



# New dyads? The effect of social robots' anthropomorphization on empathy towards human beings

Federica Spaccatini<sup>a,b,\*</sup>, Giulia Corlito<sup>a</sup>, Simona Sacchi<sup>a</sup>

<sup>a</sup> Department of Psychology, University of Milano-Bicocca, Milano, Italy

<sup>b</sup> Department of Political Science, University of Perugia, Perugia, 06132, Italy

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## ABSTRACT

Research on Human-Technology Interactions revealed that, under certain conditions, people instinctively interact with social robots in ways comparable to Human-Human Interactions. Indeed, people apply social perception schemas and attribute a mind to social robots, especially when they present anthropomorphic characteristics. Furthermore, under certain conditions, anthropomorphic social robots are awarded with moral consideration and participate to moral dyads. Thus, anthropomorphism facilitates social robots integration in people's lives. However, what is still unknown is whether adopting social schemas with social robots, in turn, affects how individuals perceive and interact with other people. To fill this gap, we experimentally investigated whether the type of mind attributed to anthropomorphic social robot, then, complementary influences the empathy towards a person in trouble. Participants ( $n = 269$ ) interacted (vs. did not interact) through a chatbot with a highly (vs. lowly) anthropomorphic social robot, evaluated it on mind dimensions and, finally, expressed their empathy towards a person. Results demonstrated that anthropomorphism fosters the attribution of agency (anthropomorphic appearance and interaction through chatbot) and experience (anthropomorphic appearance only), which, in turn, significantly, but in opposite directions, affected empathy towards the social target. Implications and future research directions are outlined.

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## Ethics approval

All procedures performed involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The present research protocol was approved by the Department of Psychology (University of Milano-Bicocca) Ethic Committee [Protocol number: RM-2022-501].

## 1. Introduction

For a long time, movies, literature, and popular culture in general have imagined a distant future society where highly sophisticated

technologies - such as humanoid social robots and artificial intelligences - serve human beings. Thanks to technological advances, this future is no longer so remote. In fact, over the last decades, the introduction of technological innovations in various aspects of human society - from security to healthcare services - have become increasingly prevalent. Contextually, academics have started to investigate how people perceive and interact with technological devices with the aim of integrating them in everyday life successfully. These lines of research revealed that, under certain conditions, in the eyes of the perceivers technological devices do not merely constitute technological gadgets, but, rather, social entities. It means that people instinctively apply social perception schemas to technological entities - from computers to more sophisticated social robots - and interact with them in ways that are comparable to Human-Human Interactions (e.g., Banks, 2020; Eyssele & Hegel, 2012; Fink, 2012; Morillo-Mendez et al., 2022; Nass et al., 1997; Nass & Moon, 2000; Westerman et al., 2020).

In the present research, we focused our attention on social robots. Social robots have been developed to socially interact with and support people in many daily activities and they are characterized by an

\* Corresponding author. University of Perugia, Department of Political Science, Via Elce di Sotto, Perugia, Italy.

E-mail address: [federica.spaccatini@unipg.it](mailto:federica.spaccatini@unipg.it) (F. Spaccatini).

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increasingly human-like appearance and behavior that emulates key characteristics of the human beings' mind (Jacobs et al., 2021; Lee et al., 2006; Müller et al., 2021). In this respect, the social robots' anthropomorphism – i.e., the degree to which they resemble human beings' appearance and behavior – is crucial in activating social perception processes (e.g., Banks, 2020; Bethal & Murphy, 2006; Broadbent et al., 2013; Ferrari et al., 2016; Fink, 2012; Jung et al., 2022; Kamide et al., 2014; Riek et al., 2009; Rothstein et al., 2020; Short et al., 2010). In particular, the more the social robots resemble human beings, the more the knowledge about prototypical mind-havers become accessible, and then, the more knowledge about human beings is applied in making inferences about social robots' qualities. Accordingly, designing social robots with human-like and social properties is an advantage to the extent that it promotes social response and, consequently, facilitates Human-Technology Interactions. However, robots' human-likeness makes the boundaries between human beings and social robots blurrier, thus determining a sort of overlap in the mental representations of such agents (Epley et al., 2007; Kiesler et al., 2008; Mussweiler, 2003; Waytz et al., 2010). In this regard, the present research aims to explore the possible social consequences of social robots' anthropomorphization. In particular, we investigated whether the attribution of mind to anthropomorphic social robots would, in turn, affect social perception of human beings.

## 2. Mind attribution and moral typecasting

Numerous models have been proposed and tested to explore humanness perception, and, consequently, whether and how people assign human qualities to social others. Among the human distinctive qualities, the attribution of mind is pivotal in activating social processes (Epley & Waytz, 2010). In this regard, the Mind Perception model by Gray et al. (2007) represents a milestone. The authors provided evidence that mind is not unidimensional, but, rather, it encompasses two distinct dimensions: agency and experience. Agency refers to the capacity to perform actions intentionally and effectively (e.g., thought, planning, self-control), whereas experience refers to the capacity for feelings (e.g., consciousness, feel pain, feel pleasure; Gray et al., 2007). The mind attribution is crucial in conferring not only personhood but also deservingness of moral standing to persons and even to non-human entities (Epley & Waytz, 2010; Gray et al., 2007, 2012). Indeed, the specific dimension of the perceived target's mind is linked to the attribution of one of two different facets of the moral status identified by the Moral Typecasting model (Gray et al., 2007; Gray & Wegner, 2009). Whereas *agency* is related to the dimension of *moral agency* – that is the capacity of acting morally – *experience* is associated to the dimension of *moral patiency* – that is the capacity of being the sensitive target of morally relevant actions (Gray et al., 2007). Such a moral typecasting functions as a cognitive working template (Epley & Waytz, 2010; Gray et al., 2012). This is particularly relevant given that the perception of mind and moral status influence social cognition and moral treatment. The attribution of agency and moral agency fosters the ascription of responsibility for moral actions, leading to praise, blame, and punishment for one's moral actions (Epley & Waytz, 2010; Gray et al., 2007). On the other side, the attribution of experience and moral patiency leads to granting moral rights, supporting, and acting pro-socially towards the social target (Epley & Waytz, 2010; Gray et al., 2007; Gray & Wegner, 2009).

Crucially, our cognitive schemas lead us to perceive people in relationship with others rather than isolated entities. This is particularly true in moral domains, where morally relevant actions, such as helping or harming someone, comprise a dyadic template of an actor who engages in the action and another actor who receives it (Gray et al., 2012; Gray & Wegner, 2009). More specifically, the bi-dimensional structure of mind determines the creation of moral dyads composed by two distinct and mutually exclusive actors: the moral agent and the moral patient (Gray et al., 2007; Gray and Wegner, 2009; Gray et al., 2012). Research

demonstrated that the moral dyads are usually composed in our social perception when the moral agent and the moral patient are involved in a morally relevant action (Gray et al., 2012). However, exceptions to this prototype exist. On the one hand, it has been shown that people tend to create or complete moral dyads automatically even when they do not exist (*phantom dyad*; Gray et al., 2012; Gray & Wegner, 2009). Thus, when someone is attributed a specific position (agent vs. patient), the need to complete the dyad leads to assign the complementary role (patient vs. agent) to a second person. Specifically, such an illusory completion might arise even when the second person is not directly involved in the moral actions or when the actions are victimless or agentless (Gray et al., 2012; Gray & Wegner, 2009). As argued by Gray and Wegner (2009), the social perception of a neutral target depends on the moral role attributed to the other actor with which it is paired. Furthermore, the creation of dyads might occur even in non-moral situations (Gray et al., 2011, 2012). Indeed, Gray et al. (2011) provided evidence that non-moral manipulations can elicit and influence the attribution of moral agency and moral patiency. Overall, these findings suggest that the creation of moral dyads can be possible even outside the moral domain.

## 3. Anthropomorphization of social robot

Human cognition allows the attribution of humanlike characteristics and mental and emotional states not only to other people, but also to non-human targets such as pets (Epley et al., 2008), religious deities (Morewedge & Clear, 2008), nature (Sacchi et al., 2013), and technological devices (Waytz, Cacioppo, & Epley, 2010). This ability, defined as anthropomorphization, is an automatic process of inference about unobservable properties of non-human entities that activates the same psychological and neural mechanisms involved in the attribution of mind and humanness to individuals (Castelli et al., 2013; Epley et al., 2007; Waytz, Cacioppo, & Epley, 2010).

Among the targets of anthropomorphization, a growing attention has been devoted to technological devices. This literature demonstrated that technological devices often activate traditional processes of impression formation and social perception (e.g., Kuchenbrandt et al., 2013; Trovato et al., 2017) and are anthropomorphized throughout the attribution of human properties such as gender or mental states (e.g., Banks, 2020; Kiesler & Goetz, 2002; Nass & Moon, 2000; Waytz et al., 2010; Westerman et al., 2020). In this respect, the above-mentioned Mind Perception model was applied to study technological devices anthropomorphization. This line of research revealed that, although people exhibit social responses even towards devices that lowly resemble human beings (e.g., computers and chatbots, Nass et al., 1997), anthropomorphism is likely to be an effective trigger for mind attribution (e.g., Banks, 2020; Duffy, 2003; Ferrari et al., 2016; Ham et al., 2012; Krach et al., 2008; Rothstein et al., 2020; Waytz, Cacioppo, & Epley, 2010; Westerman et al., 2020). In this vein, prior studies demonstrated that people attribute a higher degree of mind (i.e., agency and experience) to social and human-based robots than to less anthropomorphic technologies, such as virtual assistants (e.g., Alexa and Siri; Jacobs et al., 2021). Furthermore, within the category of social robots, the process of mind attribution is affected by the level of the target's anthropomorphism. Indeed, people tend to ascribe greater mental faculties, in terms of both agency and experience, to highly anthropomorphic social robots than to their less anthropomorphic counterparts (e.g., Banks, 2020; Broadbent et al., 2013; Ferrari et al., 2016; Rothstein et al., 2020; Short et al., 2010). Moreover, neuroscience studies have shown that, during an interactive game with increasingly anthropomorphic technological entities (i.e., computer, functional robot, and anthropomorphic robot), the cortical activity involved in mind attribution increases as the level of anthropomorphism of the technological partner increases (Krach et al., 2008).

Considering, on the one hand, the relationship between mind attribution and moral status and, on the other hand, the tendency to perceive

social robots as mind-havers, social robots are likely to become target of moral concern and treatment. Research conducted on social robots implicated in moral actions (e.g., cheating or hurting behaviors) provided support for this assumption. Indeed, people attribute intentionality and agency to a robot performing an immoral behavior such as cheating (Haring et al., 2019; Short et al., 2010), and greater capacity to experience pain and emotional capacities to mistreated robots (Harris & Anthis, 2021; Küster & Swiderska, 2021; Kwat et al., 2013; Riek et al., 2009; Rosenthal-von der Pütten et al., 2013; Suzuki et al., 2015; Ward et al., 2013).

These studies highlight that social robots are included in our moral circles and open up the possibility that they might participate to moral dyads. However, to date, only a limited number of studies have addressed this possibility. For instance, Ward et al. (2013) investigate whether perceivers complete the moral dyad when exposed to intentional harm towards mindless targets (e.g., robot, corpse). They found that exposure to intentional harm inflicted to a robot leads to perceive the robot as a patient, with increased attribution of mind and pain experience. Extending this work, Tanibe et al. (2017) examined whether the dyad completion occurs even for morally good actions. The authors primed participants with the idea of being the agent (vs. the observer) of an interaction with a broken robot, and asked them to imagine to repair it. Their results revealed that participants who imagined helping the robot attributed greater capability of experiencing pleasure to the target. Thus, participants who perceived themselves as agents completed the moral dyad assigning the role of patient to the robot.

#### 4. The present research

The research literature suggests that people tend to apply social perception schemas and attribute a mind to social robots, especially when they present anthropomorphic characteristics (e.g., Broadbent et al., 2013; Ferrari et al., 2016; Ham et al., 2012; Jacobs et al., 2021; Short et al., 2010). Furthermore, this strand of literature revealed that, under certain conditions, social robots not only deserve moral consideration in the perceiver's eyes but they can also participate to moral dyads (e.g., Riek et al., 2009; Rosenthal-von der Pütten et al., 2013; Suzuki et al., 2015; Tanibe et al., 2017; Ward et al., 2013). Eliciting such social responses, social robots' anthropomorphism facilitates their integration in people's lives. However, what is still unknown is whether the adoption of social schemas in the perception of social robots, in turn, would affect the way people perceive and interact with other human beings. The present research aimed to explore this influence by experimentally investigating the possible social consequences of social robots' anthropomorphism. In particular, we tested whether the attribution of mind to anthropomorphic social robots affect social perception of human beings, in terms of empathy.

In line with the research literature on the humanizing effect of social robots' anthropomorphism, we expected that people would attribute agency (Hp1a) and experience (Hp1b) to a greater extent to highly anthropomorphic social robots than to lowly anthropomorphic ones.

Anthropomorphism encompasses not only social robots' appearance but also other aspects, such as behaviors emulating the key characteristics of the human beings. On this basis, we hypothesized that interacting verbally with social robots would affect mind attribution. In particular, we expected that participants who interacted (vs. did not interact) with social robots through a chatbot would attribute them a higher degree of both agency (Hp2a) and experience (Hp2b).

In light of the evidence that anthropomorphic social robots are awarded with mind, moral standing, and a role within moral dyads (e.g., Suzuki et al., 2015; Tanibe et al., 2017; Ward et al., 2013), we hypothesized that mind attribution to anthropomorphic social robots would, in turn, affect social perception of human beings. Considering that ascribing agency to human beings leads to attribute experience to a broken robot (Tanibe et al., 2017), we expected that anthropomorphization of social robot would affect the perception of social target too.

More specifically, we expected that the type of mind attributed to anthropomorphic social robot would influence the empathy towards a person in troubling situation (See Fig. 1). Thus, on the one hand, we hypothesized that the attribution of agency to anthropomorphic social robot (agent) would increase the empathy towards a person in a troubling situation (patient; Hp3a). Vice versa, the attribution of experience to anthropomorphic social robot (patient) would complementarily decrease the empathy towards a person in a troubling situation (agent; Hp3b).

The hypotheses were explored through an experimental study. The study was conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki and beforehand approved by the Local Ethic Committee.

## 5. The study

### 5.1. Design and participants

A 2 (Social Robot's Anthropomorphism: high vs. low) x 2 (Chatbot: yes vs. no) between participants experimental design was adopted. Adopting a snowball sampling technique, we recruited two hundred sixty-nine participants (80.5% female;  $M_{age} = 26.88$ ,  $SD_{age} = 7.85$ ; see Table 1 for a description of the sample's characteristics). A sensitivity power analysis showed that with our sample size we had the power to detect a small to medium-sized interaction effect ( $f = 0.17$ ) in a  $F$  test with  $\alpha = .05$  and power = .80 (Faul et al., 2007). By following Schoemann et al. (2017), we ran a second sensitivity power analysis for a simple mediation model (Model 4, Hayes, 2018) using the Monte Carlo power analysis approach for indirect effects. With our sample size and assuming weak correlations between the independent variables, the mediators, and the dependent variable ( $r = 0.25$ ) and 1000 resample, it was possible to detect a significant indirect effect with power at .92 and  $\alpha = 0.05$ .

### 5.2. Procedure and materials

Data collection was conducted online using the software Qualtrics (see the Appendix for the entire questionnaire). First, participants were informed about any relevant aspect of the study and their right to refuse to participate. After providing their consent to participate in the study, participants were randomly assigned to one of the four experimental conditions, obtained crossing the two independent variables, that were the social robot's anthropomorphism (high vs. low) and the interaction with the social robot through chatbot (yes vs. no; See Fig. 2 for the visual representation of the study procedure.).

Participants assigned to the experimental condition of interaction with the social robot through the chatbot were first directed to Chatfuel.com, an online software developed to build Facebook and Instagram chatbots. A chatbot is an artificial intelligence tool designed to simulate a natural-language chat conversation between human users and machines through messaging applications. We developed ad hoc chatbot for the experiment in which participants had to choose between two possible predefined messages to be sent to the social robot via chat, then, the chatbot automatically returned an appropriate predefined response). The chatbot was developed in such a way that regardless participants' choice between the two messages, the chatbot answered with a message of similar content. The interaction lasted few minutes, and then participants were redirected to the online questionnaire on Qualtrics. Participants assigned to the experimental condition of no interaction were directed to the online questionnaire directly.

Then, we manipulated the level of anthropomorphism of social robot's appearance. Thus, participants were presented with a picture of either a highly anthropomorphic (i.e., human-like) or a lowly anthropomorphic (i.e., object-like) social robot named Atlas, and asked to look carefully at it.

*Social Robot's Anthropomorphism Manipulation Check.* Participants

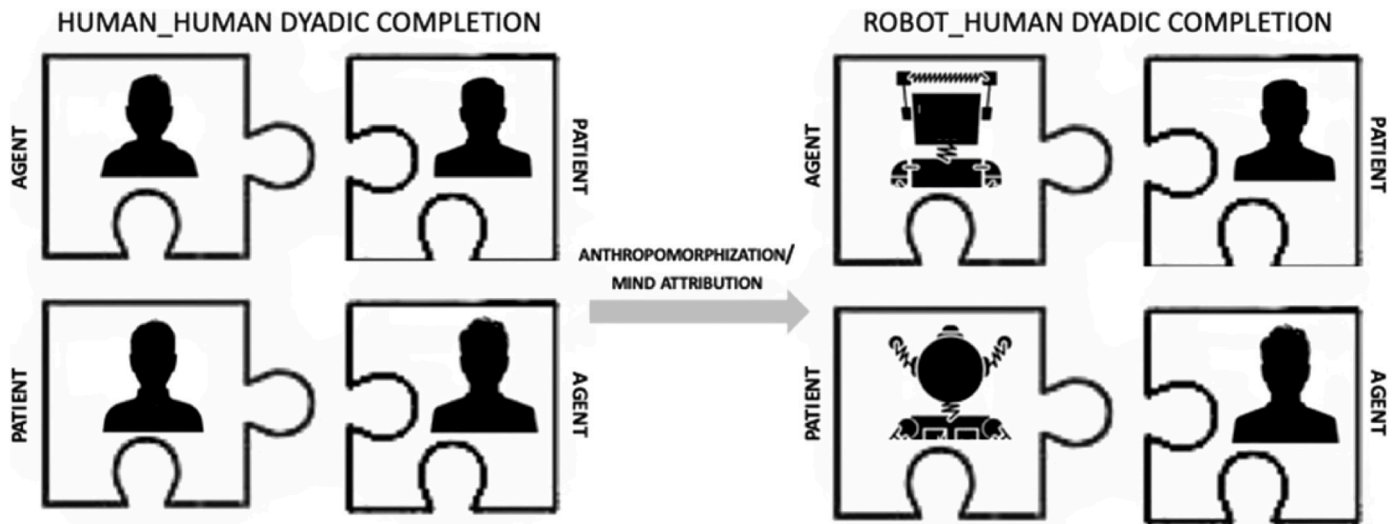


Fig. 1. The hypothesized dyadic completion between social robot and human being, elicited by the anthropomorphization (i.e., attribution of the two dimensions of mind) of the social robot.

Table 1 Sociodemographic characteristics of the sample.

		Frequency	Percentage
Age	Young Adults (18–39)	250	94%
	Middle Aged Adults (40–59)	13	3.8%
	Old Aged Adults (Over 60)	3	1.1%
	Missing	3	1.1%
Occupation	Student	173	64.3%
	Student worker	4	1.5%
	Worker	75	27.9%
	Unemployed	12	4.5%
	Retired people	2	0.7%
	Missing	3	1.1%
	Nationality	Italian	258
Foreign Nationality		7	2.6%
Dual Nationality		1	0.4%
Missing		3	1.1%

were asked to answer five items assessing the degree to which they perceived Atlas’s appearance as human-like (e.g., “Atlas resembles a human being”;  $\alpha = 0.89$ ).

**Mind Attribution.** The attribution of mental capabilities to Atlas were measured via ratings of thirteen capacities taken from previous studies (e.g., Gray et al., 2007). Six traits measured agency attribution (e.g., “Telling right from wrong and trying to do the right thing”,  $\alpha = 0.80$ ) and seven traits measured experience attribution (e.g., “Experiencing physical or emotional pleasure”,  $\alpha = 0.94$ ).

**Empathy towards Social Target.** Participants were presented with a picture of a man in severe trouble during a mountain climb and were instructed to imagine how he was feeling. Ten items were ad hoc developed and administered to capture participants’ empathy towards the portrayed man (e.g., “I feel sorry for the person in the picture”;  $\alpha = 0.77$ ).

All the variables were measured using 7-point scales ranging from 1 (= not at all) to 7 (= very much so).

Finally, participants provided their sociodemographic information (age, gender, nationality).

6. Results

A 2 (Social Robot’s Anthropomorphism: high vs. low) x 2 (Chatbot: yes vs. no) between participants ANOVA was conducted for each dependent variable (See Table 2 for the main effects and interactions

between independent variables; see Table 3 for Means and standard deviations of dependent measures as a function of independent variables; See Fig. 3 for distribution of scores for each dependent variable). We checked for potential effects of the participants’ age. A 2 (Social Robot’s Anthropomorphism: high vs. low) x 2 (Chatbot: yes vs. no) between participants ANCOVA was conducted for each dependent variable, including participants’ age as covariate. All research findings did not change with participants’ age as covariate (See Table 2). Moreover, to explore more directly a possible moderator role of participants’ age, the interaction effect between Anthropomorphism, Chatbot and Age on anthropomorphism (i.e., the manipulation check), the measures of mind attribution (i.e., agency and experience) and empathy was explored through regression models (PROCESS, Model 3). The models did not yield a three-way interaction effect on any variables ( $ps > .23$ ). Next, to investigate possible gender differences, a series of 2 (Social Robot’s Anthropomorphism: high vs. low) x 2 (Chatbot: yes vs. no) x 2 (participants’ gender: male vs. female) between-participants ANOVAs was computed on the dependent variables. The analyses did not reveal any significant interaction effect involving participants’ gender ( $Fs < 1.81$ ;  $ps > .18$ ). Given that the interaction between participants’ gender and the independent variables did not emerge on any of the dependent variables, this variable was omitted from any further analyses.

**Manipulation Check of Social Robot’s Anthropomorphism.** The ANOVA showed that our manipulation of social robot appearance’s anthropomorphism was successful, with the social robot with high level of anthropomorphism perceived as more human-like than the social robot with low level of anthropomorphism. Neither the main effect of chatbot nor the two-way interaction between the independent variables emerged as significant.

**Mind Attribution.** As expected (Hp1a), the ANOVA on the agency attribution revealed a significant effect of social robot’s anthropomorphism: participants attributed more agency traits to highly anthropomorphic social robot than to lowly anthropomorphic social robot. In line with our prediction (Hp2a), the chatbot effect emerged to be significant, with participants who communicated with the social robot assigning greater agency to the target than those who did not. The interaction between the two independent variables was non-significant.

In line with our hypothesis (Hp1b), the analysis showed a significant effect of social robot’s anthropomorphism on attribution of experience traits. In particular, the highly anthropomorphic social robot was perceived as higher in experience dimension than the lowly anthropomorphic social robot. In contrast with our expectation (Hp2b), communicating with the social robot through chatbot did not affect

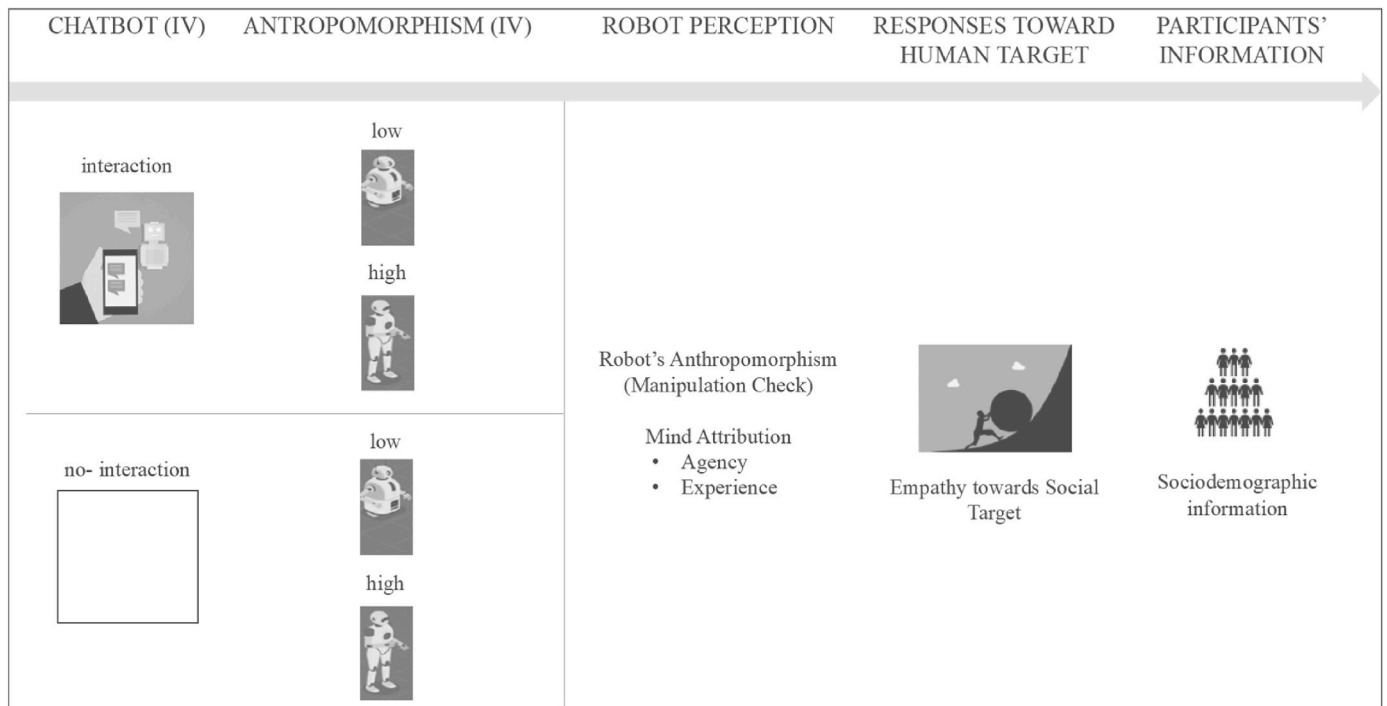


Fig. 2. Visual representation of the study procedure.

Table 2

Summary of effects of Social Robot's Anthropomorphism, Chatbot, and their interaction in the 2\*2 ANOVA (top of the Table) and in the 2\*2 ANCOVA (bottom of the Table) analyses.

		Manipulation Check of Anthropomorphism	Mind Attribution Agency	Mind Attribution Experience	Empathy towards Social Target
ANOVA	<b>Social Robot's Anthropomorphism</b>	$F(1,264) = 833.60, p < .001, \eta_p^2 = .759$	$F(1,265) = 9.20, p = .003, \eta_p^2 = .034$	$F(1,265) = 30.64, p < .001, \eta_p^2 = .104$	$F(1,265) = 5.62, p = .018, \eta_p^2 = .021$
	<b>Chatbot</b>	$F(1,264) = .26, p = .611, \eta_p^2 = .001$	$F(1,265) = 7.13, p = .008, \eta_p^2 = .026$	$F(1,264) = .39, p = .531, \eta_p^2 = .001$	$F(1,265) = 13.61, p < .001, \eta_p^2 = .049$
	<b>Social Robot's Anthropomorphism * Chatbot</b>	$F(1,264) = 1.17, p = .280, \eta_p^2 = .004$	$F(1,265) = .00, p = .983, \eta_p^2 = .00$	$F(1,264) = .35, p = .554, \eta_p^2 = .001$	$F(1,265) = .44, p = .510, \eta_p^2 = .002$
ANCOVA	<b>Social Robot's Anthropomorphism</b>	$F(1,260) = 818.19, p < .001, \eta_p^2 = .759$	$F(1,261) = 9.47, p = .002, \eta_p^2 = .035$	$F(1,261) = 31.79, p < .001, \eta_p^2 = .109$	$F(1,261) = 6.25, p = .013, \eta_p^2 = .023$
	<b>Chatbot</b>	$F(1,260) = .38, p = .536, \eta_p^2 = .001$	$F(1,261) = 6.37, p = .012, \eta_p^2 = .024$	$F(1,261) = .31, p = .578, \eta_p^2 = .001$	$F(1,261) = 10.31, p = .001, \eta_p^2 = .038$
	<b>Social Robot's Anthropomorphism * Chatbot</b>	$F(1,260) = .05, p = .307, \eta_p^2 = .004$	$F(1,261) = .00, p = .989, \eta_p^2 = .00$	$F(1,261) = .40, p = .529, \eta_p^2 = .002$	$F(1,261) = .34, p = .558, \eta_p^2 = .001$
	<b>Participants' Age</b>	$F(1,260) = .87, p = .353, \eta_p^2 = .003$	$F(1,261) = .32, p = .574, \eta_p^2 = .001$	$F(1,261) = .01, p = .907, \eta_p^2 = .000$	$F(1,261) = 5.83, p = .016, \eta_p^2 = .022$

perception of experience. The analysis did not yield two-way interaction between the independent variables.

**Empathy towards Social Target.** The ANOVA revealed that the empathy towards the social target was significantly affected by social robot's anthropomorphism, with participants expressing higher empathy towards human being when exposed to a lowly anthropomorphic social robot, than to a highly anthropomorphic social robot. The variable chatbot emerged to be significant. Therefore, participant who communicated with the social robot reported greater empathy towards the human being as compared to participants who did not. Finally, the interaction effect between the two independent variables did not reach the significance.

Mediation analyses

Finally, we tested our hypotheses about the effect of the mind

attribution to the social robot on empathy towards a person in troubling situation (Hp3a and Hp3b). We conducted mediation analyses using the PROCESS macro (Model 4) for SPSS with 1000 bootstrapping resamples (Hayes, 2018). In the first model, the social robot's anthropomorphism was entered as predictor (0 = low; 1 = high), attribution of agency and experience as two parallel mediators, and empathy towards the social target as the dependent variable (See Fig. 4). As shown by the ANOVAs, the social robot's anthropomorphism significantly and positively affected the attribution of mind in terms of both agency,  $b = 0.50, SE = 0.16, t = 3.23, p = .001, 95\% CI [0.20 to 0.81]$  and experience,  $b = 0.77, SE = 0.14, t = 5.59, p < .001, 95\% CI [0.50 to 1.04]$ . The overall equation was significant,  $R^2 = 0.06, F(3, 265) = 5.38, p = .001$ . The model revealed that the attribution of both agency,  $b = 0.16, SE = 0.05, t = 3.05, p = .003, 95\% CI [0.06 to 0.26]$ , and experience,  $b = -0.17, SE = 0.06, t = -2.91, p = .004, 95\% CI [-0.29 to -0.06]$ , significantly affected the empathy towards the social target. The direct effect of social

**Table 3**  
Means and standard deviations of dependent measures as a function of Social Robot's Anthropomorphism and Chatbot.

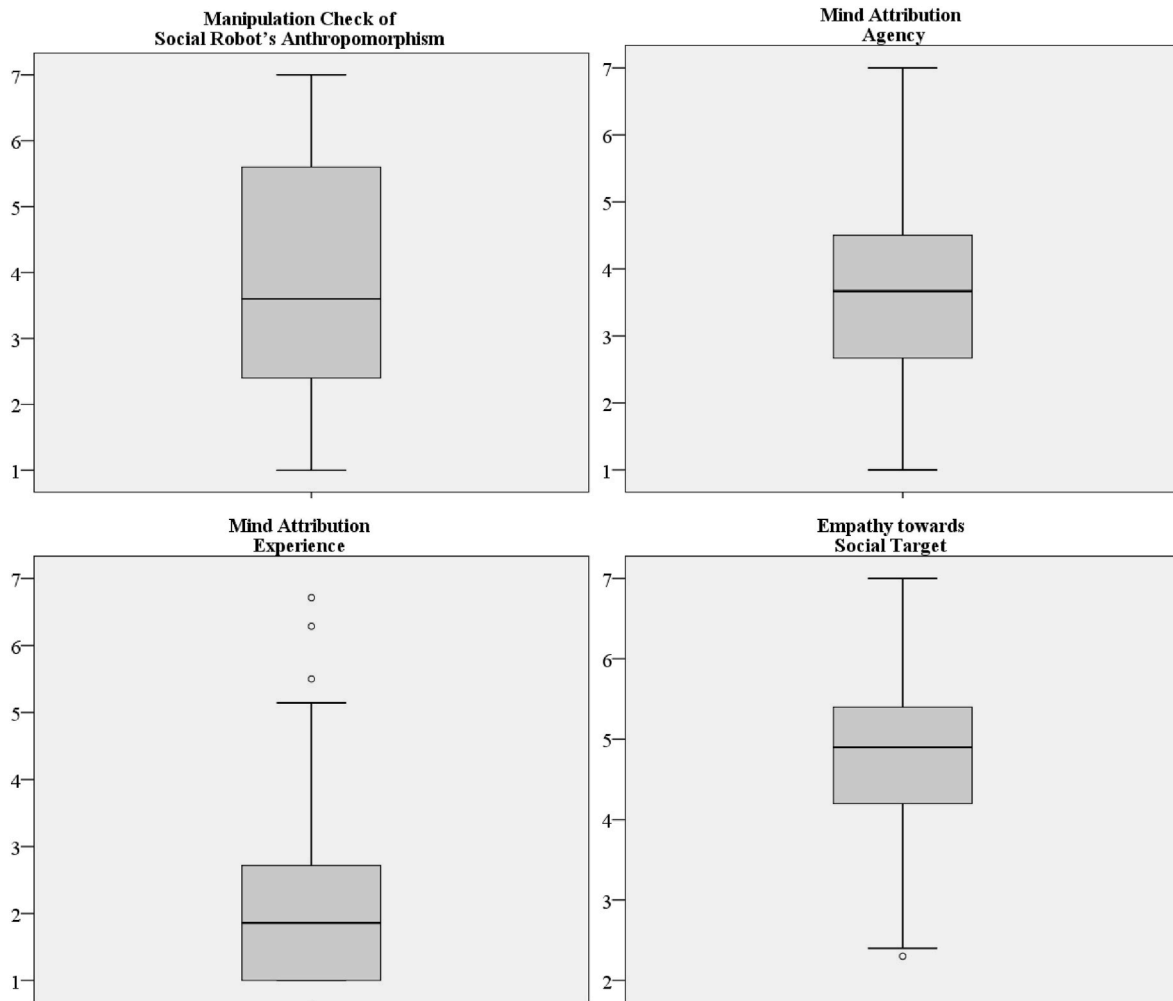
Outcome	Social Robot's Anthropomorphism		
	High	Low	Combined
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
<b>Manipulation Check of Anthropomorphism</b>			
Chatbot	5.42 (.99)	2.41 (.81)	3.99 (1.76)
No Chatbot	5.60 (.88)	2.34 (.84)	3.78 (1.83)
Combined	5.50 (.94)	2.37 (.82)	3.89 (1.79)
<b>Mind Attribution Agency</b>			
Chatbot	4.03 (1.18)	3.55 (1.29)	3.80 (1.25)
No Chatbot	3.61 (1.38)	3.14 (1.25)	3.35 (1.32)
Combined	3.84 (1.28)	3.34 (1.28)	3.59 (1.30)
<b>Mind Attribution Experience</b>			
Chatbot	2.48 (1.23)	1.80 (1.04)	2.16 (1.19)
No Chatbot	2.48 (1.33)	1.63 (.90)	2.01 (1.19)
Combined	2.48 (1.27)	1.71 (.97)	2.09 (1.19)
<b>Empathy towards Social Target</b>			
Chatbot	4.95 (.98)	5.15 (.88)	5.04 (.94)
No Chatbot	4.45 (.87)	4.80 (.99)	4.64 (.95)
Combined	4.73 (.96)	4.97 (.95)	4.85 (.96)

robot's anthropomorphism was non-significant,  $b = -0.18$ ,  $SE = 0.12$ ,  $t = 1.51$ ,  $p = .133$ , 95% CI [-0.42 to 0.06]. The bootstrapping procedure revealed that both agency,  $b = 0.08$   $SE = 0.04$ , 95% CI [0.02 to 0.18], and experience,  $b = -0.13$ ,  $SE = 0.05$ , 95% CI [-0.25 to -0.04] significantly and fully mediated the relationship between

anthropomorphism and empathy towards social target.

In the second model, the chatbot was entered as predictor (0 = no; 1 = yes), attribution of agency and experience as parallel mediators, and empathy towards the social target as the dependent variable (See Fig. 5). In line with prior analyses (i.e., ANOVA), the chatbot manipulation significantly predicted the attribution of agency,  $b = 0.46$ ,  $SE = 0.16$ ,  $t = 2.88$ ,  $p = .004$ , 95% CI [0.14 to 0.76], but not of experience,  $b = 0.15$ ,  $SE = 0.14$ ,  $t = 1.04$ ,  $p = .301$ , 95% CI [-0.14 to 0.44]. Both agency,  $b = 0.13$ ,  $SE = 0.05$ ,  $t = 2.47$ ,  $p = .014$ , 95% CI [0.03 to 0.23]. The overall equation was significant,  $R^2 = 0.09$ ,  $F(3, 265) = 8.23$ ,  $p < .001$ . Experience,  $b = -0.19$ ,  $SE = 0.06$ ,  $t = -3.39$ ,  $p = .001$ , 95% CI [-0.30 to -0.08], predicted the empathy toward social target. The direct effect of the manipulation of chatbot on empathy was still significant,  $b = 0.37$ ,  $SE = 0.12$ ,  $t = 3.22$ ,  $p = .001$ , 95% CI [0.14 to 0.50], indicating a partial mediation. In particular, the analysis provided support for the mediating role of agency,  $b = 0.06$   $SE = 0.03$ , 95% CI [0.01 to 0.15], but not of experience,  $b = -0.03$   $SE = 0.03$ , 95% CI [-0.10 to 0.02].

Thus, the attribution of mind dimensions to the humanized robot affects the responses towards the human being in two opposite directions. In line with the expectations, whereas the greater attribution of agency to anthropomorphic social robot (both anthropomorphic appearance and interaction through chatbot) increased empathy towards human being (Hp3a), the greater attribution of experience to highly anthropomorphic social robot (anthropomorphic appearance only) decreased empathy towards human being (Hp3b).



**Fig. 3.** Distribution of scores to each dependent variable.

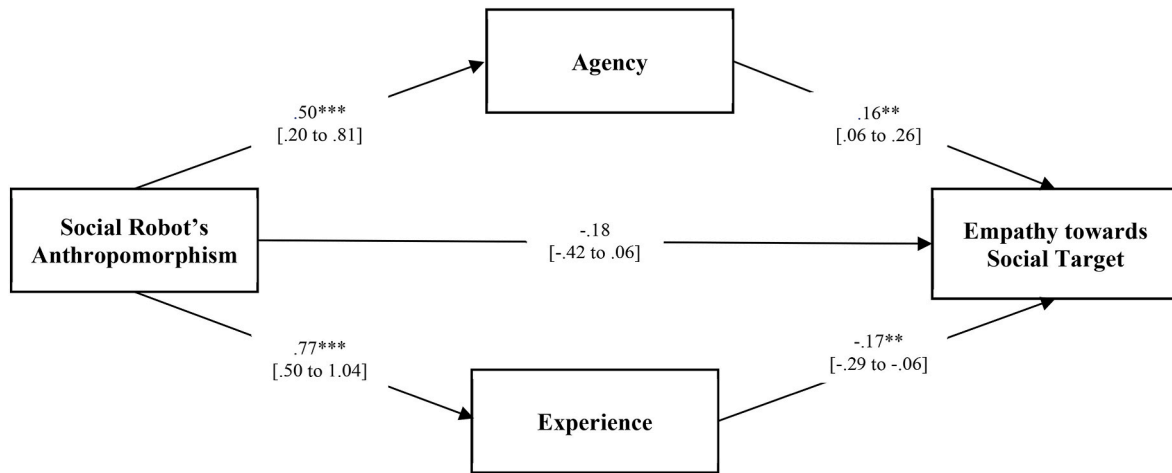


Fig. 4. The effect of the Social Robot's Anthropomorphism on the Empathy towards Social Target through the attribution of Agency and Experience to the Social Robot (PROCESS Model number 4).

\* $p < .05$ , \*\* $p < .005$ , \*\*\* $p < .001$

Social Robot's Anthropomorphism was coded: 0 = low, 1 = high.

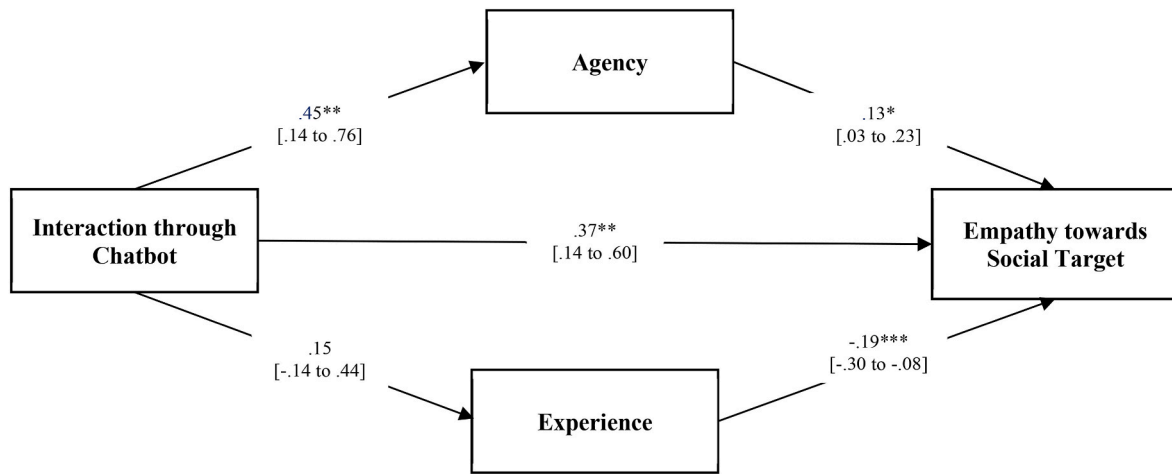


Fig. 5. The effect of the Interaction through Chatbot on the Empathy towards Social Target through the attribution of Agency and Experience to the Social Robot (PROCESS Model number 4).

\* $p < .05$ , \*\* $p < .005$ , \*\*\* $p < .001$

Interaction through Chatbot was coded: 0 = no, 1 = yes.

### 8. Discussion

Research on Human-Technology Interactions revealed that, under certain conditions, people instinctively perceive and interact with social robots in ways comparable to Human-Human Interactions. In this regard, research literature demonstrated that social robots activate traditional processes of social perception and are anthropomorphized through the attribution of mind (e.g., Banks, 2020; Ferrari et al., 2016; Jacobs et al., 2021; Rothstein et al., 2020; Short et al., 2010; Waytz et al., 2010; Westerman et al., 2020).

Furthermore, social robots are included in our moral circle, recognized as deserving of moral consideration, and awarded with a role within the moral dyad (e.g., Riek et al., 2009; Rosenthal-von der Pütten et al., 2013; Tanibe et al., 2017; Ward et al., 2013). The anthropomorphization of social robots facilitates Human-Technology Interactions, but, on the other side, it can also have an impact on Human-Human Interactions. However, this aspect has not been explored yet. In the present research, we have built on this paucity by experimentally investigating whether the anthropomorphization of social robots can affect social perception of human beings.

In particular, we looked at whether the anthropomorphization of social robots activates the dyadic completion, and, thus, influences the empathy towards social target complementary. Confirming our expectations, our main findings showed that the attribution of the two mind dimensions to the anthropomorphic social robot affects the responses towards the human being in two opposite directions. In particular, whereas the greater attribution of agency to anthropomorphic social robot (agent) affected the empathy towards human being (patient) positively, the greater attribution of experience to highly anthropomorphic social robot (patient) affected the empathy towards human being (agent) negatively.

Our results, thus, indicated that the anthropomorphization of social robots influences not only the Human-Technology Interactions, but also the Human-Human Interactions. Research literature demonstrated that the bi-dimensional structure of mind determines the automatic creation of dyads. Accordingly, when a person is awarded with the position of the moral agent (or patient), the second person is awarded with the complementary position of moral patient (or agent; Gray & Wegner, 2009). Furthermore, this happens even when no dyad exists and outside the moral domain (Gray et al., 2011, 2012; Gray & Wegner, 2009). Our

results are aligned with and extends this literature, by providing first evidence that the anthropomorphization of social robot activates the completion of phantom dyad, affecting the social perception of human beings.

Even though people attribute mind and human qualities to technological devices that lowly resemble human beings, anthropomorphism of social robots is likely to be an effective trigger for mind attribution (e.g., Ferrari et al., 2016; Jacobs et al., 2021; Short et al., 2010). In line with this literature, in the present study we induced anthropomorphization of social robots by manipulating the level of anthropomorphism of their appearance and behavior. In line with our expectation, the analyses revealed that the manipulation was effective, and that highly anthropomorphic social robots are attributed greater agency (both anthropomorphic appearance and interaction through chatbot) and experience (anthropomorphic appearance only).

Overall, our study extends the research literature on anthropomorphization of social robots in a novelty manner by providing first evidence that attributing a mind to anthropomorphic social robots generates social consequences by affecting complementary how people perceive other human beings. However, there are also some limitations to the present study. First, although we provided first evidence on the dyadic completion involving social robots and human beings as targets, our results are based on the empathy towards human beings, rather than on the attribution of mind to human beings. Despite empathy could be considered an indicator of mind attribution, especially of experience dimension, future studies should overcome such a limitation by measuring the attribution of agency and experience qualities to human beings. Second, our results suggest that the mind attribution evoked by social robots' anthropomorphism is sufficient to activate a dyadic structure in social perception processes. Our study supported the hypothesis of dyadic completion in a non-moral situation characterized by two targets – the social robot and the human being – that were not presented in the same situation but one at a time in unrelated manner. Our results are aligned with research demonstrating that dyadic structure of mind perception is applied even in non-moral context and even when no moral dyad exists (Gray et al., 2011, 2012; Gray & Wegner, 2009). However, future research should be conducted to test such a dyadic completion in moral relevant domains and in situation in which the two targets interact one with each other.

Furthermore, in our study the experimental materials consisted of pictures and a chatbot. At the light of the fact that most people have no direct experience with social robots yet, future studies should improve ecological validity of our study by, for instance, the use of virtual reality to expose people to interaction with social robots.

Finally, three methodological point need to be acknowledged. First, we adopted an experimental approach which increases internal validity and allows causal inferences through participants' random assignment to experimental conditions (Kam et al., 2007). However, experimental procedures do not grant generalizability to the entire population in every situation. Thus, further research is needed to explore boundary conditions for the effects described in the paper (i.e., the moderation of individual and contextual variables). Second, we collected data through a snowball sampling technique by spreading the link to the experiment online. This sampling strategy is widely adopted thanks to the easiness with which it allows to reach sufficient sample size quickly. However, it has some limitations, such as resulting in an unbalanced non-representative sample (Thornton et al., 2016). For instance, in our research, the sample was unbalance in term of participants' gender. However, it was more variegated according to others characteristics such as age and occupational status.

Finally, our results should be interpreted with caution given we conducted only one single experimental study. At the light of these limitations, future research is needed to test the robustness of our results, even adopting different methods (e.g., surveys) and recruitment strategies able to guarantee larger sample with different characteristics or more representative samples. In particular, future studies could

explore the moderation effect of the individual differences that play a role in anthropomorphism (Waytz, Cacioppo, & Epley, 2010).

Nowadays, only a small percentage of people has a direct experience with human-like robots (e.g., engineers; robotics developers). Thus, it is difficult – if not impossible – to explore the effect of individual variables such as expertise and familiarity with anthropomorphic machine in a naturalistic setting. Given this limitation, a follow-up study with a larger sample might explore the role of some proximal individual variables, such as knowledge and familiarity with technology in general, that are likely to reduce *effort motivation* and, thus, anthropomorphization (Epley et al., 2007). At the same time, the rapid development and the spreading of these new technologies might allow in the next future the analysis of the phenomenon outside the lab, in an everyday-life context. In this vein, the present study represents only a first preliminary step and pioneering attempt to shed light on an unexplored process, namely the impact of Human-Technology Interactions on Human-Human perception, that required empirical investigation.

## 9. Conclusions

Given its implication in social robots' acceptance, the anthropomorphizing effects of the anthropomorphism has been investigated widely. However, much less is known about the social consequences of adoption of social schemas with anthropomorphic social robots. Our result indicates that adopting social schemas with social robot is not a neutral process, but, rather, it affects the way we perceive other human beings subsequently. We provided first evidence that, consistently with the dyadic completion phenomenon, the type of mind attributed to anthropomorphic social robot, then, complementary influences the empathy towards a person in trouble. In particular, attributing agency to an anthropomorphic social robot (in terms of appearance and behaviors) increases empathy towards a person in trouble, while attributing experience to an anthropomorphic robot (in term of appearance only) decreases it. Beyond the relevance for academic field, our results have important practical implications. Indeed, although anthropomorphism is an advantage for Human-Technology Interactions, its possible consequent effect of how we perceive human beings cannot be neglected. The dyadic completion between social robots and human being is of great relevance given that the position a target occupies within the dyad affects moral cognition and treatment. This cannot be ignored considering that social robots will become more and more common in a range of morally-relevant domains, such as care of older people, education, and security.

## Credit author statement

S. Sacchi and F. Spaccatini conceived the research idea. S. Sacchi and G. Corlito ran the study. S. Sacchi conducted the data analysis. F. Spaccatini wrote the paper, the other authors read and commented on it. All authors revised and approved the final version of the paper.

## Declaration of competing interest

No potential conflict of interest was reported by the authors.

## Data availability

Data will be made available on request.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.chb.2023.107821>.

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