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Humanization of robots: Is it really such a good idea?

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Abstract

The aim of this review was to examine the pros and cons of humanizing social robots following a psychological perspective. As such, we had six goals. First, we defined what social robots are. Second, we clarified the meaning of humanizing social robots. Third, we presented the theoretical backgrounds for promoting humanization. Fourth, we conducted a review of empirical results of the positive effects and the negative effects of humanization on human–robot interaction (HRI). Fifth, we presented some of the political and ethical problems raised by the humanization of social robots. Lastly, we discussed the overall effects of the humanization of robots in HRI and suggested new avenues of research and development.

KEYWORDS

belief in human nature uniqueness, humanization, social agents, social robot, threat distinction hypothesis, uncanny valley

1 | INTRODUCTION

Imagine listening to the morning news and discovering that a man was arrested after attacking a robot. Although peculiar, The Japan Time News (2015) reported this incident in 2015, indicating that the man was arrested and charged with damaging property, but not with assaulting the robot. According to the police report, the man upset by one of the store employee behavior decided to express his frustrations by kicking Pepper, Softbank's humanoid robot. Ironically, Pepper's strongest selling point was the ability to detect human emotional states and react accordingly.

Robots, such as Pepper, belong to a class of robots designed to engage people at an interpersonal and socioaffective level (Breazeal, Takanishi, & Kobayashi, 2008), and are called social robots (see Fong, Nourbakhsh, & Dautenhahn, 2003 for a discussion of the concept of social robot). Over the last 20 years, social robots have become increasingly humanlike, not only in physical appearance, but also in the display of human psychological, affective, and behavioral features (e.g., language, emotions, and personality). A key assumption for developers is that humanlike social robots will improve human–robot interaction (HRI) and facilitate their acceptance.

However, anecdotes like Pepper's misfortune remind us of the complexity of building robots that interact naturally with humans. The present paper will examine the challenges posed by the humanization of social robots by following the viewpoint offered by current knowledge in psychological science. Furthermore, the paper will review the benefits and drawbacks of humanizing the appearance and behavior of social robots while also offering comments on the social and ethical implications of the same.

2 | HUMANIZING SOCIAL ROBOTS

By humanization of social robots, we mean the effort to make robots that more closely mimic human appearance and behavior, including the display of humanlike cognitive and emotional states. This can be performed through the implementation of social (e.g., language, nonverbal behavior, personality, emotions, and empathy), ethical (e.g., moral, values), and spiritual competences (e.g., religion, culture, and tradition) (Hashim & Yussof, 2017). The humanlike appearance of robots does not only refer to bipedality

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but to other physical characteristics such as gender (i.e., implementation of male and female phenotypic attributes) and race (e.g., appearance of Caucasian, Asian) (e.g., Bina48, Geminoid F, Sofia, and Geminoid DK).

The use of the term "humanization" avoids the often-made confusion between an anthropomorphic form (a nonliving object that reflects human-like physical qualities; see Disalvo & Gemperle, 2003) and anthropomorphism (the process by which humans attribute human thoughts, intentions, and emotions to animals, objects or artifacts; see Epley, Waytz, & Cacioppo, 2007). Thus, whereas an anthropomorphic form is the product of design, anthropomorphism is the product of a cognitive process.

Research and projects devoted to the humanization of social robots have followed two approaches. The bottom-up approach to achieve a believable agent, irrespective of its appearance, relies on implementing a combination of elements of the human body (e.g., eyebrows, lips, chin, hands, and limbs) and microbehaviors (e.g., eye gaze, tone of voice, facial expressions, and gestures) that are thought to be important for social interactions and communication (e.g., Probo, Kismet, and MDS). In the top-down approach, the purpose is to produce an autonomous replica of a human (e.g., Repliée Q2 and Actroid DER). This latter approach is more human-centric. Indeed, for the top-down approach replicating human interaction is the end in itself, whereas for the bottom-up approach is a way to improve HRI.

3 | THEORETICAL BASES FOR THE HUMANIZATION OF ROBOTS

The human ability to attribute intention and infer causality is well described in the scientific literature. From Heider and Simmel (1944) showing that people build "personality models" to explain nonlinear movements of geometric figures on a screen, to the knowledge that people mindlessly apply social norms to their interaction with computers (Nass & Moon, 2000; Nass, Steuer, & Tauber, 1994), examples of the attribution of human-like minds are plentiful. The ability to acknowledge that others have the capacity to understand, infer and attribute affect, motives and goals, just like we do, is termed theory of mind (ToM; Carruthers & Smith, 1996). The capacity to attribute a mind to others is considered central to human functioning, since it paves the way for the possibility of a common ground for interaction.

Human preferences for anthropocentric interactions are frequently presented as the reason underlying the humanization of robots (e.g., Duffy, 2006), that is, if people mindlessly apply human–human interaction rules to interactions with nonhuman beings and objects, then humanizing robots will result in more natural and efficient HRIs.

In this section we offer a brief presentation of some of the sociocognitive processes that contribute to the humanization of robots.

3.1 | Inferring agency from biological motion

People can infer qualities and attribute intentions based on minimal information. Research on the recognition of biological motion shows that people can recognize gender, personality traits, emotions, and even complex actions such as dancing (Blackemore & Decety, 2001) just by watching a film of an actor with lights attached to the main joints of the body while moving in a dark environment. As such, it is not surprising that research with robotic appliances like the Roomba, the vacuum cleaning robot, has found that users describing its random movements as gentle or clumsy and attributing the Roomba a sort of proto-personality (e.g., Fink, Bauwens, Kaplan, & Dillenbourg, 2013; Forlizzi, 2007).

Watching others' behavior was also found to facilitate (motor resonance) or disturb (motor interference) the observer's own actions (Brass, Bekkering, & Prinz, 2001; Jeannerod, 2001). Thus, motor resonance plays a major role in understanding others' actions and performing joint activities. A study comparing the effects of different types of movement (biological vs. mechanical) and agent type (industrial robot, humanoid robot, or another human) found that the brain processes biological and nonbiological movements differently. Concerning the effect of observed agent type, the study found that the humanoid robot produced motor interference. However, when the industrial robot arm closely reproduced the speed of a biological motion it produced motor interference (Kupferberg et al., 2011). In short, given people's ability to identify personal qualities and intentions from minimum movement cues, it is crucial to consider not only a robots' physical appearance, but also how it will move and interact with human partners. Li and Chignell (2011) provided an example of a robot which successfully used head and arm movements to convey emotional states.

3.2 | First impressions and the anthropomorphic form

First impressions based on physical appearance have been shown to play an important role in social interactions leading to the attribution of such diverse traits as attractiveness, trustworthiness, competence, and aggressiveness, based only on a 100 ms exposure to a face (Willis & Todorov, 2006). When designers attempt to humanize robots through physical cues, they should be aware that their creations will be subjected to these quick evaluations. Research has shown that people not only make inferences about a robots' intelligence, competence, warmth, or friendliness, based on design options like face traits (e.g., DiSalvo, Gemperle, Forlizzi, & Kiesler, 2002), height (e.g., Walters, Koay, Syrdal, Dautenhahn, & Te Boekhorst, 2009), gender (e.g., Powers et al., 2005), or speech and facial expressions (e.g., Oliveira et al., 2018), but also make decisions about what jobs a robot should perform based on a robots' appearance (e.g., Katz & Halpern, 2014; Nomura et al., 2008). Since first impressions can influence expectations and motivations for interaction, anthropomorphic robots should be designed to reduce possible expectation gaps (Komatsu, Kurosawa, & Yamada, 2012).

3.3 | Psychological account of anthropomorphism

When reasoning about nonhuman agents (i.e., anything that acts with apparent independence, such as animals, natural forces, or electronic devices), people draw inferences based not only on the agent's actual behavior, but also on homocentric knowledge (i.e., self-knowledge and knowledge about other humans) accessible at the time of judgment. According to the three-factor theory of anthropomorphism (Epley et al., 2007, p. 864), "imbuing the imagined or real behavior of nonhuman agents with humanlike characteristics, motivations, intentions, and emotions is the essence of anthropomorphism". However, the authors view this process as a case of inductive inference rather than a categorical mistake or a sign of immature intellect. The inductive inference process can be decomposed in three parts: (a) activation of knowledge about humans when making inferences about nonhumans, (b) correction and adjustment of anthropomorphic representations with knowledge about nonhuman agents, and (c) application of these anthropomorphic representations to nonhuman agents. Thus, applicable and/or accessible homocentric knowledge would be the starting point for reasoning; and if the person has the resources and motivation, they would then correct their reasoning with further knowledge.

The model posits three determinants of anthropomorphism: elicited agent knowledge (cognitive element), effectance, and sociality (motivational elements). Elicited agent knowledge comprises a person's experience about their selves and their world. Effectance motivation is the need to interact, explain, and predict the surrounding world to reduce uncertainty. Sociality motivation is the need to connect with other humans. It operates through an increase in the accessibility of social cues (human characteristics and traits), and the increase in the search for sources of social connection. These psychological determinants can be influenced by dispositional, situational, developmental, and cultural variables.

In short, although psychological anthropomorphism will follow a developmental path along the life cycle, some individuals will show a greater tendency to attribute human motives to nonhuman animals and objects. Cultural differences in the definition of what it is to be a human, an animal or an inanimate object also play part in the process. Of specific interest for the design of social robots is the fact that the perceived similarity of the target (e.g., similar motion, similar morphology), induces people to base their reasoning more on egocentric knowledge. Finally, it is important to note that the attribution of a "mind" (i.e., human mental states, like emotions, wishes, or desires) to a nonhuman agent can entail the attribution of moral worth (Waytz, Cacioppo, & Epley, 2010), and trustworthiness (Waytz, Heafner, & Epley, 2014).

3.4 | The computers are social actors paradigm

The computers are social actors (CASA) paradigm follows from the observation that people mindlessly apply social norms in their interaction with computers (Nass et al., 1994; Nass & Moon, 2000). That is, given an object with a sufficient set of cues (e.g., language, interactivity, a traditionally human role), people tend to mindlessly apply social rules (e.g., reciprocity and politeness), social categories (e.g., gender stereotypes), and infer personalities. Nass and Moon (2000) underlined the mindlessness aspect, pointing that none of the participants in their studies considered that the computer was in any way endowed with human qualities, or that it should be treated as human being. Thus, the authors distinguish this automatic response from anthropomorphism (i.e., the attribution of humanlike characteristics, motivations and intentions to nonhuman animals or objects). The idea that a small set of cues can automatically and unconsciously elicit human–human interaction social scripts has been very influential, for both human–computer interaction and HRI research, and paved the way for the current interest in humanizing both virtual and physical robotic agents.

In the next two sections will review empirical findings of the positive effects and the negative effects of humanization on HRI and Table 1 summarizes both potential effects of humanizing robots.

4 | POSITIVE EFFECTS OF HUMANIZATION FOR HRI

The humanization of robots, or the representation of (parts) robots as humans, can have several positive effects, contributing to the successful adoption of robots by our society (Paiva, Mascarenhas, Petisca, Correia, & Alves-Oliveira, 2018; Robert, 2017). Many scholars working with robots aim to create an autonomous human-like robot capable of mimicking human behaviors and emotions (Admoni & Scassellati, 2017; Breazeal & Scassellati, 2002; Fong et al., 2003; Goodrich & Schultz, 2008; Mavridis, 2015; Oliveira et al., 2018; Wiese, Metta, & Wykowska, 2017).

TABLE 1 Taxonomy for negative and positive aspects of humanizing social robots

Humanization type	Positive aspects	Negative aspects
Psychological	• Interaction engagement • Wellbeing benefits • Educational benefits • Increased motivation • Higher perceived support • Increased social connection	• Overtrust and unrealistic perceptions of a robots' autonomy and capabilities • Attachment issues • Existential threat
Physical	• Increased social interaction • Higher perceived assistance • Higher proximity	• Feelings of eeriness or discomfort
Functional	• Economic gains • Frees humans from dull tasks • Frees humans from dangerous tasks • Increased precision (e.g., health), and reaching places otherwise inaccessible (e.g., deep sea; space, disaster exploration)	• Unemployment • Requires human supervision • Creates demands for the acquisition of new skills (e.g., doctors who work with surgical robots need to know how to operate the robots).

4.1 | Humanizing robots for psychological understanding within an interaction between humans and robots

One of the most prominent positive effects of humanizing robots is to establish mutual psychological understanding within an interaction between humans and robots (Sciutti, Mara, Tagliasco, & Sandini, 2018). This can be achieved by programming social robots with some key-ingredients in their design, such as the notion of "being there," being human-aware, and being understood (Breazeal, 2004). Thus, robots that resemble humans may create familiarity in order to grounding interactions in already established human skills and social norms (Schmitz, 2011) and may thus facilitate HRI. To support the engagement of humans in long-term interactions with robots, certain design considerations must be taken into account for robots, such as their continual and incremental behaviors (e.g., using strategic behaviors of recalling previous activities); mimicking affective interactions and empathy (e.g., capturing the user's affective state, reacting accordingly, displaying contextualized affective reactions); using memory (e.g., identifying new and repeated users, storing and remembering past interactions appropriately); and adaptation (e.g., using information about users to personalize the interaction—Leite, Martinho, & Paiva, 2013; Paiva, Leite, & Ribeiro, 2014).

Several benefits have been reported regarding the programming of social robots that mimic intrinsic human abilities, many of which have been used in applied areas for healthcare and therapy (e.g., Broadbent, Stafford, & MacDonald, 2009; Cabibihan, Javed, Ang, & Aljunied, 2013), education (e.g., Belpaeme, Kennedy, Ramachandran, Scassellati, & Tanaka, 2018; Mubin, Stevens, Shahid, Al Mahmud, & Dong, 2013; Toh et al., 2016), and entertainment (e.g., Fujita, Kitano, & Doi, 2000).

In healthcare, the use of robots has been associated with several benefits such as decreasing anxiety in hospitalized children. The decrease in anxiety can also leads to distraction, a decrease in stress of pain experience, relaxation, and engagement in therapy. Furthermore, patients are reported to be more open to communication (Moerman, van der Heide, & Heerink, 2018). A survey about the benefit of social robots to assist children with autism showed promising positive results, such as helping children with their social, emotional, and communication deficits (Cabibihan et al., 2013). Other positive findings have been found in assisting older adults, such as helping them in manage medication regimes, decreasing their perceived loneliness, in addition to increasing psychological wellbeing, social connection and communication with others, among others (Bemelmans, Gelderblom, Jonker, & De Witte, 2012; Broekens, Heerink, & Rosendal, 2009; Góngora Alonso et al., 2018; Pu, Moyle, Jones, & Todorovic, 2018; Robinson, MacDonald, & Broadbent, 2014; Shibata & Wada, 2011; Tejima, 2001).

In educational contexts, research has also shown that children can achieve relevant learning gains in school curricular topics when exposed to long-term interactions with robots that mimic empathic capabilities (such as contingency behaviors and personalization during learning tasks), in contrast with short-term interactions with robots not endowed with empathic capabilities (Alves-Oliveira, Sequeira, Melo, Castellano, & Paiva, 2019). Additionally, children have shown to perceive robots that mimic empathy as their friends, even when explicitly instructed that the robot was behaving as their tutor, which indicates that interactions with robots capable of mimic human capabilities may lead to positive changes in the perception of a robot's role (Alves-Oliveira, Sequeira, & Paiva, 2016). Other studies have shown that a robot delivering personalized tutoring behaviors can have a positive influence on children's learning (Baxter, Ashurst, Read, Kennedy, & Belpaeme, 2017) leading to an increase in positive emotions in children (Gordon et al., 2016). Moreover, in some studies children showed increased learning gains when a child acted as the robot's teacher. In some of these studies, the robot was able to learn from its own mistakes through the children's feedback (e.g., Chandra et al., 2018; Jacq, Lemaignan, Garcia, Dillenbourg, & Paiva, 2016). These results also suggest that robots can increase child engagement and motivation in educational settings. Furthermore, the robot being able to adopt different roles and interaction dynamics within the school context show clear benefits (Fuglerud & Solheim, 2018).

For the purposes of entertainment and companionship, robots have been programmed with human-like characteristics to elicit joyful interactions with humans. For example, in a study in which adults played a chess game with a robot programmed to mimic empathy (defined as the ability to produce an emotional/cognitive response upon the understanding of another's emotion), the robots mimicking empathy were perceived as friendlier than those that do not (Cuff, Brown, Taylor, & Howat, 2016; Leite et al., 2013). Furthermore, the participants rated the mimicking behavior the robots offered as being similar to the level of support from humans in that context (Leite, Castellano, Pereira, Martinho, & Paiva, 2012). Another study has shown that when an expressive robot told a story to a children (i.e., the robot's voice included a wide range of intonation and emotion), the children were able to retain more of the story plot, showed more concentration and engagement than when the story was told by a flat robot (i.e., the robot sounded similar to a classic text-to-speech engine and had little dynamic range) (Westlund et al., 2017). Additionally, robots that tell funny jokes and laugh can also be perceived as funnier than when the same joke is presented using only text. This indicates that robots that are programmed to elicit humor and to display human-like characteristics, such as laughter, become more engaging which leads to more joyful interactions (Niculescu, van Dijk, Nijholt, Li, & See, 2013; Sjöbergh & Araki, 2008).

4.2 | Aesthetic appeals of robots

Robots may increasingly benefit from having anthropomorphic shapes as humans become more familiar with those shapes; as humans project their already appropriated sociocultural values onto the robot (DiSalvo & Gemperle, 2003). A robot designed with a human appearance (e.g., eyes, mouth, and other human-like attributes) may create expectations that the robot behaves in a human-like fashion (Persson, Laaksolahti, & Lönnqvist, 2000). Social robots can also be made of materials that are soft and comfortable for humans to touch, which may elicit positive interaction modalities, such as motivation for physical proximity, care, or even attraction (Argall & Billard, 2010).

Based on the idea that the act of touching can have positive outcomes in therapy (O'Mathúna, 2000), robots developed for healthcare use soft materials to mimic the feel of bodily touch or contact. The RIBA robot has dynamic sensors that drive soft but powerful arms in order to move infirm patients between care settings (Mukai et al., 2010; Mukai et al., 2011). Studies using this robot in healthcare have shown that patients report high levels of comfort when lifted by the robot (Ding et al., 2012). Another example is the therapeutic PARO robot, which was designed to look and move like a baby seal in order to seek and react to human touch (Wada & Shibata, 2007). The PARO robot seems to benefit elderly individuals indirectly by increasing their social interactions, including visual, verbal, and physical interactions (Kidd, Taggart, & Turkle, 2006; Sabanovic, Bennett, Chang, & Huber, 2013). Several other benefits have been described from developing soft robots, including safety concerns (e.g., prevent and minimize the risk of injuries) (Arnold & Scheutz, 2017).

Research has also shown that robots with human-like appearance, that is, having eyes, mouth, ears, and even human-like skin, can encourage humans to share tasks with a robot, in contrast with machine-like robots. This shows the benefit of human-like robots in job-sharing roles (Hinds, Roberts, & Jones, 2004). Hugvie, for example, is a robot inside a human-shaped cushion, designed to mimic the physical aspects of human communication. When participants have hugged it, they have reported a positive impact in both one-to-one communication and group interactions (Nakanishi, Sumioka, & Ishiguro, 2019). In the same vein, a robot made with similar cushiony material seemed to provide benefit to children with autism, by increasing eye contact (Simut, Vanderfaeillie, Peca, Van de Perre, & Vanderborght, 2016). Research also suggests that communicating through using the medium of a humanoid robot induces a pattern of brain activity in older people that is potentially similar to in-person communication (Keshmiri, Sumioka, Yamazaki, Okubo, & Ishiguro, 2018). In addition, according to Nishio, Watanabe, Ogawa, and Ishiguro (2018), when a human operator's movements are synchronized with the motions of the android that he/she is controlling, operators reported a sense of body ownership is transferred to the android robot.

5 | DRAWBACKS TO THE HUMANIZATION OF ROBOTS

The previous section showed how the humanization of social robots can lead to more positive HRIs. However, this humanization comes with some caveats. This section will explore some of the limitations of humanizing social robots (see Table 1 for a summary of possible disadvantages).

5.1 | Negative attitudes and reactions towards robots

Attitudinal surveys and experimental studies have shown that people have mixed opinions about human-like robots and their interactions with them. Eurobarometer report (TNS Opinion & Social, 2012) showed that the majority of European Union (EU) citizens have a representation of robots as instrument-like machines rather than a human-like machines, accept robots for dangerous activities (space exploration, manufacturing military, security, and rescue tasks), but reject their use in caring for children, elderly, and disabled, and to a lesser extent in education, healthcare and leisure. Interestingly, studies using Implicit Association Tests showed that people held more positive implicit associations toward other humans than toward robots (Sanders, Schafer, Volante, Reardon, & Hancock, 2016), and are actually more negative about humanoid robots than they were consciously aware (de Graaf, Ben Allouch & Lutfi, 2016).

Although people generally see humanoid robots as more acceptable for house chores, some studies have also shown that they feel uncomfortable with the idea of social interactions with them (Carpenter et al., 2009; Carpenter, Eliot, & Schultheis, 2006). In a study conducted by Broadbent et al. (2009), participants who were asked to think of a human-like robot showed a greater increase in blood pressure readings and negative emotions, than those who thought who were asked to think of a more mechanical robot. Rosenthal-von der Pütten et al. (2014) showed that (a) all bi-pedal robots or android were associated with threatening, (b) human-likeness (but not mechanicalness) predicted threatening, and (c) the humanoid robots were perceived as less familiar and likeable than android robots. Strait, Vujovic, Floerke, Scheutz, and Urry (2015), found that not only did participants rate more negatively humanlike robots than less humanlike and human agents, but also displayed greater avoidance of such encounters. Finally, analyzing Youtube comments, Strait, Aguillon, Contreras, and Garcia (2017), observed that highly humanlike robots received significantly fewer positive comments than less humanlike robots.

5.2 | Theoretical accounts for negative attitudes and reactions to social robots

5.2.1 | The uncanny valley

Originally described by Masahiro Mori in 1970, the uncanny valley refers to the feelings of eeriness, discomfort, revulsion or dread experienced by humans when observing (or touching) highly humanlike artifacts (Mori, MacDorman, & Kageki, 1970). According to Mori's recommendations, Honda's famous Asimo robot was designed to avoid the uncanny valley effects. Interestingly, uncanny aversive reactions have been observed in humans starting with infants (Lewkowicz & Ghazanfar, 2012; Matsuda, Okamoto, Ida, Okanoya, & Myowa-Yamakoshi, 2012), and continuing to children (Yamamoto, Tanaka, Kobayashi, Kozima, & Hashiya, 2009) and adults. Fascinatingly, primates have also shown this aversion (Steckenfinger & Ghazanfar, 2009). Several theoretical reasons have been proposed as to how uncanny robots activate discomfort (see Wang, Lilienfeld, & Rochat, P., 2015, for a review). The discomfort may come from disgust, which is an evolutive mechanism of avoidance (pathogen avoidance hypothesis), the uncanny aspect may signal a lack of fitness, fertility, or health (evolutionary aesthetics hypothesis). Lastly, the uncanny robot may be a reminder of death (mortality Salience hypothesis) or they provoke a mismatch between their appearance and the expectations they create (violation of expectation hypothesis).

5.2.2 | Mind perception hypothesis

According to Gray and Wegner (2012), feelings of uncanniness stems from perceiving a mind in robots because robots' human-like appearance triggers attributions of mind. The authors showed experimentally that (a) higher levels of perceived experience (i.e., the capacity to feel and sense) were ascribed to human-like robots compared to mechanical robots (no difference observed in attribution of agency); and (b) perceptions of experience (but not agency) were significant predictors of feelings of uncanniness, which partially mediated the relationship between humanlike appearance and feelings of uncanniness.

5.2.3 | The threat to human identity/distinctiveness hypothesis

Ferrari, Paladino, and Jetten (2016), suggested that as the appearance of social robots becomes more and more anthropomorphic, humans could experience a feeling of loss of distinctiveness; that is, they experience a loss of human uniqueness. Congruently, empirical results showed that robot anthropomorphic appearance (but not attribution of mind and human nature traits to robots) significantly predicted threat to the human distinctiveness and identity. In the same vein, Złotowski, Yogeeswaran, and Bartneck (2017) have found that participants experienced a higher identity threat after seeing a video that showed robots which were presented as autonomous and capable of accepting or rejecting human commands than when the same robots were presented as completely nonautonomous. Waytz et al. (2014) also found that participants experienced stronger feelings of threat when considering the substitution of humans by robots in emotion-oriented tasks (i.e., traditionally human tasks) than in cognitive-oriented tasks, (i.e., that are perceived as more appropriate for robots) but only when they were told that robots could outperform humans on various physical and mental tasks.

5.2.4 | Beliefs in human nature uniqueness

Elaborating on the threat to human identity/distinctiveness hypothesis, Giger, Piçarra and Pochwatko (2016, 2019, submitted) suggested that individuals might be motivated to deny the traditional benchmarks of humanity to robots through socialization or culture. To measure this tendency to reserve human traits to humans, they proposed the Beliefs in Human Nature Uniqueness Scale (BHNUS) and showed that endorsement of beliefs in human uniqueness were associated with negative attitudes towards robots, a lesser attribution of traits of warmth to social robots, and the experience of emotional states of avoidance towards social robots (Giger et al., 2016; Giger, Moura, Almeida, & Piçarra, 2017; Pochwatko et al., 2015).

5.3 | Perpetuation of gender and racial stereotypes

Humanizing social robots also means gendering and racializing robots.

The matching of robot's physical embodiment, perceived gender entity and gendered based role within humans' gender expectations is thought to improve HRI and elicit attitudes that are more positive. For example, Tay, Jung, and Park (2014) found that participants rated robots more positively that matched stereotypical gender-occupational role and personality-occupational role. However, gender assignment relies heavily on roboticists' common-sense assumptions about female and male gender roles (Robertson, 2010), contributing to the maintenance of gender-based stereotypes. For example, Eyssel and Hegel (2012) found that the same robot was perceived as more communal and less agentic when it wore long hair (i.e., female feature) than short hair (i.e., male feature). Trovato, Lopez, Paredes, and Cuellar (2017) also showed that the same robot is approached more closely and viewed as more feminine when it was presented as a robot guide rather than as a security robot. Other examples of sexism and female objectification can be found in fictional female-like robots (e.g., Ava from Ex-Machina, Cash from Cyborg 2) and real-life prototypes, which are portrayed as young, attractive (e.g., Geminoid F), and sometimes (hyper)sexualized (e.g., big breasts; see sex robots). Beyond aesthetic choices, the robots fulfill traditional gender roles (e.g., receptionist, nurse) or exist for sexual satisfaction (Richardson, 2016) which reinforces and exacerbates the stereotype of perfect womanhood. Moreover, analyzing *Youtube* comments, Strait et al. (2017) found that, within the category of highly humanlike robots, the comments addressed to female-gendered robots were significantly more dehumanizing and sexually objectifying than for neutral- and male-gendered robots.

Regarding race, Bartneck et al. (2018) showed that participants automatically ascribed a race to robots according their color (e.g., white, black) and extended human racial stereotypes to racialized robots. Moreover, using the shooter bias paradigm, Addison, Yogeeswaran, and Bartneck (2019) showed that racial stereotypes interfere with time decision: participants were slower to decide to not to shoot unarmed White robots than unarmed black robots.

In short, taken together, these findings demonstrate that robots' gender and racial cues facilitate the application of human gender and racial stereotypes to robots, which produces judgments and discriminative behaviors consistent with gender, and racial stereotypes.

6 | ETHICAL ISSUES AND PRACTICAL CONSIDERATIONS

Imagine the following scenario: for 1 hr, you are invited to cuddle a small and cute robotic dinosaur called Pleo. The robot reacts to your touch and vocalizes how it feels loved, similar to a pet. Later you are given knives or other weapons and instructed to torture and dismember the Pleo. Would you do it? It turns out that none of the participants involved in this experiment were willing to hurt Pleo, and only under the extreme instruction "unless one person stepped forward and killed just one Pleo, all the robots would be slaughtered" did one of the participants step forward and destroyed one of the robots (Fisher, 2013). Caring for robots, especially when they display humanized behaviors, says a lot about humans. In fact, Kate Darling, the researcher behind this study claims, “mistreating certain kinds of robots could soon become unacceptable in the eyes of society.” Now consider another example: you have bought a robotic dog, called Aibo, which you take care for several years. However, it starts to malfunction until it finally fails to work at all. Would you consider having a funeral for your robotic dog? It happened that several former Aibo owners felt so bereaved sad that they created a memorial for hundreds of “deceased” Aibos. The memorial has personal notes from the grieving owners (Millner, 2015).

In 2017, Saudi Arabia bestowed citizenship on the robot Sophia (Hanson Robotics). With this act, Sophia became the first robot with citizenship from any country. This was considered a controversial decision because it did nothing to address the known gaps in human rights observed in that country and because it masked the fact that human-level intelligence and decision-making are still a distant reality (Pagallo, 2018). Indeed, part of the controversy around robots and automation lays in the difficulty of creating legal and ethical frameworks that originate from an informed perspective of existing robot capabilities and limitations. Thus, there is a need to create laws which do not hinder progress while upholding the right to human safety. In this context, the discussion of the ethical concerns around social robots can be divided into four main categories.

First, several authors have discussed the ethical concerns associated with the physical humanization of robots. This includes, for example, concerns associated with touch and its role in HRI. Several authors underlining that despite the positive interpersonal effects of touch, there is a need for guidelines that allow the adequate introduction of touch capabilities in social robots to ensure safety in HRI (e.g., Arnold & Scheutz, 2017; van Erp & Toet, 2013). Also, there has been a recent public campaign against the use of humanized sex robots given the general concern about the effects on the individual and society. More specifically, there are concerns about the role that these sex robots could have in the dehumanizing women in pornography and prostitution (Döring & Pöschl, 2018). However, on the other side of the coin, the use and creation of sex robots raises questions about justice and parity; including issues related to inclusion. Safeguards should be put into place to avoid sexist and racist morphologies and behaviors in the development and design of robots to guaranty a lack of discrimination.

Second, both legal and ethical concerns have been raised about the psychological humanization of robots. In psychological terms, robots are increasingly more human-like (e.g., through the display of personalities). Coupled with a human tendency to attribute motivation and agency to nonhuman entities; some authors extoll the need to ensure transparency in HRI. Furthermore, increased levels of trust from the effects of robot psychological humanization have potentially dangerous outcomes. Several authors have underlined the risk of addiction and attachment to robotic agents (e.g., in the child therapy context), arguing that this can have negative effects relating to regulations and trust. The regulation environment and enforcement mechanisms are so limited at the moment that companies have a free hand to set or alter policies. What if a family using a robot therapist could no longer afford expensive updates or technical fixes? What if the company, under pressure from marketing partnerships, inserts biased information or recommendations in their communication with a child?

Second, psychological humanization can lead to overtrust or to other negative and potentially dangerous outcomes as the robot can mimic human bonds but is not obliged by human bonds (Robinette, Li, Allen, Howard, & Wagner, 2016).

Third, issues related to functional humanization must be considered. The introduction of social robots into an increasing number of contexts, including healthcare and educational contexts has catalyzed these concerns. Social robots are doing tasks that were previously done by humans. Indeed, the fear of robots taking jobs away from people is frequently reported in media and may be one the most shared concern about this type of technology (e.g., Boyd & Holton, 2018).

The negative impact of technology in general has been noted before (Rotman, 2013) and it has been shown that human workers may see the introduction of robots in the workforce in a negative light. It is generally believed that robots should perform jobs that are repetitive, dirty or dangerous, but with more and more robots working in clinical settings, several other issues arise (Takayama, Lu, & Nass, 2018). In particular, some authors have raised the issue of attachment to robots, especially in care contexts involving children and the elderly. Specifically, over reliance and trust in robots. Other authors have gone so far as to say that replacing some humans with robots could lead to the gradual loss of all human practitioners with the skills and expertise.

The increased humanization of robots on all fronts has blurred the line between being a robot and being a human (for a discussion see Bendle, 2002). This has led some authors to advocate for the necessity of recognizing a robot's autonomy, granting them liability and a degree of *personhood* (Pagallo, 2018), as has recently happened in Saudi Arabia. However, it is not the first time that governments have given human rights to nonhuman entities. In 2008, Spain granted human rights to apes, based on evidence that suggested the presence of mind. Following this trend, rivers in New Zealand and the entire ecosystem of Ecuador were given the legal status of a person in 2017 and 2008, respectively. Indeed, while people tend to use the terms as human and person interchangeably, these terms have different meanings and implications. *Human* refers to a genetic classification within the genus homo; while legally *person* refers to an entity which has inalienable rights, the most important of which include the right to dignity and safety. This does not mean that nonhuman persons should have all the rights that humans do, but instead that we need to ask what moral characteristics they have and what rights these moral characteristics afford them. A motion presented to the European Parliament (2015/2103-INL) also suggested that robots that surpass a certain threshold of autonomy and intelligence should be registered within the EU and that the companies would be liable for any damages done by their robot creation and therefore must carry liability insurance. The COMEST report on robotics ethics from World Commission on the Ethics of Scientific Knowledge and Technology (2017) has a more complex view of the issue of liability, stating that it is a case of diluted or shared responsibility between "(…) robot designers, engineers, programmers, manufacturers, investors, sellers and users" and that due to their functional versatility, robots can have "(…) implications far beyond the intentions of their developers." In order to better define the challenges and capture the concerns, several individuals and organizations, such as the Global Initiative on Ethics of Autonomous and Intelligent Systems, promoted by The Institute of Electrical and Electronics Engineers (2017), have crowd sourced the practical considerations and the ethical guidelines in HRI for the makers of this technology. Other attempts have been made to create a set of rules for machines to make moral decisions that are based on human moral decision-making (e.g., Awad et al., 2018). In addition, several robot-related standards are being discussed and developed by the IOS (see https://www.iso.org/, e.g.., ISO/TC299 Robotics).

Ultimately, it all depends on how we decide to use robots. Technology is not a mere target of regulation. It is both a regulatory actor and a regulatory tool, because the technology itself incorporates regulation and legal compliance (Palmerini, 2013). As we move forward in the consideration of these issues, we should bear in mind that there is a lot of positive potential in these technologies and that the most exciting part is that we can learn more about ourselves in the process.

7 | DISCUSSION

In this paper we aimed to provide an overview of the different theoretical and empirical perspectives regarding the humanization of social robots, as well as to characterize the different positive, negative, and ethical consequences that can result from such process. Despite the extensive efforts of roboticists, engineers and social scientists to create better, more realistic and capable robots, the reality of autonomous social robots (such as those imagined by Asimov) is still distant. However, the humanization of social robots is an issue worthy of consideration. The exponential growth of technology observed in the past decades since the industrial revolution has caught many by surprise and thus, gives special merit to these considerations. Coming back to our initial question, "Is humanizing robots really such a good idea?" we see that it is difficult to provide a clear-cut answer as this topic is complex and multifaceted.

So far empirical studies have explored HRI in very specific contexts (e.g., laboratory, and schools) and for brief periods of time. As such, little is known about the effects of long-term exposure to humanized robots. Moreover, humanized social robots are still at the anticipation stage (e.g., the stage prior to the deployment of a new technology) and research has shown that, during this stage, anticipated emotions (e.g., anticipated enjoyment, fear) and motivational states (e.g., behavioral desire) act as strong drivers of evaluations and intention to use a new technology (Bagozzi & Lee, 1999; Kwortnik & Ross, 2007; Wood & Moreau, 2006). In the case of social robots, and given the fact that as the majority of people did not yet have a direct contact with them, such evaluative emotional and motivational states can be heavily based on the information available in popular culture (e.g., movies and books) and news (Enz, Diruf, Spielhagen, Zoll, & Vargas, 2011; Mubin et al., 2016; Piçarra & Giger, 2018; Sandoval, Mubin, & Obaid, 2014). Robots are largely displayed both in popular culture and news as a threat to work and humanity. Consequently, the lack of direct experience with robots associated with mainly negative representations could explain why to date lay people displayed mixed attitudes towards social robots but also hold high expectations of them. The deployment of social robots in society could change such negative representations. Indeed, the direct contact allows for the evaluation of the usefulness of robots, as well as their potential and limitations. However, if social robots evoke a level of existential threat because they blur the line between humans and machines, an increased contact with social robots may not be the solution and consequently negative reactions towards them may persist and become more normative.

The evaluation of the consequences of humanization of social robots also depends on the level of analysis. At the physical and psychological level, the literature reviewed in this paper showed mixed opinions. On one hand, humanization seems to lead to positive relational outcomes (such as increased transparency and more natural HRI), on the other hand, excessive humanization can lead to feelings of eeriness and discomfort towards social robots. In addition, at the physical level, humanization of robots can be interpreted by some individuals as a form of identity threat to the extent that it threatens their belief of the unique nature of human existence. Indeed, the extent to which robots can mimic human behavior has been the gold standard to evaluate robot performance and effectiveness, based on the Turing test. Present research on this topic is still insufficient to deliver a definitive judgment on this issue, mainly because the uncanny and discomfort feelings from interacting with a highly humanized robot are still not fully understood. At the societal level, the humanization of robots leads to a number of ethical, legal and philosophical questions. While robots are becoming increasingly qualified to enter human environments and act autonomously, an exploration of the legal and societal mechanisms in place to regulate their safe introduction, quickly reveals how unprepared we, as a society, currently are. The issue of whether or not robots deserve human rights is exacerbated given the difficulty of achieving an overarching definition and set of criteria for personhood, both in philosophical and in legal terms. The impossibility to determine and scientifically observe the presence of mind and the nature of consciousness make us bound to an anthropocentric definition of what it means to be a person which significantly hinders the creation and implementation of new types of personhood that do not fit that model.

So, what might happen in the future? Many scenarios are possible. A first scenario could be to favor an extreme humanization of social robots resulting in mechanical replica of the human being. However, even if the pace of technological advancement is skyrocketing, many experts advocate that the creation of a replica is more a fantasy than a real technical possibility (e.g., Brooks, 2017). The second scenario would be to produce only machinelike robots with minimal human features. If such a solution seems intuitively adequate, then one should remember the psychological capacity of humans for anthropomorphism (i.e., attribution of intention and mental states to objects) and for displaying empathetic feelings and behaviors towards objects. In other words, people will always project their anthropomorphic interpretations onto social robots and see social robots as having human qualities. A third scenario could be to develop robots up to the limit of the uncanny valley and make social robots with humanlike features which stops right before being uncanny. However, it is difficult right now to forecast which scenario society will follow as the humanization of social robots seems to be ineluctable as it is on the agenda of developers and marketers.

In conclusion, what steps can we make to tackle the issue of humanization? First, we can start by anticipating and solidifying our knowledge of the different types of consequences (positive and negative). Using a technology is not the equivalent of accepting it. Scholars and developers who are interested in social robots should embrace the mission of creating technological platforms that provide the best and safest user experience possible. This is true for all types of humanization discussed in this paper but might be particularly relevant, in the context of the current HRI literature, for the physical humanization of assistive robots that due to their objective need to present special characteristics. Second, we need to ask ourselves about the limits of humanization. In other words, if humanizing robots is a means to an end (i.e., improve HRI), then when and how is that end achieved? Is the partial humanization (i.e., embedding robots with a limited set of human features that are relevant to a specific task) enough? If not, what does the need to have fully humanized robots add to HRI that partial humanization does not? More research is necessary to answer these questions and all the others posed by the introduction of social robots.

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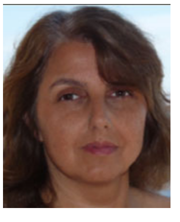

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