et al., 2016; Złotowski et al., 2017). The third-person effect predicts that perceptual discrepancies drive behavioral outcomes. But when the valence of the technology is positive, will such discrepancies still influence people's behavior? An altruist perspective argues that people will support policies that benefit many people. The larger that gap between the self and the others, the more beneficial they perceive the policies to be for others. On the other hand, a self-centered view suggests that people will support policies that directly benefit themselves. In this study, we ask.

RQ2, How will perceptions of social robots' utility for the self, for other people, and perceptual differences between self vs. others predict support for social robots research?

1.1.3. Attitudes dimensions

The perceptions of social robots' utility for the self and others are cognitive evaluations, which may be connected with attitudes (affective evaluations) towards robots. Individuals learn or form beliefs about an object, and these beliefs influence their attitudes toward the object (Fishbein & Ajzen, 1972). Perceptions of social robots' utility reflect beliefs about how good, useful, helpful, and beneficial social robots are for people. These beliefs can impact their attitudes toward social robots. Many studies have investigated people's favorable or unfavorable attitudes toward social robots, the causes, and the downstream consequences. These studies suggest that important factors, such as anthropomorphism, manipulations of social robots' roles and capacities, how people perceive the mind of robots, and how people encounter robots, all impact people's attitudes, positive or negative, towards social robots (Appel, Izydorczyk, Weber, Mara, & Lischetzke, 2020; Banks, 2020; Broadbent, 2017; Cave, Coughlan, & Dihal, 2019, pp. 331–337; Diel, Weigelt, & Macdorman, 2021; Gnambs & Appel, 2019; Koverola, Kunnari, Sundvall, & Laakasuo, 2022; Liu, Shen, & Hancock, 2021; Nomura, Kanda, Suzuki, & Kato, 2004, pp. 35–40; Reeves et al., 2020; Smith & Anderson, 2017; Stapels & Eyssel, 2021; Yogeeswaran et al., 2016).

Attitudes are not just positive or negative. People can feel both ways about the same thing. This simultaneous positive and negative attitude is called ambivalence (Conner & Sparks, 2002; Cuddy, Fiske, & Glick, 2007). For example, people form both positive and negative attitudes toward social groups, such as viewing rich people as competent but cold while homemakers as warm but incompetent (Cuddy al. al, 2007).

Several studies suggest that people have simultaneous positive and negative ambivalent attitudes toward social robots (Dang & Liu, 2021; Stapels & Eyssel, 2021). People see robots as both allies and enemies (Dang & Liu, 2021). Social robots trigger strong positive and negative perceptions (Stapels & Eyssel, 2021). Social robots provide convenience, companionship, and entertainment, but they also pose threats to jobs, resources, safety, and identity (Ferrari, Paladino, & Jetten, 2016; Stein, Liebold, & Ohler, 2019; Strait, Aguillon, Contreras, & Garcia, 2017, pp. 1418–1423; Złotowski et al., 2017). Each hope for what robots can do is paired with a fear of what they might cause (Leyer & Schneider, 2019). For example, people hope for a life free from work but fear becoming redundant. They hope AI and robots can fulfill their desires but fear humans will become redundant (Cave & Dihal, 2019).

The presumed allo-enhancement effect has three main components: perceptions of social robots' utility for self, for other people, and perceptual discrepancy between self vs. others. All three beliefs can shape attitudes. When focusing on ambivalent attitudes, that is, a mixed of positive and negative attitudes, the difference between how useful social robots are perceived for oneself versus others becomes more relevant. The larger the incongruencies, the more likely that people will have a higher level of mixed ambivalent attitudes toward social robots. We propose.

H2. Perceptual differences between social robots' utility for the self vs. for others will predict how ambivalent people's attitudes toward social robots are.

We conducted two studies to test the hypotheses and answer the research questions. Study 1 explored the connections among the perceptions, attitudes, and behavioral indicators. Study 2 was a replication.

2. Study 1

2.1. Method

2.1.1. Participants, materials, and procedure

We conducted an *a priori* power analysis using the small effect size identified in prior work on perceptions of AI-based technologies (Bao, 2022), which indicated 787 participants were needed to detect a small effect size ($d = 0.1$) with 80% power. Participants were recruited from Amazon mechanical Turk using the Cloud Research platform, a platform that tends to provide higher quality data (Peer, Rothschild, Gordon, Evernden, & Damer, 2022). In order to be eligible, mTurkers were required to have completed more than 5000 tasks and to have an approval rate of 95% or above. Using this method, we recruited 820 individuals. As a check on data quality, we used two attention check questions. Four individuals failed the check and were therefore excluded from the study. Each participant received $1.50 for participating in the study.

The final sample included 816 participants (45.3% female). They represented a wide range of ages: 32.2% of the participants are 25–34 years old, followed by 29.7% are 35–44 years old, 17.5% are 45–54 years old, 10.3% are 55–64 years old, 5.5% are 18–24 years old, and 4.8% are 65 and above years old. Of the participants, 42.3% had Bachelor's degree, followed by some college but no degree (16.8%), Master's degree and higher (16.4%), Associates or technical degree (11.9%), high school graduate (11.3%), some high school or less (0.6%) and prefer not to say (0.7%). With regard to their employment status, 71.5% of the participants were working paid employees, followed by working self-employed (13.6%), not working and looking for work (6.4%), retired (3.2%), not working for other reasons (2.5%), not working disabled (1%), and prefer not to answer (1.8%).

At the beginning of the survey, we asked participants, "Have you ever heard of social robots?" Those who responded "yes" (53.1%) were asked "How would you describe social robots to a friend?" as an open-ended question. Those who indicated they had never heard about social robots (46.9%) were provided a neutral, scientific definition of social robots adopted from Vollmer et al. (2018): "A social robot is an autonomous robot that interacts and communicates with humans or other autonomous physical agents by following social behaviors and rules attached to its role." All participants were asked to fill out demographics and social robot-related questions. All procedures were approved by the [University] Institutional Review Board.

2.1.2. Measures

Perceived utility of social robots (for self and for others). To examine the extent to which individuals perceived social robots as useful and beneficial to themselves, and to others, we adapted items regarding perceived usefulness (Davis, 1989) and attitudes towards robots. The resulting items asked participants to indicate their agreement or disagreement with the following statements (Koverola et al., 2022): (1) social robots are good for me in general, (2) social robots are beneficial for me in general, (3) social robots are useful for me, and (4) social robots are helpful for me. All items were measured on a 5-point Likert scale: 1 indicating "strongly disagree "and 5 indicating "strongly agree"

($M = 3.01$, $SD = 1.17$, $a = 0.97$). Perceptions of social robot utility for others were measured by adapting the above items to refer to others (e.g., "Social robots are good for other people in general") ($M = 3.56$, $SD = 0.97$, $a = 0.96$). The presentation of items regarding the self and others were randomized in blocks on Qualtrics to avoid any priming or anchoring effects (Gehlbach & Brinkworth, 2011).

Perceptual differences of social robot utility. To quantify the self-other differences in perceptions of social robot utility, we subtracted self-perceptions from other perceptions ($M = 0.64$, $SD = 0.71$). We further used the analysis of particle variance (Cohen & Cohen, 1983) to calculate an index of change to reflect the perceptual differences (Rosenthal, 2013). We first used the perceived utility of self to predict the perceived utility for others and generated an unstandardized B (=1.692). We then computed the index of change of perceived utility using the formula (Index of change = Perceived utility for others - perceived utility for self * unstandardized B) ($M = -1.54$, $SD = 1.41$).

Endorsement of social robots research. Support for social robots research and investment has been used as a policy outcome indicator and a proxy of behavioral implications in previous research (Yogeeswaran et al., 2016; Złotowski et al., 2017). Three items from Zlotowski, Yogeeswaran, and Bartneck (2017) were adapted to measure support for social robots research (e.g., "How much do you support using taxpayer dollars for social robots research? How much do you support increasing investment in social robotics industries?"). All items were measured on a 5-point Likert scale: 1 indicating "not much" and 5 indicating "fully" ($M = 3.01$, $SD = 1.09$, $a = 0.89$).

Ambivalent attitudes towards social robots. We adapted items from Dang and Liu (2021)'s Ambivalent Attitudes towards Robots scale and the General Attitudes towards Artificial Intelligence Scale (GAAIS) (Schepman & Rodway, 2022) to capture more nuanced perceptions of robots. Ten items assessed individuals' attitudes about the positive aspects of social robots ("Please consider only the positive aspects of social robots and ignore the negative ones. Please tell us what you think about the following statements") All items were measured on a 5-point Likert scale: 1 indicating "strongly disagree" and 5 indicating "strongly agree". An exploratory factor analysis with principal axis factoring indicated a one-factor solution accounting for 62.52% of variance ($M = 3.25$, $SD = 0.89$, $a = 0.93$).

We used ten items to measure negative aspects of social robots with the instruction that "Please consider only the negative aspects about social robots and ignore the positive ones. Please tell us what you think about the following statements." An exploratory factor analysis with principal axis factoring indicated a one-factor solution, accounting for 57.70% of variance ($M = 2.64$, $SD = 0.95$, $a = 0.92$). Ambivalence attitudes were calculated by half the polarization of the positive (P) and negative (N) judgments, minus the absolute difference between the two (Thompson, Zanna, & Griffin, 1995; Conner & Sparks, 2022): Ambivalence = (P + N)/2 - |P - N|. Higher scores indicated more intense attitudes toward social robots, across positive and negative aspects ($M = 1.61$, $SD = 1.20$).

Digital literacy. We adapted measures of digital literacy from Guess and Munger (2020) and Sirlin et al. (2021) to measure individuals' perceptions of their ability to navigate digital spaces (e.g., "I prefer to ask friends how to use any new technologies instead of trying to figure it out myself", "Using information technology makes it easier to do my work"). All items were measured on a 5-point Likert scale: 1 indicating "strongly disagree "and 5 indicating "strongly agree." An exploratory factor analysis with principal axis factoring a one-factor solution, accounting for 62.52% of the variance ($M = 4.20$, $SD = 0.68$, $a = 0.67$).

2.2. Results

2.2.1. Better for you, than for me: perceptual differences in social robot utility

To examine whether there are systematic differences in people's perceptions of the utility of social robots for themselves versus others (H1), we conducted a paired-samples t-test. As shown in Table 1, results were the t-test significant, $t(809) = -19.637$, $p < 0.001$, Cohen's $d = -0.69$ (95% CI [-0.77, -0.61]). Respondents consistently believed that social robots were better, more useful, and more beneficial for others ($M = 3.56$, $SD = 0.97$) than for themselves ($M = 3.01$, $SD = 1.17$).

2.2.2. Digital literacy shapes positive perceptions of social robots

To explore the influence of digital literacy on perceived utilities (RQ1), we conducted three hierarchical regression analyses. We first entered gender, age, education, occupation, and income as predictors, followed by digital literacy, The outcome variables were perceptions of social robot utility for the self, perceptions of social robot utility for others, and self-other discrepancies, respectively. Results indicated that people who were more digitally literate perceived social robots to be more enhancing for themselves [$\beta = 0.12$, $SE = 0.06$, bootstrapped 95% CI = (0.08, 0.33), $p = 0.002$] and others [$\beta = 0.19$, $SE = 0.05$, bootstrapped 95% CI = (0.17, 0.37), $p < 0.001$]. Digital literacy did not significantly predict the perceptual discrepancy between self and others (See Table 2).

Furthermore, why might some people hold more positive perceptions of social robots than others? One possibility is that people with prior knowledge about social robots may appraise their potential benefits differently than people who have never heard about social robots before the study. We tested this with a one-way ANOVA, which confirmed the role of prior knowledge about social robots on this perceptual difference. Compared with participants who did not know about social robots, participants with prior knowledge had significantly more positive perceptions of the utility of social for both themselves, $F(1, 812) = 13.39$, $p < 0.001$, $\eta 2p = 0.016$, and other people, $F(1, 811) = 16.643$, $p < 0.001$, $\eta 2p = 0.02$ (See Table 1). However, the self-other discrepancy (the difference between the perceptions for self and for others) was not significantly different between the two groups, $F(1, 808) = 0.024$, $p = 0.877$, $\eta 2p = 0.00$. Together, these findings indicate that having prior knowledge about social robots increases perceptions of their utility across the board, but that all individuals tend to believe that social robots are more beneficial for others.

2.2.3. The presumed allo-enhancement effect: behavioral implications of perceptual differences

Next, we examined whether perceptions of social robot utility and self-other perceptual differences are related to behavior by examining support for social robots research, a policy outcome indicator and a proxy of behavioral implications (RQ2).

To reduce overestimating R^2 and multicollinearity (Rosenthal, 2013), we conducted two multiple regression models with support for social robots research as the dependent variable. In the first regression

Table 1
Descriptive data of perceptions of social robot utility for self, and others perceptions for self, for others and self-other discrepancies.

		N	M	SE	M Bootstrapped 95% *CI*	
					LL	UL
For Self	Never heard of robots	383	2.86	0.06	2.74	2.97
	Heard of robots	431	3.15	0.06	3.04	3.26
	Total	814	3.01	0.04	2.93	3.09
For Others	Never heard of robots	381	3.41	0.05	3.31	3.50
	Heard of robots	431	3.69	0.05	3.60	3.78
	Total	812	3.56	0.03	3.49	3.63
Discrepancies	Never heard of robots	381	0.64	0.04	0.57	0.72
	Heard of robots	429	0.65	0.04	0.58	0.71
	Total	810	0.64	0.02	0.59	0.69

Note: N indicates number of participants. M indicates mean. SE indicates standard error. Bootstrapped CI indicates bootstrapped 95% confidence interval. LL and UL indicate the lower and upper limits of a confidence interval respectively.

Table 2
Relationship between digital literacy and demographic variables on perceptions of social robot utility.

DVs	For Self		For Others		Discrepancies		Tolerance	VIF
	β	p	β	p	β	p		
Gender	−0.02	0.58	−0.01	0.78	0.07	0.06	0.93	1.07
Age	−0.02	0.68	−0.03	0.42	−0.01	0.76	0.97	1.04
Education	0.02	0.55	−0.03	0.69	−0.05	0.24	0.79	1.26
Employment	−0.07	0.05	−0.05	0.15	0.06	0.09	0.92	1.08
Income	−0.00	0.92	0.01	0.90	−0.01	0.79	0.79	1.26
Digital literacy	0.13	<0.001	0.19	<0.001	0.03	0.33	0.99	1.01
Adjusted R^2	0.015		0.032		0.013			

Note: β indicates standardized beta coefficient. p indicates significant value. VIF indicates variance inflation factor. Adjusted R^2 indicates adjusted variance scores.

model, we used perceptions of social robot utility for the self and others as predictors and in the second regression model, we used self-other perception discrepancies (index of change) as a predictor. For both models, we entered demographic variables (gender, age, education, employment, and income) in block 1, prior knowledge about social robots and digital literacy in block 2, followed by perceptions of social robot utility for the self in block 3 and for the others in block 4 in model 1, and self-other perception index of change in block 3 in model 2 (see Table 3 and Table 4).

Results from model 1 showed that perceptions of social robots drove individuals' support, or lack thereof, for future work on social robots. Individuals who believed social robots to be more beneficial for themselves ($\beta = 0.41$, $p < 0.001$) and for others ($\beta = 0.39$, $p < 0.001$) provided stronger support for social robots research, revealing implications for their support of technology-related policies, $F(9, 793) = 119.854$, $p < 0.001$. These perceptions explained 57% of the variance in social robot research support. Furthermore, education ($\beta = 0.07$, $p = 0.006$) and digital literacy ($\beta = 0.09$, $p < 0.001$) also predicted support for social robots research (See Table 3).

Results from model 2 showed that people with greater self-other perceptual discrepancies (i.e., who believed social robots to be more helpful for others than for themselves) were less likely to support social robots research, ($\beta = -0.49$, $p < 0.001$), $F(8, 794) = 41.19$, $p < 0.001$. These perceptions explained 29% of the variance in social robot research support. Furthermore, digital literacy ($\beta = 0.19$, $p < 0.001$) also predicted support for social robots research.

Taken together, the results indicate that when people think that social robots are useful and beneficial for themselves and others, they are more likely to support investment in social robots research and industry. However, believing social robots to be better for others than for themselves leads individuals to be less supportive of such work.

2.2.4. *Perceptions of social robots drive attitudinal ambivalence*

Our H2 focuses on the relationship between perceptual differences

Table 3
Perceptions of social robot utility predicts support for social robots research and attitudes ambivalence.

		Support social robot research			Ambivalent attitudes			Tolerance	VIF
		β	R^2	ΔR^2	®	R^2	ΔR^2		
Block 1			0.01	0.01		0	0.01		
	Gender	0.03			0.02			0.94	1.07
	Age	0.00			−0.04			0.97	1.03
	Education	0.07			0.00			0.80	1.26
	Employment	−0.08*			0.06			0.93	1.08
	Income	−0.02			0.04			0.80	1.26
Block 2			0.06	0.05		0.07	0.07		
	Gender	0.01			0.04			0.94	1.07
	Age	−0.02			−0.02			0.96	1.04
	Education	0.07			0			0.79	1.26
	Employment	−0.06			0.04			0.92	1.09
	Income	−0.03			0.05			0.79	1.26
	Heard or robots	0.09*			−0.09**			0.99	1.01
	Digital literacy	0.21***			−0.26***			0.99	1.01
Block 3			0.51	0.45		0.07	0.00		
	Gender	0.02			0.03			0.93	1.07
	Age	−0.01			−0.01			0.96	1.04
	Education	0.06			0.0			0.79	1.26
	Employment	−0.02			0.04			0.92	1.09
	Income	−0.02			0.05			0.79	1.26
	Heard or robots	0.01			−0.09*			0.97	1.03
	Digital literacy	0.12***			−0.26***			0.97	1.03
	For self	0.68***			−0.02			0.96	1.04
Block 4			0.58	0.07		0.08	0.01		
	Gender	0.02			0.03			0.93	1.07
	Age	0.01			−0.01			0.96	1.04
	Education	0.07**			0			0.79	1.26
	Employment	−0.02			0.04			0.92	1.09
	Income	−0.03			0.05			0.79	1.26
	Heard or robots	−0.01			−0.10**			0.96	1.04
	Digital literacy	0.09***			−0.27***			0.95	1.05
	For self	0.41***			−0.13*			0.44	2.25
	For others	0.39***			0.15**			0.43	2.31

Note: β indicates standardized beta coefficient. R^2 indicates adjusted variance score. ΔR^2 indicates adjusted variance score change. VIF indicates variance inflation factor. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Table 4
Predicting Support for Social Robots Research and Attitudes Ambivalence focusing on Discrepancies.

		Support social robot research			Ambivalent attitudes			Tolerance	VIF
		β	R^2	ΔR^2	β	R^2	ΔR^2		
Block 1			0.01	0.01		0	0.01		
	Gender	0.03			0.02			0.94	1.07
	Age	0.00			−0.04			0.97	1.03
	Education	0.07			0.00			0.80	1.26
	Employment	−0.08*			0.06			0.93	1.08
	Income	−0.02			0.04			0.80	1.26
Block 2			0.06	0.05		0.07	0.07		
	Gender	0.01			0.04			0.93	1.07
	Age	−0.02			−0.02			0.96	1.04
	Education	0.07			0			0.79	1.26
	Employment	−0.06			0.04			0.92	1.09
	Income	−0.03			0.05			0.79	1.26
	Heard or robots	0.09**			−0.09**			0.99	1.01
	Digital literacy	0.21***			−0.26***			0.99	1.01
Block 3			0.29	0.23		0.07	0.0		
	Gender	0.02			0.03			0.93	1.07
	Age	−0.01			−0.01			0.96	1.04
	Education	0.05			0.0			0.79	1.26
	Employment	−0.03			0.04			0.92	1.09
	Income	−0.03			0.05			0.79	1.26
	Heard or robots	0.06			−0.09*			0.96	1.04
	Digital literacy	0.19***			−0.25***			0.95	1.05
	Index of Change	−0.49***			0.07			0.94	1.06

Note: β indicates standardized beta coefficient. R^2 indicates adjusted variance score. ΔR^2 indicates adjusted variance score change. VIF indicates variance inflation factor. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

and attitudes ambivalence. We used the same hierarchical regression approach as RQ2. The model was significant, $F(8, 779) = 8.75$, $p < 0.001$. The model explained 7% of the variance in attitudes ambivalence. Specifically, previous knowledge of social robots ($\beta = -0.09$, $p = 0.014$) and digital literacy ($\beta = -0.25$, $p < 0.001$) significantly predicted attitudes ambivalence. But the perceptual differences between the self and others was not a significant predictor of attitudes ambivalence ($\beta = 0.07$, $p = 0.055$), H2 was rejected.

We further explored whether perceived utility for self and perceived utility for others were connected with attitudes ambivalence. Results from the model showed that perceptions of social robots predicted attitudes ambivalence. Individuals who believed social robots to be more beneficial for themselves ($\beta = -0.13$, $p = 0.01$) and for others ($\beta = 0.15$, $p = 0.003$) had more ambivalent attitudes toward social robots, $F(9, 778) = 8.46$, $p < 0.001$. These perceptions explained 8% of the variance in attitudes ambivalence. Furthermore, previous knowledge of social robots ($\beta = -0.10$, $p = 0.006$) and digital literacy ($\beta = -0.27$, $p < 0.001$) also predicted attitudes ambivalence (See Table 3).

Overall, the result suggested that individuals who possess prior knowledge of social robots, combined with a higher level of digital literacy, had less ambivalence in their attitudes towards social robots compared to those who lack such knowledge or have a lower level of digital literacy. Furthermore, the perception of social robots as good for oneself correlated with a decrease in ambivalent attitudes, while perceiving social robots as good for others increased the likelihood of ambivalent attitudes, However, differences in perceptions of social robot utility for self versus others did not significantly influence attitude ambivalence.

3. Study 2: replication of the presumed allo-enhancement effect

Study 1 revealed that individuals rated social robots as better, more helpful, useful and beneficial for others than for themselves. Perceptions for self, for others and perception discrepancies significantly predicted support for social robots research. The goal of Study 2 is to test whether the presumed allo-enhancement effect can be replicated, confirming the robustness of the findings from Study 1.

3.1. Method

3.1.1. Procedure

We used the same approach in Study 1 to recruit participants through the Cloud Research platform. Amazon mTurkers were eligible to participate if they completed more than 5000 tasks and had an approval rate of 95% or higher. We recruited 280 participants, 13 of whom failed the two attention check questions and were excluded from the study. Each participant received $1.00 for their participation in the study.

The final sample size included 267 participants (41.6% female). 34.8% of the participants are 35–44 years old, followed by 34.5% are 25–34 years old, 13.59% are 45–54 years old, 9.7% are 55–64 years old, 4.5% are 18–24 years old, and 2.6% are 65 and above years old. 46.8% of the participants have Bachelor's degree, followed by some college but no degree (15%), high school graduate (13.9%), Master's degree and higher (11.6%), Associate or technical degree (11.6%), some high school or less (0.7%). 69.3% of the participants are working paid employees, followed by working self-employed (21.3%), not working and looking for work (2.6%), retired (2.2%), not working other reasons (1.1%), not working for disabled (0.7%), and prefer not to answer (1.1%). 49.1% of the participants have heard about social robots, while 50.9% of them have not heard about social robots.

3.1.2. Measurement

We used the same measures in Study 1 to assess *perceptions of social robot utility for self* ($M = 3.25$, $SD = 1.13$, $a = 0.97$) and *perceptions of social robot utility for others* ($M = 3.73$, $SD = 0.90$, $a = 0.96$). As before, the sequences of question blocks regarding self and other perceptions were randomized on Qualtrics. Self-other perceptual discrepancies were calculated by subtracting self perceptions and other perceptions ($M = 0.47$, $SD = 0.76$).

3.2. Results

3.2.1. Replication of the self-other perceptual discrepancy

We tested if the perceptual differences between the utility of social robots for the self, versus for others, would replicate in this study by conducting a paired samples *t*-test. Results indicated replication, with people again being more likely to say that social robots were more beneficial for others ($M = 3.73$, $SE = 0.06$, $CI = (3.62, 3.82)$ than for themselves ($M = 3.26$, $SE = 0.07$, $CI = (3.11, 3.39)$ $t(263) = -10.01$, $p < 0.001$, $d = -0.62$, 95% CI = $(-0.75, -0.48)$.

Next, we tested if our finding that prior knowledge about social robots would increase positive perceptions of social robots would replicate. Results of a one-way ANOVA indicated that participants with prior knowledge about social robots believed them to be more useful and beneficial for other people than those who had not heard of them prior to the study, $F(1, 265) = 9.07$, $p = 0.003$, $\eta 2p = 0.008$. People with a prior knowledge of social robots have a higher score of social robots utility for self ($M = 3.56$, $SD = 0.10$) than those without a prior knowledge ($M = 3.15$, $SD = 0.10$), although the difference was not statistically significant, $F(1, 263) = 2.11$, $p = 0.147$, $\eta 2p = 0.00$. Perpetual differences were not significantly different between people who had prior knowledge of social robots or not, $F(1, 262) = 2.28$, $p = 0.132$, $\eta 2p = 0.00$ (See Table 5). The results of study 2 replicated the main findings of Study 1.

4. Discussion

As social robots become more common, it's important to understand how people view their utility, which can shape how these new technologies are developed, adopted, and received by the public. This study defines the presumed allo-enhancement effect as the consistent perceptual difference wherein individuals perceive social robots to be better, more useful, and more beneficial to other people than themselves. By investigating this biased perception, we offer a new theoretical lens to understand how individuals vie new technologies.

The presumed allo-enhancement effect suggests that people think social robots are more beneficial for others than for themselves. This perception influences their behavior and attitudes towards robots. When people believe that social robots are useful for both themselves and others, they tend to support research into these technologies. However, when they think social robots are much more useful for others than for themselves, their support decreases. This indicates that people consider the potential benefits for themselves compared to others when deciding whether to support new technologies.

The findings of this study are consistent with the third-person effect, which posits that self-other perceptual differences predict behavioral tendencies (Perloff, 1999, 2002). Our findings are also in line with the technology adoption literature (Davis et al., 1989), which indicates that perceptions of a technology's usefulness predict individuals' behavioral intentions towards adopting that technology. Previous research in human-machine and human-robot interactions has found that individuals are more likely to accept social robots when they perceive these technologies as relevant and useful to their lives (Chatzoglou, Lazaraki, Apostolidis, & Gasteratos, 2023; David, Thérouanne, & Milhabet, 2022; De Graaf & Allouch, 2013; de Graaf, Allouch, & Van Dijk, 2019). Our study builds upon these findings by highlighting that individuals' perceptions of complex systems like robots are multi-faceted and extend beyond simple assessments of harm or general usefulness.

Table 5
Means and standard errors of the presumed allo-enhancement effect.

		N	*M*	*SE*	Bootstrapped *CI*	
					LL	*UL*
For Self	Never heard of robots	134	3.15	0.10	2.96	3.34
	Heard of robots	131	3.56	0.10	3.15	3.55
	Total	265	3.25	0.07	3.11	3.39
For Others	Never heard of robots	135	3.56	0.08	3.40	3.72
	Heard of robots	131	3.89	0.07	3.75	4.03
	Total	266	3.73	0.06	3.62	3.83
Discrepancies	Never heard of robots	133	0.40	0.06	0.28	0.52
	Heard of robots	131	0.54	0.07	0.40	0.68
	Total	264	0.47	0.05	0.38	0.56

Note: N indicates number of participants. M indicates mean. SE indicates standard error. Bootstrapped CI indicates bootstrapped 95% confidence interval. LL and UL indicate the lower and upper limits of a confidence interval respectively.

Specifically, the current findings suggest that when evaluating complex systems such as robots, individuals' perceptions are nuanced and incorporating various dimensions of utility. Unlike the third-person effect, which primarily focuses on perceived harms of messages, or the technology acceptance model, which emphasizes general perceived usefulness, this study reveals that individuals pay closer attention to the specific utility of the technology for themselves compared to others. Both perceptions for self, for others and these self-other differences in perceived utility predict behavioral intentions.

Regarding attitudes, individuals have ambivalent attitudes toward social robots, which is consistent with the findings from previous studies (Dang & Liu, 2021; Naneva et al., 2020; Stapels & Eyssel, 2021). This ambivalence is characterized by simultaneous positive and negative feelings toward social robots, reflecting the complexity of human-robot interactions. Furthermore, our findings extend previous research by exploring underlying sources of these ambivalent attitudes toward social robots. We found that these simultaneous mixed positive and negative attitudes are linked to individuals' perceptions of social robots' utility for self and for others but are not directly related to the perception discrepancies. The perception of social robots as good for oneself correlated with a decrease in ambivalent attitudes, while perceiving social robots as good for others increased the likelihood of ambivalent attitudes. This indicates that when the perceived benefits of social robots are externalized, individuals may experience a conflict between recognizing the potential societal advantages and their own reservations or lack of direct benefit, thus increased ambivalence.

The rich literature in human-machine communications and human-robot interactions has identified various factors that influence individuals' attitudes toward social robots. These factors include anxiety, perceived threats posed by social robots to humans, lack of control, privacy concerns, safety, and ethical considerations (David et al., 2022; Liu et al., 2024; Natale & Depounti, 2024; Naneva et al., 2020; Wu et al., 2014).

Our findings further revealed that both self-referential and other-referential perspectives are important to understand attitudes towards social robots. By identifying the specific conditions under which ambivalence arises and examining the roles of self-referential versus other-referential perspectives, this study provides insights for the design and implementation of social robots. For example, emphasizing the personal benefits of social robots may help reduce ambivalent attitudes.

4.1. What does the presumed allo-enhancement effect mean?

What are the implications of the presumed allo-enhancement effect of social robots? One way of understanding this effect is through a consideration of the stages of technology adoption. As evidenced by the fact that half of the individuals in our sample had not heard about social robots, these technologies are emergent and not yet integrated into many people's everyday lives. Therefore, when technologies are foreign, it may be difficult for individuals to conceptualize their benefits or to perceive them as useful to their own lives - instead viewing them as potentially beneficial for others, in the abstract.

Previous literature has suggested that individuals' perceptions of social robots evolve from initial first impressions after they have interacted with the technology (Delgosha & Hajiheydari, 2021; Edwards et al., 2016, 2019; Spence, Westerman, Edwards, & Edwards, 2014). Our findings are consistent with the previous literature. We found that familiarity with technology can impact the magnitude of the presumed allo-enhancement effect. Individuals with prior knowledge of social robots and higher digital literacy were more likely to perceive social robots positively. This suggests that the presumed allo-enhancement effect can be conceptualized as a psychological response to technological innovations, closely tied to the prevalence and familiarity of the technology. As individuals become more familiar with social robots through exposure and interaction, their perceptions are likely to shift from seeing these technologies as beneficial for others to recognizing their personal utility and relevance. Longitudinal analyses of such effects over time may shed light on the mechanisms and trajectory of this effect.

This general pattern of biased perceptions may also be an indicator of implicit avoidance of technology. The notion that "social robots are good for me, but they are better for other people" reflects an inherent hesitancy and resistance to social robots, as individuals may be concerned about the impacts of these technologies on their lives (Smith & Anderson, 2017). They may threatened by the implications of social robots on their livelihood (e.g., threatening jobs), and even their sense of identity (e.g., threats to human identity) (Ferrari et al., 2016; Rios, Sosa, & Osborn, 2018; Vanman & Kappas, 2019; Yogeeswaran et al., 2016; Zlotowski et al., 2017). One way individuals may respond to these threats is by feeling a reduced sense of control, which may be particularly salient for social robots, an object that existed in the imaginary before they appeared in reality (Cave & Dihal, 2019). Social robots can press our "Darwinian Buttons" (Turkle, 2011) and elicit intense hopes and fears beyond regular technology and media (Leyer & Schneider, 2019). Therefore, the presumed allo-enhancement effect can reflect individuals' basic protective motive to avoid this intense technology.

4.2. A new perspective to understand perceptions of technology

The presumed allo-enhancement effect provides a new perspective to understand how people perceive technology. First, it reveals that people have biased perceptions of social robots' utility for themselves and others. This self vs. other difference reflects classic self-bias studies in communication and psychology. It also adds a new approach to studying people's beliefs, attitudes, intentions, and behaviors toward technology. We demonstrated that the presumed allo-enhancement effect has a predictive ability. The perceptions of self and others and the perception discrepancies can explain people's support for social robots research and ambivalent attitudes toward social robots. To summarize, this novel presumed allo-enhancement effect can help us untangle people's complex perceptions, attitudes, and anxiety toward technology.

4.3. Limitations and future directions

There are several important limitations to our work. First, both of our studies use a cross-sectional design, which limits our ability to examine causal relationships between perceptions and behaviors. Although extensive research has traced the pathway from beliefs to attitudes and behavior through survey methodologies (Fishbein & Ajzen, 1972), future work should use experimental or longitudinal designs to establish the causality of the presumed allo-enhancement effect. For example, it may be beneficial to experimentally manipulate individuals' perceptions of the utility of social robots for themselves or others, by using the saying-is-believing paradigm (e.g., "Please tell us about some of the ways using social robots could enhance your life", Walton & Wilson, 2018) or by sharing vignettes from peers about the beneficial role social robots have played in their lives. Observing increases in participants' support for social robots research, or their own willingness to purchase or interact with social robots in the future, would provide support for this causal relationship.

In a similar vein, future research should examine the presumed allo-enhancement effect in a broader range of behavioral outcomes. While our study focused on support for social robots research and investment as it is widely used as an indicator of policy endorsements (Yogeeswaran et al., 2016; Zlotowski et al., 2017), other studies could explore actual engagement with social robots, such as purchasing, using, or interacting with them. Researchers can also investigate the effect of perceptions of social robot utility and self-other discrepancies on other-directed behavior, such as gifting or sharing a social robot with family members and friends.

Third, future work could consider the inherent diversity of social robots that are available now, and under development. Our study relied on individuals' mental models of social robots, shaped either by their prior knowledge or by their visualizations of the definition provided to them. However, as seen in the Stanford Social Robots Database (Reeves et al., 2020), social robots come in many shapes and sizes ranging from the intensely mechanical and humanoid, to soft and round animal-esque creatures. Indeed, scholars have found that the physical characteristics of social robots influence how people think about and engage with them (Mieczkowski et al., 2018; Liu et al., 2019). Therefore, additional research on the presumed allo-enhancement effect should explore interactions between the characteristics of social robots and the dynamics of perceptions of their utility.

Finally, the presumed allo-enhancement effect may apply to other technologies beyond social robots. Future work should explore whether this effect is observed in perceptions of other AI-powered innovations, like autonomous vehicles and AI chatbots. Understanding whether this effect is specific to certain technologies or reflects a broader psychological process can help us better understand people's complex attitudes towards new technologies.

5. Conclusion

Our research shows that individuals believed that social robots are more beneficial for others than for themselves. We named this systematic perception bias the presumed allo-enhancement effect of social robot perceptions. The findings suggested that when individuals perceive that social robots have a higher utility for themselves and others, their support for social robot research is enhanced. However, when people believe that social robots have a much higher utility for others than for themselves, their support for social robots research is reduced. Through a replication study, the findings suggested that the presumed allo-enhancement effect of social robot perceptions is robust.

Social robots are good for me, but better for other people

The Presumed Allo-enhancement Effect of Social Robot Perceptions.

Funding

The research was supported by the National Science Foundation under Grant No. CHS 1901151/1901329.

CRediT authorship contribution statement

Xun Sunny Liu: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jeff Hancock:** Writing – review & editing, Funding acquisition, Conceptualization.

Declaration of competing interest

There are no conflicts of interest to disclose.

Acknowledgment

We extend our gratitude to Sonny Ben Rosenthal for his valuable feedback on the manuscript and suggesting term "the presumed allo-enhancement effect". We thank Angela Lee for her valuable feedback on the manuscript.

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