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Our tools redefine what it means to be us: perceived robotic agency decreases the importance of agency in humanity

Weifeng Xu^{1*}, Chao Li¹, Xiaoyan Miao¹ and Li Liu^{1*}

Abstract

Past work has primarily focused on how the perception of robotic agency influences human–robot interaction and the evaluation of robotic progress, while overlooking its impact on reconsidering what it means to be human. Drawing on social identity theory, we proposed that perceived robotic agency diminishes the importance of agency in humanity. We conducted three experiments ($N = 920$) to test this assumption. Experiments 1 and 2 manipulated perceived robotic agency. Experiments 2 and 3 separately measured and manipulated distinctiveness threat to investigate the underlying mechanism. Results revealed that high (vs. low) perceived robotic agency reduced ratings of the essentiality of agency in defining humanity (Experiments 1 and 2); distinctiveness threat accounted for this effect (Experiments 2 and 3). The findings contribute to a novel understanding of how ascriptions of humanity are evolving in the AI era.

Keywords Perceived robotic agency, Distinctiveness threat, Human mind, The importance of agency in humanity

“We shape our tools, and afterwards our tools shape us.”

—*John M. Culkin (1967, p. 70)*

Recent years have witnessed the rapid and extraordinary development of artificial intelligence (AI), particularly in the realm of robotics. For instance, AlphaGo has become the top Go player, defeating numerous human champions [50], and medical AI has achieved expert-level accuracy in disease diagnosis [15, 40]. The human-like or even superior performance of AI robots prompts people to attribute mental capacities or minds to these machines [3, 12, 23]. In particular, as a core dimension of minds, agency—the capacity for thought and action

[22] has been perceived significantly increased. The rise of machine agency has introduced a fundamental tension between robotic and human agency, prompting a search for balance between the two [59]. Accordingly, researchers have largely focused on the impact of perceived robotic agency on human–robot interactions (e.g., [2, 7, 10, 11, 57]).

However, in the face of robotic progress, humans’ reactions not only point to those nonhuman entities but can also reflect back on themselves. As Culkin [8] claimed, humans’ endeavors to create more innovative tools are always accompanied by a refreshed understanding of what it means to be a human. Likewise, the dual nature of computational objects, such as robots—both as things and as human-like entities—is believed to evoke a reconsideration of humanness [17, 62]. This raises an important yet underexplored question: Does the perception of robotic agency influence how people ascribe agency to humanity? Inspired by the social identity theory, we

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posited that individuals may downplay the importance of agency in humanity when they perceive high levels of robotic agency, in order to preserve their own sense of distinctiveness [16, 60]. Therefore, the current research examined whether perceived robotic agency decreases the importance of agency in humanity through increased distinctiveness threat.

Mind perception and perceived robotic agency

Minds refer to the mental capabilities of an entity [22]. Mind perception is primarily along two dimensions: agency and experience. The agency dimension entails the capacity to think and act, such as self-control and communication, while the experience dimension involves the capacity to feel, such as hunger and fear [22, 68]. Among the numerous entities in the natural world, humans perceive themselves to possess the highest degree of both agency and experience, which are considered important features of humanity [23, 26, 43]. In particular, agency represents human uniqueness that distinguishes humans from nonhuman animals, whereas experience is tied to human nature, setting humans apart from robots and inanimate objects [26].

Mind perception of robots powered by AI is evolving, with a prominent focus on the agency dimension. Robots used to be perceived as entities with moderate agency and low experience [22, 68]. However, with the advent of the AI era, robots have made rapid technological progress, leading to an increased perception of their agency in areas such as communication and thinking. Although advancements have also enhanced perception of robots' experience, people still perceive robotic agency to be much higher than their experience [33]. For instance, people place greater trust in AI robots for agency-related tasks than for experience-related ones [4, 44]. Following the widespread belief that robots are capable of agency but lack experience [14], this study focused on perceived robotic agency.

Existing research on perceived robotic agency has typically focused on its consequences for human responses to or interactions with robots, with the goal of facilitating robotic development and application [24, 25, 30]. For instance, some studies have found that people's trust, liking, and support for robots are influenced by the belief that robots can think and act autonomously [9, 69, 74]. Despite this prevailing robot-focused perspective, it remains unclear how people conceptualize the role of agency in humanity in response to increased perceived agency in robots. Therefore, we turned to a human-focused perspective, shifting the focus to the transformation of human identity in the era of AI, by examining the effect of perceived robotic agency on ascribing the importance of agency in humanity.

Perceived robotic agency, distinctiveness threat, and the importance of agency in humanity

Humanity is conceptualized as comprising the attributes that characterize the essence of being a human [27]. Building on this, we define the importance of agency in humanity as the extent to which agency is considered integral and fundamental to human identity. It is crucial to note that the perception of importance of one attribute in a construct is not objective and static, but adjustable strategically, contingent upon contextual and motivational factors [45, 46, 49]. For example, the importance of competence/morality in self-esteem is swayed by the general system justification [39]. Before the AI era, agency was universally regarded as a vital human characteristic [23, 26]. However, the exceptional agency exhibited by robots today may well challenge the ongoing relevance of agency as a human-centric attribute.

We argue that perceived robotic agency facilitates an increase in distinctiveness threat. Distinctiveness threat refers to the degree to which the ingroup's sense of distinctiveness is compromised, or the degree of overlap that occurs at the group boundaries [34, 53]. While both robots and humans are seen as having agency, humans are typically viewed as possessing a higher level of agency than robots, thereby creating a boundary between the two entities [22, 33]. Nonetheless, the progression of artificial intelligence has hastened, blurring the lines between humans and robots in terms of agency [54, 55]. This convergence poses a distinctiveness threat by eroding the boundaries that once distinctly separated humans from robots. Empirically, prior studies have found that robots with high (versus low) autonomy are perceived as a threat to human uniqueness and identity [47, 73, 74].

Distinctiveness threat might diminish the importance of agency in humanity. According to social identity theory, distinctiveness threat motivates individuals to adopt strategies to preserve or restore human distinctiveness [29, 35, 65]. These strategies can be categorized as realistic or cognitive. Realistic strategies, such as social mobility and social competition, aim to restore distinctiveness through tangible actions, like competing with outgroups or changing group membership [16]. However, given the irreversible advancements in AI, robots will inevitably possess features once considered uniquely human [64], making realistic strategies less viable.

Instead, the social creativity strategy—a cognitive approach that preserves distinctiveness without altering the ingroup's status—emerges as the most feasible and effective option in this context [1, 60]. One crucial way the social creativity strategy addresses distinctiveness threat is by altering the ingroup's perception of the threatened dimension [37, 52, 60]. In human–robot interaction, as robots increasingly exhibit agency,

humans may no longer perceive agency as exclusive to human mental capacities, given that it can now be realized through automation [42]. Consequently, the importance of agency within humanity may diminish, serving to preserve human–machine distinctions and maintain human uniqueness.

Based on the above arguments, we hypothesized that perceived robotic agency decreases the importance of agency in humanity (Hypothesis 1), and distinctiveness threat mediates this effect (Hypothesis 2).

Overview of the current research

We tested the hypotheses with a preliminary investigation and three experiments. Specifically, the preliminary investigation confirmed that public perception of robotic agency surpasses that of experience, providing the rationale for focusing subsequent experiments on perceived robotic agency (rather than experience). Experiment 1 examined the effect of perceived robotic agency on the extent to which participants viewed agency as essential to being a human. Experiments 2 and 3 further examined the mediating role of distinctiveness threat with both measurement-of-mediation and experimental-causal-chain designs [56], respectively. Moreover, in these two experiments, we also exploratorily investigated whether perceived robotic agency impacts participants' ascribing importance of experience in humanity.

We preregistered the design and analysis plans for Experiment 2 (https://osf.io/2y74f/?view_only=805588bcc2c04b308c4a8d0d22d4d58b) and made data and analysis code of the preliminary investigation and three experiments available on Open Science Framework (OSF, https://osf.io/ef7ns/?view_only=b5b8618637684ba085709697a4b4c903). The following information is provided in Supplementary Materials: description and results of the preliminary investigation, stimulus materials, and the supplement analyses.

Experiment 1

Experiment 1 aimed to investigate whether the perceived robotic agency decreases the importance of agency in humanity. We manipulated participants' perception of robotic agency and measured their ascribed importance of agency in humanity. We predicted that participants in the high (vs. low, and control) perceived robotic agency condition would rate agency as less important in humanity.

Method

Participants

Experiment 1 recruited participants through the Credamo online survey platform (<https://www.credamo.com/>). Due to uncertainty about the appropriate sample

size for this study, we planned to recruit 80 participants per condition. Participants who did not successfully complete the attention check were automatically excluded by the platform's built-in exclusion system. The final sample, excluding only those who failed the attention check (as in the following experiments), consisted of 240 participants (102 males, 138 females; $M_{\text{age}} = 30.27$, $SD_{\text{age}} = 7.67$; 18–67 years old). Sensitivity analysis using G*Power [13, 18] indicated that, with a statistical power of 80% and a significance level of 0.05 for the three-condition experiment, the current sample size ($N = 240$) is sufficient to detect a minimum effect size of $f = 0.20$. Participants were randomly and evenly assigned to the three experimental conditions, and they received 3 CNY as compensation.

Materials and procedure

Perceived robotic agency manipulation In experimental groups, participants read textual materials about robotic agency (see Supplementary Materials for more details). Specifically, in the high agency condition, the text stated that robots (e.g., ChatGPT, Ernie Bot) have reached a remarkable level of agency and have achieved high scores in the agency assessment. Conversely, in the low agency condition, the text stated that robot development is still in its infancy and the robotic agency remains quite low, exemplified by robots like Roomba and Spot. In the control condition, participants did not read any textual material.

As a manipulation check, we presented participants with a list of seven agency capabilities, such as planning, communication, and thought [22], and asked them to rate the extent to which they believe robots possess these capabilities on a 7-point Likert scale (1 = *not at all*, 7 = *very much*). The capabilities were randomized for each participant, and the scores of all items were averaged to create the agency index ($\alpha = 0.89$).

Ascribed importance of agency in humanity Adopted from Jackson et al.'s [32] measurement, we asked participants, "Among the following abilities and traits, which are more essential for humans versus robots?" Participants then rated the importance of seven abilities on a 7-point scale (1 = *more essential for robots*, 7 = *more essential for humans*). The seven abilities were based on the agency capability items developed by Gray et al. [22], such as planning, communication, and thought for participants ($\alpha = 0.69$). The order of items was randomized for each participant.

Results

Manipulation check

To test the effectiveness of manipulation, we conducted a one-way ANOVA analysis with perceived robotic agency

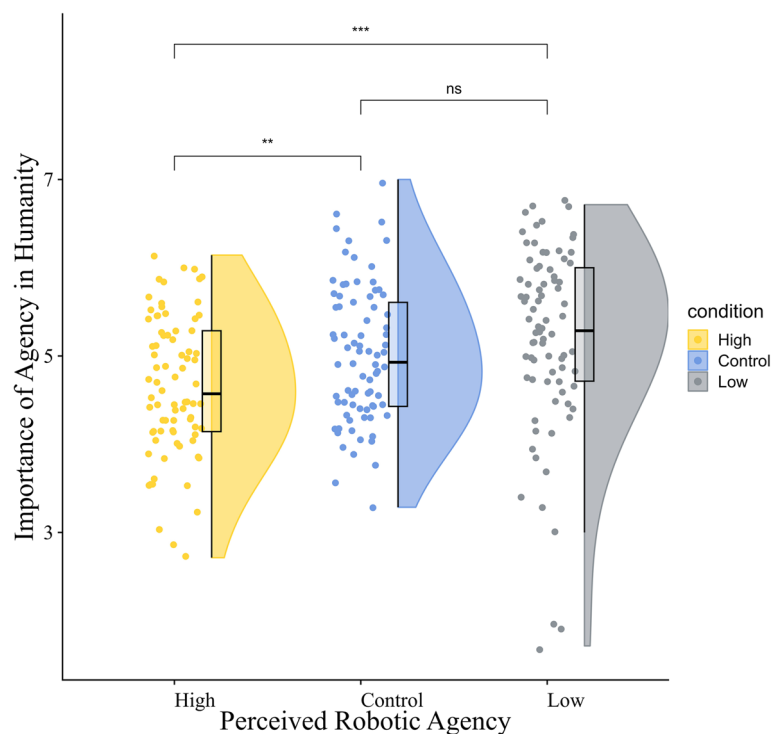


Fig. 1 Effects on the importance of agency in humanity in Experiment 1

Note. Dots depict jittered individual data points. Boxplots display the median (central line), the first quartile (bottom line), and the third quartile (top line). Colored fields display the distribution of responses. ** $p < .01$, *** $p < .001$

as the dependent variable. The results revealed a significant difference in robotic agency perception across conditions, $F(2, 237) = 76.00, p < 0.001, \eta_p^2 = 0.391$, 90% CI $[0.310, 0.456]$. Further planned comparisons revealed that perceived robotic agency in the high condition ($M = 5.18, SD = 0.90$) was higher than that in the control ($M = 4.41, SD = 1.07; t(237) = 4.40, p < 0.001$, Cohen's $d = 0.78$, 95% CI $[0.46, 1.10]$) and low conditions ($M = 3.06, SD = 1.29; t(237) = 12.17, p < 0.001$, Cohen's $d = 1.91$, 95% CI $[1.53, 2.28]$). Furthermore, the difference between the control condition and the low condition was also significant ($t(237) = 7.78, p < 0.001$, Cohen's $d = 1.14$, 95% CI $[0.81, 1.47]$). Thus, the manipulation of robotic agency perception was effective.¹

Effect of perceived robotic agency on the importance of agency in humanity

A one-way ANOVA was conducted with the importance of agency in humanity scores as the dependent variable. The results revealed a significant difference in the importance of agency in humanity across conditions, $F(2, 237)$

$= 7.98, p < 0.001, \eta_p^2 = 0.063$, 90% CI $[0.019, 0.114]$. Further planned comparisons (see Fig. 1) revealed that participants in high perceived robotic agency condition ascribed less importance to agency in defining humanity ($M = 4.65, SD = 0.78$) than those in the control condition ($M = 5.01, SD = 0.78; t(237) = -2.56, p = 0.033$, Cohen's $d = 0.46$, 95% CI $[0.15, 0.78]$) and low conditions ($M = 5.20, SD = 1.07; t(237) = -3.94, p < 0.001$, Cohen's $d = 0.59$, 95% CI $[0.27, 0.90]$). However, there was no significant difference between the control and the low conditions ($t(237) = -1.38, p = 0.510$, Cohen's $d = 0.20$, 95% CI $[-0.11, 0.51]$).²

The above findings showed that perceived robotic agency decreases the importance of agency in humanity, supporting Hypothesis 1. In other words, perceived high robotic agency did induce a social creativity strategy. It is important to note that no significant difference was observed between the control condition and the low condition. This suggests that the social creativity strategy is only triggered when the high agency characteristics of robots are emphasized.

¹ For the planned comparisons in Experiment 1, we applied the Bonferroni correction to control Type I error rates.

² As a robustness check, we included gender and age as covariates in our analyses, and the results remained unchanged in all three experiments.

Experiment 2

Experiment 2 aimed to test the mediating role of distinctiveness threat. Specifically, we manipulated perceived robotic agency, and measured both distinctiveness threat and ascribed importance of agency in humanity. Given that Experiment 1 found no significant differences in the importance of agency in humanity between the control and low conditions, we removed the control condition from Experiment 2. In addition, we incorporated the measurement of the importance of experience in humanity to further explore whether the perceived robotic agency would also affect the experience dimension of the mind that is important to humanity. We predicted that the perceived robotic agency would decrease the importance of agency in humanity via increasing distinctiveness threat.

Method

Participants

We utilized Monte Carlo analysis (https://schoemanna.shinyapps.io/mc_power_med/) to estimate the sample size for the mediation model in this study. We set a meaningful minimum effect size (SESOI) of $r_s = 0.21$ for the three paths in the mediation model (i.e., paths a, b, and c'). Based on these parameters, the minimum required sample size is 291, with a power of 80%, and $\alpha = 0.05$. We finally recruited 350 participants (137 males, 213 females; $M_{\text{age}} = 27.84$, $SD_{\text{age}} = 6.87$; 18–59 years old) who passed the attention check through Credamo, and we offered each participant a reward of 2 CNY. Participants were randomly assigned to either the high ($n = 175$) or the low agency condition ($n = 175$).

Materials and procedure

Perceived robotic agency manipulation We employed the same materials as in Experiment 1 to manipulate participants' perceptions of robotic agency. As a manipulation check, all participants were required to rate their perception of robotic agency, utilizing items consistent with Experiment 1 ($\alpha = 0.89$).

Distinctiveness threat The measurement of distinctiveness threat was adapted from Ferrari et al. [19] and comprised three items ("I have the impression that the differences between machines and humans have become increasingly flimsy", "When looking at robots, I wonder/ask myself what are the differences between robots and humans", "I think the development of robots blurs the boundaries between humans and machines"). All items were rated on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*). We used the average score of the

3 items as an indicator of distinctiveness threat, where higher scores indicate a higher level of distinctiveness threat ($\alpha = 0.76$).

Ascribed importance of agency & experience in humanity We used the same items as in Experiment 1 to assess the importance of agency in humanity ($\alpha = 0.67$). Additionally, based on the mental capability items developed by Gray et al. [22], we added five items about experience capabilities, such as having desire, personality, and experiencing emotions, to measure the importance of experience in humanity ($\alpha = 0.89$).

Results

In the pre-registration, we planned to exclude outliers during analysis. However, since excluding outliers did not affect the results, we present the original data here, while providing the outlier-removed results in the supplementary materials.

Manipulation check

To test the effectiveness of manipulation, we conducted an independent *t*-test analysis with perceived robotic agency as the dependent variable. The results revealed that, compared to the low condition ($M = 3.37$, $SD = 1.05$), participants in the high condition ($M = 5.35$, $SD = 0.86$) perceived higher robotic agency, $t(334.73) = 19.32$, $p < 0.001$, Cohen's $d = 2.07$, 95% CI [1.80, 2.32]. Thus, the manipulation of perceived robotic agency was deemed effective.

Effect of perceived robotic agency on distinctiveness threat

An independent *t*-test on distinctiveness threat revealed that participants in the high condition ($M = 5.10$, $SD = 1.05$) perceived significantly greater distinctiveness threat from robots than those in the low condition ($M = 4.09$, $SD = 1.35$), $t(328.22) = 7.84$, $p < 0.001$, Cohen's $d = 0.84$, 95% CI [0.62, 1.06]. This showed that perceived robotic agency increases distinctiveness threat.

Effect of perceived robotic agency on the importance of agency & experience in humanity

We incorporated exploratory analysis of the experience dimension in pre-registration into the formal analysis, thus a 2 (perceived robotic agency: high vs. low) \times 2 (mind dimension: agency vs. experience) mixed ANOVA was conducted with the importance for humanity scores as the dependent variable. Results revealed a significant interaction, $F(1, 348) = 8.94$, $p = 0.003$, $\eta_p^2 = 0.025$, 90%

Table 1 Means (SDs) of dependent variables in both conditions in Experiment 2

Condition	Importance of Agency	Importance of Experience
High Agency	4.85 (0.84)	6.12 (1.12)
Low Agency	5.27 (0.91)	6.19 (1.11)

CI [0.005, 0.058]. Simple effects analysis³ (see Table 1 and Fig. 2) revealed that on the agency dimension, participants in the high condition ascribed less importance to agency in defining humanity than those in the low condition, $F(1, 348) = 19.92, p < 0.001, \eta_p^2 = 0.054$, 90% CI [0.022, 0.097]. The result is consistent with Experiment 1, suggesting that the perceived robotic agency diminishes the importance of agency for being a human (Hypothesis 1). However, on the experience dimension, there was no significant difference between the low and high conditions, $F(1, 348) = 0.39, p = 0.534, \eta_p^2 = 0.001$, 90% CI [0.000, 0.014].

The mediating role of distinctiveness threat

We analyzed the mediating role of distinctiveness threat between the perceived robotic agency and the importance of agency in humanity. We utilized the PROCESS V3.4 plugin in SPSS 25.0 for the mediation model test [28], Model 4, 5,000 bootstrap resamples). The high and low conditions were coded as 1 and 0, respectively. The results (see Table 2 and Fig. 3) revealed a significant indirect path from perceived robotic agency to the importance of agency in humanity via distinctiveness threat (Indirect effect = -0.082 , 95% CI [$-0.179, -0.008$], $SE = 0.04$). Furthermore, since there was no significant correlation between distinctiveness threat and the importance of experience in humanity ($r = -0.036, p = 0.50$), which does not meet the premises for the mediation analysis [48], we did not analyze the mediating effect of distinctiveness threat on the relationship between perceived robotic agency and the importance of experience in humanity.

These findings supported Hypothesis 2 that distinctiveness threat mediates the effect of perceived robotic agency on the importance of agency in humanity. However, we did not find that perceived robotic agency affects the importance of experience in humanity. This null effect may stem from the consistent perception that robots lack emotions [14]. Since experience has been identified as a key distinguishing factor in human–robot

comparisons [26, 43], it follows that, regardless of fluctuations in perceived robotic agency, experience remains the most important feature in humanity.

Experiment 3

Experiment 2 indicated that distinctiveness threat mediated the effect of perceived robotic agency on the importance of agency in humanity. However, based on the measurement-of-mediation design [48], we need to further validate the causal relationship between the mediating variable and the dependent variable to provide stronger support for the mediation model. Therefore, in Experiment 3, we manipulated distinctiveness threat and tested its effect on the importance of agency in humanity. Similar to Experiment 2, we also measured the importance of experience in humanity. To confirm the null effect of distinctiveness threat and the importance of experience in humanity, we also measured this dependent variable.

Method

Participants

Experiment 3 employed a 2×2 mixed-factorial design, with distinctiveness threat (high vs. low) as the between-subjects factor and mind dimension (agency vs. experience) as the within-subject factor. A priori power analysis revealed that a sample size of 290 was enough to achieve 80% power to detect a small interaction effect ($f = 0.1$). We finally recruited 330 participants (140 males, 190 females; $M_{age} = 28.91, SD_{age} = 7.94$; 18–67 years old) who passed the attention check through Credamo, compensating each participant with 2 CNY. Participants were randomly assigned to the high ($n = 165$) or the low distinctiveness threat condition ($n = 165$).

Materials and procedure

Distinctiveness threat manipulation We used material adapted from Wilson and Hugenberg [70] for distinctiveness threat manipulation (see Supplementary Materials for more details). Specifically, all participants were first presented with a paragraph outlining general advancements in the field of robotic agency. Next, in the high distinctiveness threat condition, participants read a paragraph describing that the agency behaviors exhibited by robots are sufficient to establish that they possess agency similar to humans. In contrast, in the low distinctiveness threat condition, participants read a paragraph describing that the agency behaviors exhibited by robots are insufficient to establish that they possess agency similar to humans, as there are fundamental differences in the mechanisms underlying these behaviors between robots and humans. As a manipulation check, participants rated

³ For the simple effects analyses in Experiments 2 and 3, we applied the Bonferroni correction to control Type I error rates.

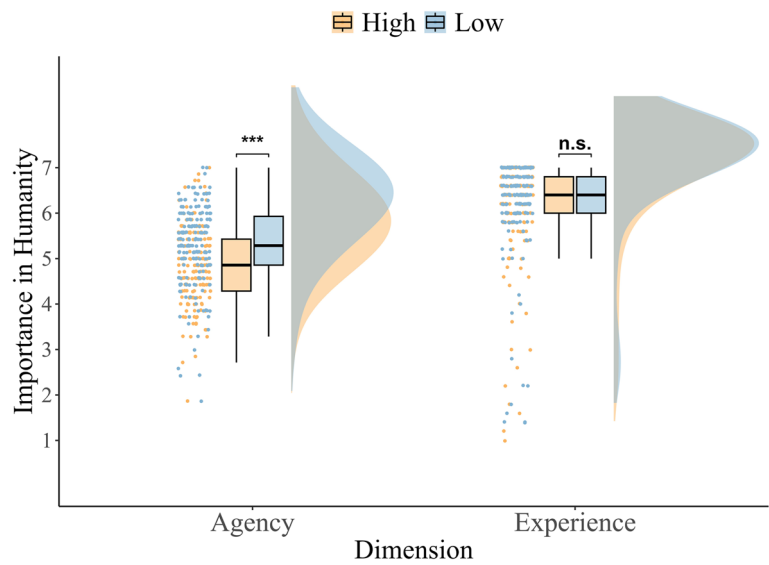


Fig. 2 Effects on the importance of agency & experience in humanity in Experiment 2

Note. Dots depict jittered individual data point. Boxplots display the median (central line), the first quartile (bottom line), and the third quartile (top line). Colored fields display the distribution of responses. *** $p < .001$

distinctiveness threat using the same items as Experiment 2 ($\alpha = .84$).

Ascribed importance of agency & experience in humanity We used the same items as Experiment 2 to measure the importance of agency ($\alpha = 0.68$) and experience ($\alpha = 0.85$) in humanity.

Results

Manipulation check

To test the effectiveness of manipulation, we conducted an independent t -test analysis with distinctiveness threat as the dependent variable. The results revealed that, compared to the low distinctiveness threat condition ($M = 4.02$, $SD = 1.42$), participants in the high condition ($M = 5.66$, $SD = 0.88$) perceived higher distinctiveness threat, $t(273.19) = 12.61$, $p < 0.001$, Cohen’s $d = 1.39$, 95% CI [1.15, 1.63]. Thus, the manipulation of distinctiveness threat was deemed effective.

Effects of distinctiveness threat on the importance of agency & experience in humanity

A 2 (distinctiveness threat: high vs. low) \times 2 (mind dimension: agency vs. experience) mixed ANOVA was conducted with the importance scores as the dependent variable (see Table 3). The results revealed a significant interaction, $F(1, 328) = 4.72$, $p = 0.030$, $\eta_p^2 = 0.014$, 90% CI [0.001, 0.042]. Simple effects analysis (see Table 3 and Fig. 4) revealed that on the agency dimension,

Table 2 Mediation analysis in Experiment 2

Paths	B	SE	t	95% CI
Agency condition \rightarrow DT (a)	1.01	0.13	7.84***	[0.76, 1.27]
DT \rightarrow IOAIH (b)	− 0.08	0.04	− 2.10*	[− 0.16, − 0.01]
Agency condition \rightarrow IOAIH (c’)	− 0.34	0.10	− 3.32**	[− 0.53, − 0.14]
Agency condition \rightarrow IOAIH (c)	− 0.42	0.09	− 4.46***	[− 0.60, − 0.23]

SE Standard Error, CI Confidence Interval, DT Distinctiveness Threat, IOAIH Importance of Agency in Humanity

* $p < .05$. ** $p < .01$. *** $p < .001$

participants in the low distinctiveness threat condition ascribed greater importance to agency in defining humanity than those in the high condition, $F(1, 328) = 4.54$, $p = 0.034$, $\eta_p^2 = 0.014$, 90% CI [0.001, 0.042]. However, on the experience dimension, there was no significant difference between the low and the high distinctiveness threat conditions, $F(1, 328) = 0.22$, $p = 0.642$, $\eta_p^2 = 0.001$, 90% CI [0.000, 0.013]. These results validated the causal effect of distinctiveness threat on the importance of agency (rather than experience) in humanity.

General discussion

Throughout history, advancements in technology have inevitably shaped how humans view themselves and their features. For instance, the Second Industrial Revolution reshaped the importance of manual and mental labor for humans [38, 63]. Today, the Fourth Industrial Revolution continues to confirm this pattern. Rooted in social identity theory, our research explored the influence of

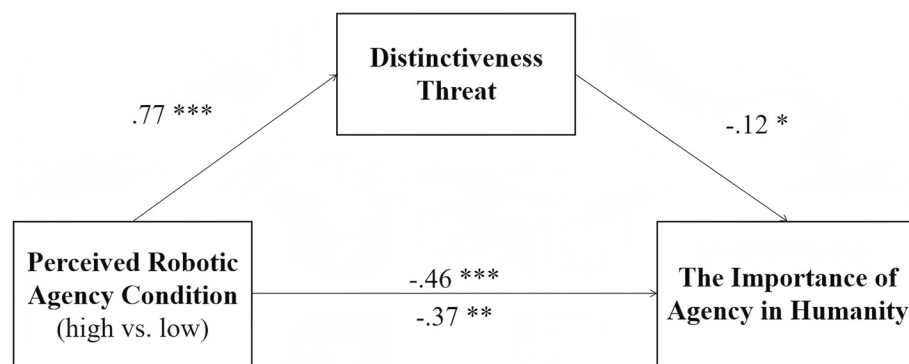


Fig. 3 Mediating role of distinctiveness threat in Experiment 2

Note. Coefficients are standardized. The value above the direct path is total effects, and the value below the direct path is direct effects. * $p < .05$, ** $p < .01$, *** $p < .001$

perceived robotic agency on the importance of agency in humanity across three experiments. The results indicate that when individuals perceive high robotic agency, they would reduce the importance of agency in humanity (Experiment 1), and distinctiveness threat mediates this effect (Experiments 2 & 3).

Notably, our findings in Experiment 2 seem to contradict some prior studies. For example, while earlier research found no change in importance ratings on the threatened dimension [5, 51], we observed this null effect on the alternative dimension. We posit that these inconsistencies may originate from differences in experimental manipulations. On the one hand, for the threatened dimension, unlike the humanlike traits (e.g., morality, thought) of robots examined in our research, previous studies focused on robots' features that have long been viewed as shared between humans and machines (e.g., computations, sound detection), likely leading to consistently low importance ratings in both conditions. On the other hand, for the alternative dimension, prior studies contrasted robot-salient versus no-robot conditions. In contrast, our Experiment 2 compared high-agency (e.g., ChatGPT) and low-agency (e.g., Roomba) robots. This inherent salience of robots in both conditions may have resulted in consistently high importance ratings on the alternative dimension (i.e., experience).

The current research enriches our understanding of the impact of perceived robotic agency on reconsidering what it means to be human. Taking the perspective that robots are the mirror of the human [71], we found that the advancement of robotic agency changes the importance of agency as a human feature. Previous studies have treated agency as an important component of humanness, using it as a benchmark to assess the current state of robot advancement [21, 36, 66]. However, this perspective focuses solely on the development of robots,

Table 3 Means (SDs) of dependent variables in both conditions in Experiment 3

Condition	Importance of Agency	Importance of Experience
High Distinctiveness Threat	4.63 (0.97)	6.21 (0.84)
Low Distinctiveness Threat	4.84 (0.86)	6.16 (1.04)

neglecting the possibility that the fundamental characteristic of being a human may also change as the perceptions of robots evolve. From the perspective of social identity, our research shows that similar features from robot groups also affect the importance of agency in humanity [16, 60]. This aligns with the media evocation paradigm, which examines how computational agents, including robots, are perceived as both an extension of the self and part of the external world, thereby evoking questions about humanity [17, 62]. Our findings suggest that the relationship between robots and humans is a reciprocal shaping process: as we continuously imbue robots with new features, they, in turn, influence and transform our own human characteristics. This interplay not only demonstrates our control over technology but also reveals the reverse effect technology has on us.

Furthermore, we introduced the distinctiveness threat to clarify how the perceived agency of robots impacts the importance of agency in humanity. Previous discussions about the reshaping role of our tools in humanity have primarily focused on the domains of economics and philosophy [41, 63]. For instance, Marx posited that the advent of mass production altered the identity and worth of workers [38]. However, few studies have delved into the psychological mechanism underlying this phenomenon. From the perspective of group distinctiveness, we provide an explanation for this effect. Specifically, the perception

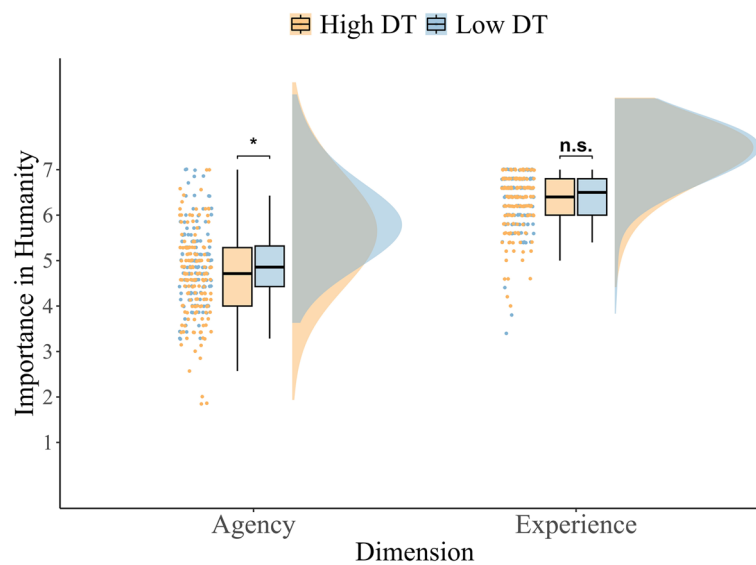


Fig. 4 Effects on the importance of agency & experience in humanity in Experiment 3

Note. Dots depict jittered individual data point. Boxplots display the median (central line), the first quartile (bottom line), and the third quartile (top line). Colored fields display the distribution of responses. DT = Distinctiveness Threat. * $p < .05$

of high robotic agency obscures the distinctiveness of the human group, prompting humans to alter their perceptions of agency as a response to this threat. Our research reveals that the core motivation behind modifying one's view of humanity in human–robot interaction is to preserve the unique position of humans in nature.

This research offers practical insights into how we perceive humanity in the AI era and how to guide robotic development. First, as we integrate robots into society [11, 72], it is crucial to recognize that this process redefines what it means to be human. This transformation not only impacts the essence of human identity but also holds the potential to reshape labor distribution patterns. For instance, the job market may evolve such that tasks demanding agency are delegated to robots, while the contributions of human workers related to experience are increasingly valued [31]. Thus, when appraising the capabilities that enable robots to integrate into human society, we must consider how these capabilities could transform the essence of humanity. Second, it is critical to preserve human distinctiveness as we advance robotics. Current strategies address robot mimicry of human agency through social creativity, but their effectiveness may be lost if robots can fully emulate human characteristics, potentially provoking hostility and resistance to technological advancements [20, 67]. Hence, the evolution of robots should aim to enhance rather than imitate human beings, ensuring they provide unique contributions without eroding the distinctiveness of human communities.

The limitations of the present research warrant attention. First, all of our studies relied on self-report

measures, which may introduce social desirability bias or demand characteristics. Therefore, we encourage future research to incorporate alternative measurement methods, such as behavioral measures. Second, our research exclusively recruited Chinese participants. Given that cultural values (e.g., collectivism vs. individualism) may moderate this effect, cross-cultural replications are essential to establish generalizability. Third, we operationalized the perception of robotic agency through specific exemplars (e.g., ChatGPT vs. Roomba). This approach might inadvertently activate broader AI-related concepts (e.g., strong AI vs. weak AI). Thus, future studies could employ standardized robot stimuli to isolate the effects of agency perception more precisely. Finally, this study focused on symbolic threats arising from increased perceptions of robotic agency. However, as outlined in Integrated Threat Theory [58], advanced robots also pose realistic threats, such as job displacement and resource competition [72]. Future research could explore how humans preserve their uniqueness while addressing these tangible challenges.

This research opens avenues for future exploration. First, future studies should investigate the application of social creativity strategies across diverse contexts. While this study highlights how perceptions of robotic agency influence the attributed importance of agency in humanity, social creativity strategies in human–robot interactions are not limited to agency alone. For example, the assertion that “machines only have a chip-core, and humans have a heart” [61] illustrates how emphasizing physiological advantages helps preserve positive distinctiveness. Different contexts may shift the dimensions on

which humans and robots are compared, leading to varying outcomes from the use of social creativity strategies. Furthermore, these strategies may dynamically reshape the perceived importance of specific characteristics, redefining what it means to be human.

Moreover, it is essential for future research to explore the downstream consequences of an altered view of the human agency. Social creativity strategies, which serve as a cognitive mechanism for redefining group boundaries [60], recalibrate the importance of agency within the construct of humanity. Given the pivotal role that agency plays in the dynamics of dehumanization and moral decision-making [6, 26], it is imperative to comprehend how changes in the perceived importance of agency in humanity might exert influence on these processes.

Conclusion

Advancements in tools, particularly robots, have the potential to profoundly impact our lives, prompting many studies on their integration into human society. However, these developments also subtly reshape our understanding of humanity. Our research demonstrates that perceiving robots with high agency can threaten our sense of distinctiveness, leading us to downplay the role of agency in defining what it means to be human. As AI technology advances and the relationship between robots and humans becomes closer, it is crucial to explore how these tools might redefine human identity.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

WX conceptualized, conducted the statistical analysis and wrote the main manuscript, CL and XM critically reviewed and commented on the manuscript, LL conceptualization (Revision), writing-review & editing, funding acquisition, supervision.

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Data availability

The data presented in this study are available on Open Science Framework (OSF, https://osf.io/ef7ns/?view_only=b5b8618637684ba085709697a4b4c903).

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Beijing Normal University (protocol code 202111010060, 19 November 2021). Informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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