What Does It Mean to Anthropomorphize Robots? Food For Thought for HRI Research

Samia Cornelius Bhatti
School of Information
University of Michigan
Ann Arbor
samiaco@umich.edu

Lionel Peter Robert
School of Information
University of Michigan
Ann Arbor
lprobert@umich.edu

ABSTRACT

Anthropomorphism is a well-used but vague concept that demands further understanding and clarification to be effectively used in HRI research. Although most HRI research defines and uses anthropomorphism as a human-like attribution process, there is lack of distinction between its deployment in design versus its manifestation in user response. Furthermore, researchers need to separate mindless from mindful anthropomorphism and find ways to theorize and measure each. Researchers also need to consider the dynamic and contextual nature of anthropomorphism to generate relevant findings for research as well as practice.

CCS CONCEPTS

• HCI design and evaluation methods • User interface design • Analysis and design of emerging devices and systems • Robotics

KEYWORDS

Anthropomorphism, Robots, Human-likeness, Human-like design

ACM Reference format:

Samia Cornelius Bhatti and Lionel Peter Robert. 2023. What Does It Mean to Anthropomorphize Robots? Food For Thought for HCI Research. In *Proceedings of 2023 ACM Conference Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction (HCI'23 Companion), March 13—16, 2023, Stockholm, Sweden.* ACM, New York, NY, USA, XX pages. https://doi.org/10.1145/ 3568294.3580119

1 Introduction

An engineer or software developer would often talk about anthropomorphizing as embedding technology with human-like physical features, behaviors, and emotions. A psychologist would probably talk about it as a cognitive process made up of perceptions and attributions. A technology user may perhaps consciously consider anthropomorphizing a design marvel and unconsciously an attribution of humanistic characteristics. A researcher may use one or all of the above considerations in research as suited to a particular study, resulting in multiple definitions and ontologies that make conceptualization complex and problematic.

Overall, the goal of this paper is to bring attention to the challenges associated with the lack of clarity in the use of the term anthropomorphism in HRI literature through design, interaction, and/or response to robots. In this paper, we review several bodies of literature that inform and motivate our paper. First, we present and discuss the various definitions of anthropomorphism. Then, we present points of contention in the employment of the term anthropomorphism that calls for clarification. Specifically, these include 1) design versus mechanism; 2) mindful versus mindless; 3) static versus dynamic, and 4) general versus contextual. Finally, we highlight how addressing these points of contention can help reduce the ambiguity associated with the term anthropomorphism in HRI research.

2 What is anthropomorphism?

Anthropomorphism is derived from the Greek words *anthropos* (human), and *morphe* (shape or form) and is the human tendency to attribute human characteristics to inanimate objects, animals and other non-human entities [12][21][29][15][8][14]. This attribution is based on past knowledge acquired through observation of, and interaction with, other human beings, and is observed to understand the world in a better way [15], and to build social connections [22], and to enhance feelings of belonging [3][12]. The anthropomorphism of a given technology can be driven by its features [15][21], an innate human tendency [12] and/or an inductive reasoning process that comprises the acquisition, activation, and application of knowledge to a target [12]. Consequently, the anthropomorphism of a given technology can be driven by a mindful deliberative slow thought process or a quick mindless process [19]. Mindful anthropomorphism is considered to be an inductive reasoning process while mindless anthropomorphism is taken to be a reflexive human response to understanding.

Most HRI research talks about anthropomorphism as the act of assigning human characteristics to nonhumans as a result of human-like design in robots [28][14], but the term has also been used to discuss processes such as humanization (developing technology that is human-like in form and function) [27] and

animism (a culture of attributing a soul to a nonhuman entity) [1][24]. These processes may be related but can be defined distinctly. Using the term interchangeably with other processes, concepts, or principles creates confusion and vagueness that continues to grow as technology becomes more and more human-like. At the core of the concept, however, is the attribution of human-like characteristics. But is this attribution associated with embedding human-like characteristics into technology design or is it related to perceptions of users as a result of an observation or interaction? Confusing the two or using them interchangeably can result in speculation and confusion. Furthermore, when studied as a human-like attribution process, it is sometimes based on first encounters [6] and other times on interaction [5]. Only a few studies highlight both observational and interactional anthropomorphic responses together, or how one can differ from the other. Without a clear definition or taxonomical and ontological boundaries, the term remains open to various interpretations and, consequently, uses in research.

Researchers have employed and measured anthropomorphism as an attribution process without paying much attention to mindless versus mindful anthropomorphism. Perceptions of human likeness can change over time. Hence understanding and knowing what kind of anthropomorphism leads to what kind of perception or reaction can help engineers better anticipate user response to design. Extant research also highlights the dynamic nature of anthropomorphism with respect to context, as well as time—people get tired of attributing human-like characteristics. The changing nature of attribution with respect to culture and time questions its role in motivating human-like design or anticipated responses.

Scholars are also divided on what anthropomorphism means and its effect on user response. While most HRI researchers would advocate the positive effects of anthropomorphism on technology use and utility, others view anthropomorphism as a process that distorts user's understanding of machines and humans, i.e., these scholars view anthropomorphism as a categorical mistake that should be avoided [13]. Others claim that anthropomorphism builds false perceptions of machines of abilities or characteristics that machines are not capable of having [26]. Still, others believe that anthropomorphism is a cognitively straining process and while people may anthropomorphize at the beginning of an interaction, they tend to drop it after some time [16]. Finally, there is a group of scholars who believe that anthropomorphism is something that cannot be avoided, i.e., people are born with such tendencies, and they anthropomorphize regardless of stimuli [8][15]. What then is the significance of anthropomorphism, and when and how should it be studied? We believe that, although widely used and studied, the concept of anthropomorphism is vaguely defined and largely misunderstood. It is oversimplified in research and needs to be reconceptualized to be used for methodological validity. With this paper, we outline the first steps towards developing a theory of robotic anthropomorphism that will reconceptualize the concept to be reliably used in robotic research. We present considerations that robotic researchers as well as practitioners should bear in mind when studying anthropomorphism in the context of robots.

3 Anthropomorphism and HRI

Given the various conceptualizations of anthropomorphism and the confusion associated with its use as a concept in research, and a practical developmental endeavor, we present a list of concerns that demand clarification and further understanding. We believe that HRI research needs to focus on these considerations to provide methodological reliability and validity to anthropomorphism-related research.

3.1 Design versus Mechanism

The first ambiguity that researchers need to clarify is the difference between anthropomorphism and the stimuli that invoke it. If HRI researchers believe that anthropomorphism is the attribution of human mental and behavioral characteristics to a nonhuman entity [28], why then is anthropomorphism also considered a design intervention used to elicit anthropomorphism? Perhaps the difference in definition or conceptualization is congruent with the difference in perspectives. An engineer's perspective will often project anthropomorphism in the development of robots and is visible in the design [25]. When this robot interacts with a human being, the attribution of human-like characteristics is a perceptive process that is manifested in the user response [5]. Is the engineer's perspective of anthropomorphism then a precursor to the user's notion of anthropomorphism?

We believe that anthropomorphism itself remains the attribution of human-like characteristics. However, it is manifested in human-like design from one perspective and response from the other. While clarification with the help of perspectives may be useful for understanding the concept, it does not help with methodological inquiry. Researchers need to separate and distinguish *anthropomorphic design* from *anthropomorphism* in order to use the concept for research. The purpose of such a separation is not taxonomical clarity but conceptual precision which is important for purposeful inquiry. For example, currently, the movement also referred to as kinetic anthropomorphism can be considered a stimulus to anthropomorphism (design) or an attribution of human likeness (anthropomorphism). Although the term has the same meaning, the ontological order in terms of design (robot) versus perception (human) is very different. Hence, setting boundaries to define what constitutes the concept of anthropomorphism itself will be helpful for future HRI research.

3.2 Mindful versus Mindless

Some researchers explain that anthropomorphism can be mindless or mindful [19]. Mindless anthropomorphism is explained to be a heuristic approach to processing informational cues present in the object, where the human-like similarity in the object makes people attribute human-like characteristics to it. Mindless anthropomorphism is explained to be motivated by the lack of cognitive effort employed to understand an object since human-like cues are familiar and easy to associate with similar cues found in human beings. Whereas, mindful anthropomorphism is explained as an inductive reasoning process, the core mechanism of which is

the same as any process of inductive inference: in the absence of relevant explanatory information, human beings acquire and access knowledge representations present in their brain and activate them for application to an object to facilitate understanding [12]. In this case, human beings make a conscious decision to attribute human-like characteristics to non-human entities. They access, activate, and apply human-like knowledge representations in the brain objects that may or may not appear to be human [7][12][11]. We have struggled to find studies in HRI that highlight when or under what stimuli mindless or mindful anthropomorphism takes place. Perhaps the distinction or its consequences are not important or significant enough to be studied, but we posit that an exploration is necessary to come to that conclusion.

We believe that conceptually differentiating and studying anthropomorphism as either a mindless or mindful process is necessary for several reasons. First, to inform design principles: if all anthropomorphism is mindless should robots be more or less human-like? According to Computers As Social Actors, simplistic human cues can lead to a human-like attribution [23]. If that is the case, there is no need for a complicated human-like robot appearance. But Kim and Sundar [19] suggest that heuristic information processing is based on cues, which could mean that a more human-like design can lead to more anthropomorphism. Unfortunately, extant research provides no guidance for human-like design based on the kinds of anthropomorphism. Second, to inform theory: heuristic information processing can be grounded in different theoretical frameworks than cognitive reasoning. Researchers ought to understand what theory they should use to ground their research. So far, since most research does not distinguish between mindless and mindful anthropomorphism, theoretical grounding is weak and generic. Third, to provide contextual specificity: some contexts may be conducive to mindless versus mindful anthropomorphism and vice versa. Studying each will not only help researchers decide on the theories they want to use for their study but also anticipate and understand user responses in various contexts.

3.3 Static versus Dynamic

Relationship-building between the human and robot is often the primary motivator behind many HRI studies. Most scientists would want people to form long-term relationships with the robots they interact with. But channel expansion theory explains that users' interactions with media change over time (become richer) as people understand it better [9][18]. In the same vein, we suggest that people may appropriate more human-likeness to a robot based on their experience and have a more human-like relationship with it, or people may appropriate more machine-likeness to a robot based on their experience to have a more functional relationship with it. Evidence about change in behavior with robots over time can be found in extant literature. A number of studies involving users' interactions with robots over time have suggested that it takes hard work for humans to sustain human-like attributions towards humanoid robots, and such efforts fail over time [17]. Humans find it cognitively straining to project human-like attributes onto robots when interacting with them in social spaces, and so over time tend to treat them like machines. Thus, while robots remain fixed in their anthropomorphism as embedded in them by their engineer, anthropomorphism based on human perception can change over time. This is another reason why the design perspective should be separated from the user perspective. Although the reason behind this change in behavior is unknown, one explanation found in literature is "the novelty effect", that is, interest in new technology [20]. This interest fades over time. Other explanations include the cognitive strain associated with attributing human-like characters to machines [17] and unmanaged expectations in the design [26][30][2].

This ambiguity associated with research on anthropomorphism calls for longitudinal studies to assess change in user response to human-like design over a period of time. Since the time associated with a change in behavior is unknown, researchers should also try to explore how long it takes people to tire of their human-like attribution efforts or lose interest in the novelty associated with technology. Of course, theoretical explanations as to why the change in behavior occurs are also open for discussion.

Studying anthropomorphism as a static concept is a grave mistake that has been ignored in most literature. Interaction makes an important part of robot acceptance, and interaction over a period of time can result in behavioral changes that are left unexplored in HRI research. For an engineer, not being able to anticipate user behavior over a period of time can have implications for robot acceptance and utility. For researchers, experimental evidence based on one-time observation and interaction may be useful, but it is not sustainable for future research.

3.4 General versus Contextual

People form meanings of things in the context of social interactions with other people [4]. If anthropomorphism is a cognitive reasoning process, it involves people who are creating meaning out of an interaction. Human beings actively create and modify meaning in response to robot design and behavior. Most HRI research focuses on studying user perception of robots as evoked by robot design. In the process, most studies ignore the context in which the interaction is taking place. Extant research has seen a change in user response in different cultures [17][16][10][13]. We believe that perceptions of robots can change with respect to age, organizational setting, and culture. This area of research needs more attention in HRI research. Contextual exploration can help provide more reliability to research and help researchers generalize with caution.

4 Conclusion

To understand and use the various dimensions of anthropomorphism in HRI research, scholars first need to define anthropomorphism itself, or provide boundaries to its dimensions (for e.g., design and perception). They also need to define different kinds of anthropomorphism and how these can be measured (For e.g., mindless versus mindful). The kinds of anthropomorphism

also need to be related to the dimensions of anthropomorphism. Finally, scholars need to be aware of the contextual and temporal effects of anthropomorphism and how these can affect both design and user response. By exploring and clarifying these ambiguities, we believe that scholars can come to a conclusion about the efficacy of anthropomorphic design and its implications.

REFERENCES

[1] Barber, O., E. Somogyi, A. E. McBride, and L. Proops. 2021. "Children's evaluations of a therapy dog and biomimetic robot: influences of animistic beliefs and social interaction." *nternational Journal of Social Robotics* 13(6), 1411-1425.

[2] Bartneck, C., D. Kulić, E. Croft, and S. Zoghbi. 2009. "Measurement instruments for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots." *International journal of social robotics* 1(1), 71-81.

[3] Baumeister, R. F., and M. R. Leary. 2017. "The need to belong: Desire for interpersonal attachments as a fundamental human motivation." *Interpersonal development* 57-89.

[4] Blumer. 1986. *Symbolic interactionism: Perspective and method.* Univ of California Press.

[5] Burgoon, J. K., J. A. Bonito, B. Bengtsson, C. Cederberg, M. Lundeberg, and L. Allspach. 2000. "Interactivity in human–computer interaction: A study of credibility, understanding, and influence." *Computers in human behavior* 16(6), 553-574.

[6] Cafaro, A., H. H. Vilhjálmsson, and T. Bickmore. 2016. "First impressions in human--agent virtual encounters." *ACM Transactions on Computer-Human Interaction (TOCHI)* 23(4), 1-40.

[7] Caporael, L. R. 1986. "Anthropomorphism and mechanomorphism: Two faces of the human machine." *Computers in human behavior* 2(3), 215-234.

[8] Caporael, L. R., and C. M. Heyes. 1997. "Why anthropomorphize? Folk psychology and other stories." *Anthropomorphism, anecdotes, and animals* 59-73.

[9] Carlson, J. R., and R. W. Zmud. 1999. "Channel expansion theory and the experiential nature of media richness perceptions." *Academy of management journal* 42(2), 153-170.

[10] Du, N., X. J. Yang, and L. Robert. 2022. "A Cross-cultural Investigation of the Effects of Explanations on Drivers' Trust, Preference, and Anxiety in Highly Automated Vehicles." *Highly Automated Vehicles, Transportation Research Record* Accepted.

[11] Duffy, B. R. 2003. "Anthropomorphism and the social robot. Robotics and autonomous systems." *Robotics and autonomous systems* 42(3-4), 177-190.

[12] Epley, N., A. Waytz, and J. T. Cacioppo. 2007. "On seeing human: a three-factor theory of anthropomorphism." *Psychological review* 114(4), 864.

[13] Esterwood, C., K. Essenmacher, H. Yang, F. Zeng, and L. P. Robert. 2021. "A meta-analysis of human personality and robot acceptance in human-robot interaction." *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* 1-18.

[14] Fink, J. 2012. "Anthropomorphism and human likeness in the design of robots and human-robot interaction." *International conference on social robotics.* Springer, Berlin, Heidelberg. 199-208.

[15] Guthrie, S. E. 1997. "Anthropomorphism: A definition and a theory." In *Anthropomorphism, anecdotes, and animals*, by R. W. Mitchell, N. S. Thompson and H. L. Miles, 50–58. State University of New York Press.

[16] Hasse, C. 2020. "How robots challenge institutional practices." *Learning, Culture and Social Interaction* 26, 100223.

[17] Hasse, C. 2022. "Humanism, Posthumanism, and New Humanism: How Robots Challenge the Anthropological Object." In *The Palgrave Handbook of the Anthropology of Technology* , 145-164. Singapore: Palgrave Macmillan.

[18] Hoorn, J. F. 2020. "Theory of robot communication: I. The medium is the communication partner. ." *International Journal of Humanoid Robotics* 17(06), 2050026.

[19] Kim, Y., and S. S. Sundar. 2012. "Anthropomorphism of computers: Is it mindful or mindless?" *Computers in Human Behavior* 28(1), 241-250.

[20] Leite, I., C. Martinho, A. Pereira, and A. Paiva. 2009. "As time goes by: Long-term evaluation of social presence in robotic companions." In *RO-MAN 2009-the 18th IEEE international symposium on robot and human interactive communication*, 669-674. IEEE.

[21] Mitchell, R. W., N. S. Thompson, and H. L. Miles. 1997. *Anthropomorphism, anecdotes, and animals.* Suny Press.

[22] Mourey, J. A., J. G. Olson, and C. Yoon. 2017. "Products as pals: Engaging with anthropomorphic products mitigates the effects of social exclusion." *Journal of Consumer Research* 44(2), 414-431.

[23] Nass, C., J. Steuer, and E. R. Tauber. 1994. "Computers are social actors." *Proceedings of the SIGCHI conference on Human factors in computing systems* 72-78.

[24] Okita, S. Y., and D. L. Schwartz. 2006. "Young children's understanding of animacy and entertainment robots." *International Journal of Humanoid Robotics* 3(03), 393-412.

[25] Richardson, K. 2010. "Disabling as mimesis and alterity: making humanoid robots at the Massachusetts Institute of Technology." *Etnofoor* 22(1), 75-90.

[26] Skitka, L. J., K. L. Mosier, and M. Burdick. 1999. "Does automation bias decision-making?" *International Journal of Human-Computer Studies* 51(5), 991-1006.

[27] Spatola, N., B. Kühnlenz, and G. Cheng. 2021. "Perception and evaluation in human–robot interaction: The Human–Robot Interaction Evaluation Scale (HRIES)—A multicomponent approach of anthropomorphism." *International Journal of Social Robotics* 13(7), 1517-1539.

[28] Spatola, N., S. Marchesi, and A Wykowska. 2022. "Different models of anthropomorphism across cultures and ontological limits in current frameworks the integrative framework of anthropomorphism." *Frontiers in Robotics and AI* 230.

[29] Złotowski, J., D. Proudfoot, K. Yogeeswaran, and C. Bartneck. 2015. "Anthropomorphism: opportunities and challenges in human–robot interaction." *International journal of social robotics* 7(3), 347-360.

[30] Zawieska, K., B. R. Duffy, and A. Strońska. 2012. "Understanding anthropomorphisation in social robotics." *Pomiary Automatyka Robotyka* 16(11), 78-82.