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Perceiving Sociable Technology: Exploring the Role of Anthropomorphism and Agency Perception on Human-Computer Interaction (HCI)

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PERCEIVING SOCIABLE TECHNOLOGY: EXPLORING THE ROLE OF ANTHROPOMORPHISM AND AGENCY PERCEPTION ON HUMAN-COMPUTER INTERACTION (HCI)

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Jose David Pineda Delgado

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To: Dean Joanne Li
College of Business

This dissertation, written by Jose David Pineda Delgado, and entitled Perceiving Sociable Technology: Exploring the Role of Anthropomorphism and Agency Perception on Human-Computer Interaction (HCI), having been approved in respect to style and intellectual content, is referred to you for judgment.

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Florida International University, 2021

DEDICATION

I would like to dedicate this dissertation to:

- My wife and best friend Luisana Brito who supported me throughout this part of my life, kept pushing me forward day after day and made it possible for me to complete this program. I love with you all my heart and am looking forward to seeing where our lives will take us now.
- To my parents Yvan Pineda and Yajaira Delgado, as well as my grandparents, who always supported me and made me into the person I am today. Thank you for lighting in me the desire to become the best. I am proud of you and strive to continue making you proud for the rest of my life.
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ABSTRACT OF THE DISSERTATION

PERCEIVING SOCIABLE TECHNOLOGY: EXPLORING THE ROLE OF ANTHROPOMORPHISM AND AGENCY PERCEPTION ON HUMAN-COMPUTER INTERACTION (HCI)

by

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Florida International University, 2021

Miami, Florida

Professor George Marakas, Major Professor

With the arrival of personal assistants and other AI-enabled autonomous technologies, social interactions with smart devices have become a part of our daily lives. Therefore, it becomes increasingly important to understand how these social interactions emerge, and why users appear to be influenced by them. For this reason, I explore questions on what the antecedents and consequences of this phenomenon, known as anthropomorphism, are as described in the extant literature from fields ranging from information systems to social neuroscience.

I critically analyze those empirical studies directly measuring anthropomorphism and those referring to it without a corresponding measurement. Through a grounded theory approach, I identify common themes and use them to develop models for the antecedents and consequences of anthropomorphism.

The results suggest anthropomorphism possesses both conscious and non-conscious components with varying implications. While conscious attributions are shown to vary based on individual differences, non-conscious attributions emerge whenever a technology

exhibits apparent reasoning such as through non-verbal behavior like peer-to-peer mirroring or verbal paralinguistic and backchanneling cues.

Anthropomorphism has been shown to affect users' self-perceptions, perceptions of the technology, how users interact with the technology, and the users' performance. Examples include changes in a users' trust on the technology, conformity effects, bonding, and displays of empathy. I argue these effects emerge from changes in users' perceived agency, and their self- and social- identity similarly to interactions between humans.

Afterwards, I critically examine current theories on anthropomorphism and present propositions about its nature based on the results of the empirical literature. Subsequently, I introduce a two-factor model of anthropomorphism that proposes how an individual anthropomorphizes a technology is dependent on how the technology was initially perceived (top-down and rational or bottom-up and automatic), and whether it exhibits a capacity for agency or experience. I propose that where a technology lays along this spectrum determines how individuals relates to it, creating shared agency effects, or changing the users' social identity. For this reason, anthropomorphism is a powerful tool that can be leveraged to support future interactions with smart technologies.

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CHAPTER 1: INTRODUCTION

For little over two decades we have known humans react socially to artificial agents, applying social rules and expectations to their interactions and causing individuals to "humanize" technology. Humans stereotype technology, may feel need to reciprocate favors or benefits and may even perceive personalities in them, however, research in other fields has suggested that these social reactions are far more than a mindless response to social cues and may instead be an example of humans' brains perceiving the technology as possessing intention and mental and affective states not much difference from other humans or other animals capable of acting on their own and with which an individual may interact with (Gray, Gray, and Wegner, 2009) (Urquiza-Haas and Kotrschal, 2015). As artificial agents become more widespread, and developments such as artificial intelligence allow them to be more autonomous and social, understanding why we perceive these technological artifacts as something more than a tool becomes increasingly important. Therefore, there is a growing need for researchers in IS to understand the underlying mechanisms that cause humans to perceive a technological artefact as a tool under one situation and as a subject in a different one, as well as what factors cause differences in perception between individuals and the implications that these changing perceptions have over the behavior and beliefs of an individual.

The Arrival of Artificial Agents

The field of Artificial Intelligence (A.I.) has been attempting to replicate human-like thinking in machines since the early 20th century, with researchers such as Alan Turing suggesting that a point may arrive where we cannot differentiate machines from humans as we interact with them. While such a point remains distant in the future, sociable technology that relies on typically human-to-human methods of communication or behaviors are becoming widespread. On one hand, embodied robots have achieve a widespread penetration in the global market for the first time with personal and domestic services robots accounting for over 4 million units sold with an estimated value of $1.7 Billion USD in 2013 alone, and estimated growth figures going for over 18 million units sold by 2020 for a total market value speculated to be above $15 billion USD (Kumar, 2015) (Robotics, 2014). Contrary to prior technologies, these embodied robots are performing household tasks with a level of autonomy never seen before.

On the other hand, smart devices in the form of Chatbots and Virtual Personal Assistants (VPAs) such as Apple's Siri, Google's assistant, Amazon's Alexa, or Microsoft's Cortana are offering new ways of interaction that had typically been reserved for humans' interaction with other humans such as voice conversations, body gestures, and even the capability to initiate conversations. These artificial agents have become widespread gaining a market size of $1.64 billion USD worldwide in 2017 and with the expectation that they will reach a market of $16.79 billion USD by 2021 (Statista, 2018) with the total amount of assistant enabled devices being expected to surpass human population as early as 2021 (Renesse, 2017).

Developing Human-like Robots & Machines

While researchers in the field of Information Systems (IS) have recognized this social nature of the interaction with technology (Nass, Steuer, & Tauber, 1994) (Marakas, Johnson, & Palmer, 2000), most of the research into this phenomenon has come from the literature on Anthropomorphism within the fields of Human-Robot Interaction (HRI) and Social Psychology (Broadbent, Interactions With Robots: The Truths We Reveal About Ourselves, 2017) (Kiesler & Hinds, Introduction to This Special Issue on Human-Robot Interaction, 2004). These researchers have look at the psychology behind individuals' interaction with robots to improve their interactions within fields such as:

- healthcare for older adults where robots are being used to assist people with physical tasks (e.g. walking or carrying objects), cognitive issues (e.g. memory games), health management (e.g. fall detection) and psychological issues (e.g. companionship and entertaining) (Robinson, MacDonald, & Broadbent, 2014).

- Communicating with children with autism where the less complex nature of robots is being used to teach the children about different social cues (Simut, Vanderfaeillie, Peca, Perre, & Vanderborght, 2016) (Diehl, Schmitt, Villano, & Crowel, 2012).

- Education where robots have been used to learn technical skills, assist teachers in foreign language classes, and in sexual education classes (Mubin, Stevens, Shahid, Mahmud, & Dong, 2013).

- Guides in Shopping Mall and Museums where robots have been used to improve the experience individuals have in the facility and as a method for studying their interactions (Sabelli & T., 2015).

Apart from exploring the usage of robots within different fields, researchers have also conducted vast research into the relationship between anthropomorphic perception of a machine and some other factors. Current research of antecedents of anthropomorphism in HRI has gone beyond just considering the appearance of machines (Fong, Nourbakhsh, & Dautenhahn, 2003) (Hancock, et al., 2011), and explore the impact of signals and cues emitted by robots (Hegel, Gieselmann, Peters, Holthaus, & Wrede, 2011), the inclusion of both appearance and human-robot interaction factors (e.g. autonomy, imitation, intrinsic moral value, privacy, & reciprocity) (Choi & Kim, 2009) (Khan, Ishiguro, Friedman, & Kanda, 2006), verbal and non-verbal communication (Mutlu, Yamaoka, Kanda, Ishiguro, & Hagita, 2009) (Salem, Eyssel, Rohlfing, Kopp, & Joubling, 2011), the perceived emotion of the robot (Eyssel F. , Kuchenbrandt, Bobinger, De Ruiter, & Hegel, 2012), among others.

The consequences of perceived anthropomorphism have also been explored in the literature. Different appearances for the same machine have been associated with different perceptions of intelligence and intentionality (Hegel, Krach, Kircher, Wrede, & Sagerer, 2008), anthropomorphic devices lead to more visual attention than a perceived inanimate device (Bae & Kim, 2011), the perception of anthropomorphism changes the perceived personality traits of the machine (Walters, Syrdal, Dautenhahn, & Te Boekhorst, 2009), and the origin and language of use has also been associated with different mental models of the robot’s perceived mind (Lee, Lau, Kiesler, & Chiu, 2005). The appearance of a robot was found to affect the non-verbal communication of humans, but not their verbal communication (Kanda, Miyashita, Osada, Haikawa., & Ishiguro, 2005), and the role of the robot was also found to affect the way humans provided commands to the robot (Austernmann, Yamada, Funakoshi, & Nakano, 2010).

1.1 PROBLEM STATEMENT

Humans can perceive other entities as either objects or subjects on different situations potentially leading to different interaction dynamics. However, there is a paucity of empirical researcher exploring the factors leading to perception of technology as a subject and its effects on users.

While practitioners continue to develop artificial agents that engage humans through modes of interaction typically reserved for human to human interaction, our current theories fail to take into account how different perceptions of a technology can alter how users interact with it, and instead focus on the use of technologies as tools. This view, fails to take into account that as technologies are perceived as social agents, users may become vulnerable to effects typical of the social interactions with others such as social pains (Eisenberger, 2012), they may develop feelings of empathy and pro-social behavior (Lieberman, 2012), gain a sense of shared-agency on a task with an artificial agent, or they may feel social pressures and a need to harmonize thus changing their sense of self

(Lieberman, 2013). Additionally, without furthering our understanding of what makes individuals change their perception of technology under different circumstances, society's response to any technology that is perceived as human-like cannot be correctly predicted, potentially leading to unexpected and possibly detrimental effects to the introduction of the technology. Therefore, there is a need to explore how this form of interaction takes place and what differentiates it from our current understanding of technology as a tool.

1.2 Significance of the Study

This study will significantly contribute to the current knowledge in the field on how human interaction with artificial agents can become social, what factors cause variations in perception among different individuals, and how it affects the individuals themselves. The study will cover not only empirically tested behavioral responses, but also known psychological and neurological correlates of these perceptions which will provide insights that will allow both practitioners and researchers to alter the user's perception of the technology as it may fit them. The findings of this study will help practitioners gain control over the perception of their technologies allowing them to develop their technologies to make users more comfortable and trustful, and allowing the practitioners to encourage desired behaviors and changes in beliefs such as the promotion of empathy in children or helping elderly and lonely individuals become socially active. On the other hand, it will help researchers by providing them with a basis upon which they explore the impact of these changes in perception on our current theories including to what extent do humans become more susceptible to the social effects of their interaction, and how their behavior and beliefs may change over the long-term.

1.3 PURPOSE OF THE STUDY

The aim of this study is to expand our understanding of the underlying process leading a person's perception of technology as a social agent and develop propositions as to how this phenomenon affects our field. As new technologies appear offering new modes of interaction that resemble more and more the interactions between humans, the likelihood of a user anthropomorphizing an entity and interacting with it socially drastically increase. Therefore, by exploring how this attribution of socialness takes place, what factors affects it, and which effects it has over the individuals involved in the interaction we will be able to expand on our current understanding of how humans interact with human-like technologies beyond what the CASA framework proffers, allowing practitioners to design technologies to provoke or inhibit the social perception of their technologies as needed to achieve their goals, and researchers to evaluate how the differences in perception of technology may change current theories, and how it may affect individuals in the long term. Therefore, our aim is to:

Develop an empirically-based model of the social perception of technology based on the extant literature and including the salient factors that lead to it and its known effects over the user in order to develop propositions on how it may affect our current theories and an individual's behavior and beliefs.

This study will be based on a combination of theories of the attribution of mind to others as exemplified by Urquiza-Haas and Kotrschal (2015) and Airenti (2018) that view the attribution of socialness to artificial agents as being a form of anthropomorphism bounded to the interaction modality and based on the same mechanisms that humans use to understand other humans. The study will use the results of the extant empirical research within the fields of information systems, human-robot interaction, and social psychology and neuroscience in order to build an empirically-based model that is informed by previous theoretical pieces to provide a foundation upon which this phenomenon could be further researched in our field.

1.4 RESEARCH QUESTIONS

Based on our literature review, it appears that the social perception of technology is dependent on an individual's anthropomorphism of it. At the same time, the anthropomorphism appears to be a modality of the interaction dependent on the role we give a given technology and not a fundamental characteristic of the technology itself, however, it the results from empirical studies appear to suggest that there exist both internal and external factors to the technology and the individual interacting with it that can encourage or inhibit this perception, key among them being the perception of intention and agency. Additionally, research suggests it depends on the same biological processes used when human interact with other humans and therefore it appears likely that a person anthropomorphizing the interaction with a technology could not only react socially to it, but be vulnerable to the same effects on their behavior and sense of self that their interaction with other humans could have (e.g. groupthink, social conformity, and harmonizing effects on behavior). Based on this, our explicit research questions are:

1. What are the factors that encourage an individual to perceive technology as a social agent?

2. What effects does the perception of socialness on technology has over its users?

1.5 SUMMARY

As new technologies are developed to become more social and autonomous while relying on methods of interaction typical of human to human interaction such as voice or written conversations or the expression of body gestures, the need to understand how our perceptions of these technologies may change and its repercussions becomes much more important. While research in Information systems is limited, other fields such as human robot interaction and social psychology and neuroscience promise to expand our understanding of this phenomenon after having benefited from recent advances in brain imaging techniques that allow them to explore it in an unprecedented level. By leveraging on advances in theories of attribution of mental states to others, as well as empirical results on the interaction between humans and human-like technologies this paper will develop a comprehensive model that will fill in the gaps on how we perceive other entities and attribute socialness to them, as well as on what the implications of doing so are for the individuals involved and our current theories in the field.

In the following sections we will explore the extant literature related to how individuals perceive other non-human entities as either objects without capacity to act on their own or feel, or subjects with minds and capable of social behavior. This literature review will cover the state of the art research into this phenomenon from 3 levels of analysis: a **behavioral** level that explores **what** the phenomenon entails, a **psychological** level that explores **why** we perceive others as being agents in some scenarios, and a **physiological** level that explains **how** the human brain attributes mental states to others that enable them to be perceive as social agents. To be precise, the literature review will be separated into 4 parts: The first part will cover our current understanding of social machines within the Information Systems (IS) discipline. Afterwards, we will explore behavioral studies and theories regarding how humans interact with anthropomorphic machines as explored within the field of **Human-Robot Interactions** (HRI) including how we may perceive these machines to have minds and be capable of experiencing the world around them. Thirdly, we will explore the psychological processes that enable the perception of others as agents. Finally, we will explore the functions and structures in the human brain that enable and support these perceptions. At the end of the literature review we will proceed to summarize how these findings support each other to provide a better overview of the phenomenon.

2.1 EARLY STUDIES IN IS

Since its early days, the field of Information Systems has been focused on exploring the role and impact of technology on individuals and organizations while they interact with it, with the majority of researchers recognizing it as an important tool that enhances the effects of other factors on variables such as user satisfaction and organizational performance. While this view has become widespread and well supported, recent research has suggested that as humans interact with technology, humans may place a role on it as a social agent giving it the capacity to elicit social responses on individuals (Tahiroglu & Taylor, 2018) (Airenti, The Development of Anthropomorphism in Interaction: Intersubjectivity, Imagination, and Theory of Mind, 2018). In the following sections we will describe the beginning of research on technology as a social agent as well as the state-of-the-art theories on how humans' perception of technology can vary between a tool and an agent.

2.1.1 The Media Equation: Computers are Social Actors (CASA)

Early studies into the social perception of technology can be traced back to the early to mid-1990s to the seminal works of a researcher by the name of Clifford Nass and his colleagues who conducted a series of experiments in which they demonstrated that people tend to treat computers and other as if they were other humans, even when they are aware they are not human (Nass & Moon, 2000). These experiments culminated in the development of the seminal work of the Computers are Social Agents (CASA) framework, which states that people mindlessly (i.e. non-consciously) apply social rules and expectations to their interactions with computers and other media and that, therefore most social science findings should be capable of being replicated through the interactions between humans and computers (Nass & Moon, 2000) (Nass, Steuer, & Tauber, 1994). In essence, Nass and his colleagues (Nass & Moon, 2000) proposed that as individuals pay conscious attention to some contextual cues in their interactions with computers, these cues trigger various scripts and expectations in the mind of individuals that cause them to unconsciously react as they have done so in the past. Nass et al. based their conclusions on 3 facets of the human cognition:

1) The **overuse of human social categories** which refers to the use of categories in society like race, gender, ethnicity, young/old, etc. To test this idea, Nass et al. (Nass, Moon, & Green, 1997) conducted an experiment with a computer that interacted with user's through its voice. In this experiment the participants used the computers through 3 phases, while the researchers monitored the differential impact for the gender of the voice in the computer. The results of the study indicated that the participants did *apply stereotypes* to the computer, as shown by their consideration that the male voiced computer was friendlier than the female voiced computer, or that the participants perceived the female-voiced computer to be more knowledgeable about traditionally female topics such as love and relationships. The authors also conducted similar experiments about other categories such as ethnicity

(Nass, Isbister, & Lee, 2000), and ingroup vs outgroup behavior (Nass, Fogg, & Moon, 1996), obtaining similar results that supported the hypothesis that individuals applied these social categories to computers.

2) Individual's engagement in **overlearned social behavior**, that is repeated behaviors that became a 2nd nature (such as being polite) are reapplied unconsciously due to how ingrained it is in their minds. This hypothesis was tested by examining if people were polite to computers (Nass, Moon, & Carney, 1999). Nass, Moon, and Carney explain that when a person asks another person to evaluate them in a face to face meeting, the resulting evaluation tends to be positively bias showing a form of politeness. The authors replicated this same study by having participants work with a computer, and after the work was finalized, asking then to evaluate the performance of the computer. The evaluation was given in one of two ways: Either the participants evaluated the computer in the same computer they had used in the previous phase, or they used a different computer to submit the evaluation of the performance of the previous computer. As the authors expected, the evaluations given on the same computer that had been used before by the participants were consistently more positive than those given to a different computer even though the participants claimed their answers were not biased (Nass, Moon, & Carney, 1999).

3) People’s tendency to **conduct premature cognitive commitments** by making and holding assumptions early on based on incomplete information. Nass and his colleagues tested this hypothesis by categorizing a TV as either a specialist (only shows one type of tv show) or a generalist (shows both entertainment and news coverage). Participants assigned to the generalist group were allowed to watch TV from a TV they were told could show both entertainment and news shows, whereas the participants that were assigned the specialist group were told they would watch the 2 categories on 2 different occasions. After having the participants view a series of news and entertainment segments, the participants in the specialist condition evaluated the news as being of higher quality than the participants in the generalist condition did, even though the programming did not vary between the specialist and generalist TVs (Nass & Moon, 2000). This provided support to the hypothesis that people make premature cognitive commitments that influence them.

Nass et al. (2000) discarded anthropomorphism as a possible alternative explanation for the CASA framework based on the argument that Anthropomorphism was a mindful process in which people belief that computers are essentially human, and that it argues “that social responses to computers emerged from ignorance concerning the ontological status of computers qua people” [page 93]. The authors argued that the fact all the participants in one of their experiments stated they would never respond socially to a computer was evidence that anthropomorphism was not at play. Moreover, they contended that while individuals could develop very strong relationships with computers and other objects, the emotional attachment was *not a direct response to the object themselves* but were the result of an evocation of memories or of emotion management. These arguments however, tend to contradict the definition of anthropomorphism used by other researchers which considers it to have both a conscious (Guthrie S. E., 1993) (Guthrie S. , 1995) and a non-conscious component (Waytz, Klein, & Epley, Imagining Other Minds: Anthropomorphism Is Hair-Triggered but Not Hare- Brained, 2013) (Sundar, 2004) (Kim & Sundar, 2012). These arguments for a dual process of anthropomorphism have also been empirically supported in the literature (Tahiroglu & Taylor, 2018). Additionally, factors such as emotional attachment towards computers could be explained through Anthropomorphism (Hortensius, Hekele, & Cross, 2017).

2.1.2 The Computing Technology Continuum of Perspective

After Nass and his colleagues published their findings, other researchers began exploring ways in which they could build use it to improve user interfaces and the overall experience of interacting with technology. Building upon this framework, Marakas, Johnson and Palmer explored how individuals differed in their use of anthropomorphism as a form of describing the behavior of technological artefacts as humans interact with them (Marakas, Johnson, & Palmer, 2000). The authors examined the social perception of technology as an attribution process in which individuals recognize technology as either being a neutral tool that responds to the actions of the individual, or as a social actor capable of stimulating social responses from its users. Following this view of anthropomorphism, they proposed a computing technology continuum of perspectives through which on one side individuals perceived computers to be tools completely under the control of humans (locally simplex), and on the other they are perceived to be social actors that exert control or influence an individual’s daily life (locally complex). Rather than claim individuals are in one category permanently, Marakas et al. developed a theoretical model of the computer as a social actor in which they examined the possible inputs to the anthropomorphism attribution process that explain what leads people to view technology from a locally simplex or locally complex perspective, or somewhere in between. This model claims that the degree to which a particular perspective dominates is dependent on the characteristics of the individual (such as her Core self-evaluation), characteristics of the technology that indicated socialness (such as perceived intelligence), the nature or context of the interaction, and perceived cues in the information exchanged.

Since its development, parts of this model have been empirically tested. The impact of a person's core self-evaluations on the attribution process and on the continuum of perspective, as well as the impact of the social character of the technology on the attribution, and the impact of the continuum perspective on the attribution itself were found to be all significant (Johnson, Marakas, & Palmer, Differential Social Attributions Toward Computing Technology: An Empirical Investigation, 2006). However, the self-esteem of the person was not found to be a significant factor in a later study (Tussyadiah, When cell phones become travel buddies: Social attribution to mobile phones in travel, 2013).

2.1.3 Anthropomorphizing Machines

Parallel to these studies on sociable behavior towards computers in IS, researchers in other fields have explored how we anthropomorphize non-human and non-living entities by perceiving them as being human-like and sociable (Broadbent, et al., 2013) (Broadbent, Interactions With Robots: The Truths We Reveal About Ourselves, 2017). The term anthropomorphism refers to the tendency that humans have to attribute human characteristics to non-human entities such as inanimate objects, animals among others (Duffy, 2003). The word originates from the Greek word *Anthropos* (referring to man) and *morphe* (referring to form), but it is usage is not limited to recognizing an entity as being alive, or to describing its physical characteristics or engaged behavior, and instead focuses on the attribution of human-like properties, characteristics or mental states to non-human agents (Epley, Waytz, & Cacioppo, On Seeing Human: A Three-Factor Theory of Anthropomorphism, 2007). The process of anthropomorphism is recognized as occurring within each human observer and consequently it is not an innate property of the entity being observed, though the entity's external characteristics can influence its attribution (Zlotowski, 2015). Therefore, research on the process of anthropomorphism tends to explore the characteristics of the anthropomorphized entity, the context where the attribution happened, and the characteristics of the individual making the attribution (Marakas, Johnson, & Palmer, 2000) (Hancock, et al., 2011) (von Zitzewitz, Boesch, Wolf, & Riener, 2013) (Choi & Kim, 2009).

"Anthropomorphism is therefore a process of inference about unobservable characteristics of a nonhuman agent, rather than descriptive reports of a nonhuman agent's observable or imagined behavior"

- (Epley, Waytz, & Cacioppo, 2007)

ORIGINS OF ANTHROPOMORPHISM

Many researchers from the fields of psychology and anthropology consider anthropomorphism to have evolved as an adaptive trait in early hominids. They belief that recognizing the human-like characteristics on non-human agents allowed them to improve their interactions and form alliances by enabling them to interpret shapes as faces and bodies (Guthrie S. , 1995). While these areas of research can be tracked down through the decades, the construct of anthropomorphism has only been applied to technology within the past few decades. In our field, early studies on anthropomorphism can be tracked down to Sherry Turkle and her studies of human computer interaction (HCI) during the 1980s. Turkle performed a series of psychoanalytic studies on children in order to better understand how they interacted with machines (Turkle, 1984). During these studies, she noticed how children would describe and interact with machines using human terms, describing simple machines as "cheating machines" when they fail to make the same mistakes twice while playing games, or even going as far as calling computers "sort of alive" because they must "know how to do [pictures]" when showing pictures (Turkle, 1984). These studies provided her with early evidence of how humans and computers interacted and assisted her record anecdotical evidence of the child's perceptions of the anthropomorphic characteristics of computers which formed the foundation for later research on the construct.

2.1.4 Sociality, Effectance, and Elicited Agent Knowledge (SEEK)

As researchers continue to explore social responses to computers, and anthropomorphism, a question appears: Why do different individuals anthropomorphize at different rates? In order to answer this question Epley, Waytz, and Cacioppo (2007) develop a theory that aims to explain the process through which people anthropomorphize non-human entities. Based on this theory, they propose that we can better understand when people are likely to anthropomorphize and when they are not, and by extension when people are likely to Dehumanize other individuals. Epley et al. proposed that anthropomorphism is a process of inductive inference, and therefore it should possess the same basic cognitive operations (e.g. acquisition of knowledge, activation or elicitation of knowledge, etc.) of other inductive processes (Higgins, 1996). Based on this principle, Epley et al. (2007) proposed 3 components that determine a person's likelihood of anthropomorphizing an entity:

- The primary determinant of anthropomorphism is the **elicitation of knowledge about the agent itself**. Because knowledge about humans and the self are likely to be acquired earlier and to be richer than knowledge about nonhuman agents, the authors argue that this knowledge is more likely to be accessible by individuals whenever they attempt to make a judgement about a nonhuman agent thus increasing their chances of anthropomorphizing until adequate mental models about the entity are created. Some studies argue that the elicitation of agent's knowledge can be induced if the perceived entity already possesses some human-like attributes such as a human-like appearance or behavior (Zlotowski, 2015).

- **The motivation that individuals' have to interact effectively with others** can also lead them to perceive other entities as processing human-like characteristics and mental states when their behavior appears to be complex. By doing so, individuals expect to improve their capacity to explain the behavior of others in the future.

- An individuals' **need and desire to establish social connections** which can lead individuals to feel isolated which increases their tendency to treat other entities as if they were humanlike social agents. This component has received support in a series of studies conducted by Epley et al. to study the impact of chronic isolation as well as induced feelings of loneliness on a person's likelihood to anthropomorphize non-living entities (Epley, Akalis, Waytz, & Cacioppo, 2008).

Additionally, they argue that these factors work in conjunction to increase or decrease the extent that a person will anthropomorphizes a nonhuman agent (Epley, Waytz, & Cacioppo, 2007). This theory has been widely applied in the field of Human-Robot Interaction (HRI) (Epley, Akalis, Waytz, & Cacioppo, 2008) (Eyssel, Hegel, Horstmann, & Wagner, 2010) (Kuchenbrandt, Eyssel, Bobinger, & Neufeld, 2013) (Salem, Eyssel, Rohlfing, Kopp, & Joubling, 2011), though due to the field's focus on the design of the robots most studies review the effectance motivation component without considering the others (Zlotowski, 2015).

Role of Appearance & Behavior

Other theories of anthropomorphism have focused more on the physical characteristics that affect our perception of human-likeness and lead us to assign mental states to entities instead on the mental processes proposed by Epley and colleagues. A model of human-likeness proposed by von Zitzewitz (von Zitzewitz, Boesch, Wolf, & Riener, 2013) and colleagues attempts to characterize our perception as being dependent on both the **static aspects of appearance** which reflect what we perceive through our different senses (visual appearance, sound, smell, haptic appearance, and taste), and **dynamic aspects of behavior** which includes how the entity moves, its verbal and nonverbal communication, its capacity to interact with an individual, and the social behaviors that it signals to the perceiver. While the model proposes both aspects to be critical, the authors suggest that the appearance of the entity might be more significant at the beginning of the interaction, while the behavioral factors become more important as the interaction progresses.

Other authors have explored the impact of both the appearance and behavior of an entity towards how likely we are to anthropomorphize it, and have found supporting evidence of this impact leading to the perceiver of the interaction to recognize mind in the agent and change both how they rate it (Looser & Wheatley, 2010) (Waytz, et al., 2010) (Hackel, Looser, & Van Bavel, 2014) (Martini, Gonzalez, & Wiese, 2016), and how they perceived it had performed (Kiesler, Powers, Fussell, & Torrey, 2008) (Morewedge, 2009) (Süßenbach & Schönbrodt, 2014) (Wiese, Wykowska, & Müller, 2014) (Mandell, Smith, Martini, Shaw, & Wiese, 2015).

While appearance related factors, and behavior related factors have become accepted as instrumental to the perception of anthropomorphism, the effects of these 2 categories appears to differ from each other with some researchers exploring the differential these factors have on other constructs. One study in particular found that both factors appeared to function in isolation with the appearance of an entity having a higher impact on the attitudes towards said entity, and its behavior having a stronger effect on the perceived performance of the entity (Abubshait & Wiese, 2017).

Interaction related Factors and the Pass of Time

Another model of the perception of anthropomorphism developed by Lemaignan and colleagues recognized the importance of robot-related factors (perceived) as suggested by von Zitzewitz et al. in perceiving anthropomorphism but expands upon their view by proposing the inclusion of human-related (perceiver), and context-related factors (environment) as additional critical factors influencing the perception of anthropomorphism (Lemaignan, Fink, Dillenbourg, & Braboszcz, 2014) in a similar way as was proposed within the Computing Technology Continuum Perspective before (Marakas, Johnson, & Palmer, 2000). Lemaignan continued to expand upon this model by proposing that the perception of anthropomorphism is not something fixed, but that instead it can change through time as the perceiver develops and adapts her own mental model of the agent. The model proposed 3 stages of adaptation:

- **A pre-cognitive phase** where other entities are intuitively perceived as being alive and emotional responses such as empathy can be developed. After observing or interacting with the agent for some time, individuals move to the following phase.

- In the **familiarity-based phase** individuals project familiar mental models upon the entity. After continuing to interact with it for some more time the individual moves to the third and final phase.
- The adapted phase is characterized by the individual recomposing the existing mental model about the entity, based on prior experience with it, in order to improve its accuracy. This phase leads towards an adapted interaction modality that could still be anthropomorphic depending on the person's understanding of the inner workings of the entity, as well as his/her tendency to anthropomorphize. At this point the impact of both the appearance and behavior of the entity is significantly reduced.

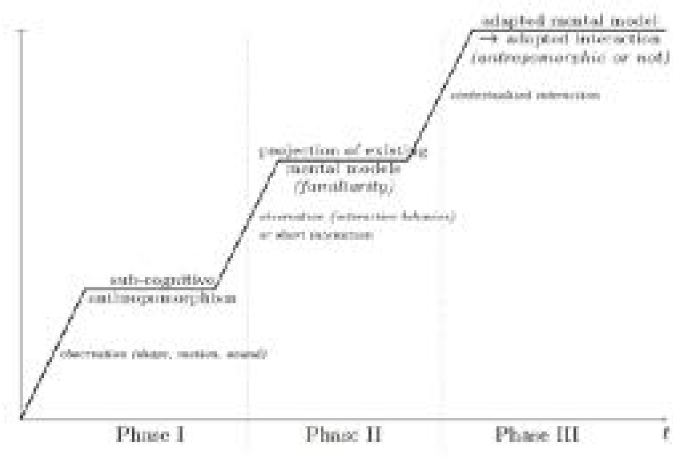


Figure 1 The phases of anthropomorphism. From Lemaignan et al. (2014).

Anthropomorphism & Dehumanization

An alternative approach to exploring anthropomorphism has been to explore the process of dehumanization. Contrary to Anthropomorphism which projects human mental attributes to others, dehumanization describes the process through which we fail to "attribute basic human qualities to others" denying their humanness (Waytz & Epley, 2012). Because of the similarity of the 2 concepts, some researchers have suggested that they might be opposite sides of the same construct (Waytz, Epley, & Cacioppo, 2010) and thus suggest that exploring this concept could bring about clarity to process of anthropomorphization. As part of his dissertation, Zlotowski conducted the first comprehensive attempt to test the validity of using an inverse process of dehumanization as a tool to anthropomorphize machines (Zlotwski, Sumioka, Bartneck, Nishio, & Ishiguro, 2017). In his theory, he proposes that by exploring the factors that cause people to dehumanize others, we can understand what factors may have an impact on a robot's anthropomorphism. Zlotowski looked at the factors identified in Haslam's theory of dehumanization (Haslam, 2006) which proposes that 2 senses of humanness based on perceived personality traits:

- A first set of characteristics were associated with being **Uniquely Human (UH)** in that they were proposed to be exclusive of the human species. This included complex characteristics such as civility, intelligence, moral sensitivity, rationality and maturity.

- The second set of characteristics were though of being part of the **Human Nature (HN)** and differed from the Uniquely Human characteristics in that they could be shared with other living beings. This included primary emotions and warmth, as well as other factors such as cognitive openness, agency, individuality and depth.

Zlotowski (Zlotwski, Sumioka, Bartneck, Nishio, & Ishiguro, 2017) notes that HU characteristics tend to represent the socialization and culture of others, and therefore it reflects their social learning which can vary across different cultures. On the other hand, HN tends to be part of a person’s biological dispositions since birth, and therefore it tends to be prevalent among populations and cultures. HN tends to represent essential characteristics of a living being, while HU tends not to be perceived as essential (Haslam, 2006). Nevertheless, the results from Zlotowski’s study were inconsistent, and suggested that there are no 2 dimensions of anthropomorphism based on humanness and instead only the HN and not the HU traits tend to be influential (Zlotowski, Stasser, & Bartneck, 2014) (Zlotwski, Sumioka, Bartneck, Nishio, & Ishiguro, 2017).

Table 1 Facilitators of Anthropomorphism based on main theories available.

Study	Facilitators of Anthropomorphism	Bottom Line
(Epley, Waytz, & Cacioppo, 2007)	1) Anthropomorphism can be induced when an entity appears more humanlike 2) Perceived agents are complex or behave in a complex way inciting us to look for explanations of their behavior to predict their future state. 3) Loneliness enhances our likelihood of anthropomorphizing in an attempt to establish social connections.	Anthropomorphism as a psychological process depends on our perception of the entity we interact with, or likelihood of perceiving it as an agent based on our own need to explain its behavior and our need for social contact.
(von Zitzewitz, Boesch, Wolf, & Riener, 2013)	- Static aspects of appearance: Visual appearance, sound, smell, haptic appearance, and taste.	Anthropomorphism depends on 2 key aspects: The Appearance and behavior of others. The appearance appears to predispose us to perceive others as

	- Dynamic aspects of behavior: Movement, nonverbal communication, interactive behavior, verbal communication, and social behavior.	agents if they are "human-like", and the behavior is what ultimately drives our perceptions about the entity with more human-like behavior being perceived as social agents. Von Zizewitz brings about some factors that we can exploit to comprehensively and consciously design robots and other machines.
(Lemaignan, Fink, Dillenbourg, & Braboszcz, 2014)	1) Perception of Human-likeness varies through time. 2) Human-Centered Factors: Personality and individual traits of the human user: Psychological characteristics/determinants that influence a person's tendency to anthropomorphize artifacts [age, gender, cultural background, professional background]	Anthropomorphism is not constant and as we interact with an artificial agent, we can begin to perceive it as having mental states, or we can stop perceiving it that way.

	3) Robot-Related Factors: robot's design and how it appears to the human user including the characteristics of the robot's form, behavior, and interaction modalities. 4) Situation-Centered Factors: real or imagined purpose of the robot, situational context in which it is used, and role in which the robot is used/experienced.	It also discusses the need to include the human, machine, and context related factors typical of HCI.
(Haslam, 2006)	1) Human Nature factors 2) Uniquely Human factors	Some authors argue for Anthropomorphism to be the inverse process of Dehumanization. Haslam's theory describes dehumanization as being composed of 2 types of factors: uniquely human factors that if denied

		equal humans to animals and automata, and human nature factors that if denied equal humans to objects.
(Gray, Gray, & Wegner, 2007)	1) Perception of Agency (i.e. self-control, morality, memory, emotion recognition, planning, communication, & thought) 2) Experience (i.e. feel hunger, fear, pain, pleasure, rage, and desire, to have personality & consciousness, to feel pride, embarrassment & joy)	Humans cannot know if other entities possess actual mental processes or are just automata and therefore what matters is whether we perceive others to have a mind. Humans may perceive others as having any combination of these 2 factors: adults may have both high agency and experience, children may have low agency but high capacity to experience, and robots may have high agency but low capacity to experience.

(Airenti, The Development of Anthropomorphism in Interaction: Intersubjectivity, Imagination, and Theory of Mind, 2018)	- Anthropomorphism is bound to an interaction and not to the technology itself - An individual could interact with an artefact as if it were a tool or a subject under different contexts	Anthropomorphism is a mode of interaction where human's give the role of interlocutor to a technology and it is more dependent on the cognitive processes of the individual than on any characteristic of the artefact. The cognitive processes of an individual are more important to how they will interact with a technology than the technology's appearance or behavior.

2.2 PERCEIVING MIND IN ARTIFICIAL AGENTS

The attribution of mind to non-human entities has been identified as being an important determinant of anthropomorphism (Zlotowski, Proudfoot, Yogeeswaran, & Bartneck, 2015), and recent research has supported that individuals tend to differentially attribute mind to a wide range of entities, from animals, to other humans and even other nonliving entities (Eyssel, et al., 2016). While the question of whether machines can think as made famous by Alan Turing's imitation game (Turing, 1950) is certainly an important one, what we explore here is not the actual existence of a mind, but the perception of one by an individual observing another entity including other humans, animals, and artificial agents.

The perception of mind has often been defined by researchers such as Abubshait & Eva Wiese (2017) as "the degree to which an agent is judged to have a mind as a function of their physical humanness" (Hackel, Looser, & Van Bavel, 2014) (Martini, Gonzalez, & Wiese, 2016), suggesting that mind perception is dependent on the level of anthropomorphism that we attribute to others. This interpretation relating mind perception and anthropomorphism is further supported by the theory of Theory of Mind (ToM). Similarly to how anthropomorphism refers to the attribution of mental states to non-human animals and things, Theory of Mind refers to the ability that agents (humans in particular but potentially also other animals) possess to perceive mind in others attributing them with different mental states ranging from intentions, hopes, expectations, desires, and beliefs among other states while going as far as understanding that others may have beliefs about others' beliefs (Leslie, 2001).

At its core, Theory of Mind represents the capability that an agent has to develop hypotheses about the thoughts of other perceived agents with a focus on 3 key capabilities, i.e. 1) reflecting on the goals of the other agents which is often referred to as their **desires**, understanding their **beliefs** about the world, and understanding whether they mean what they say and do through an inference of their intention or pretense (Leslie, 2001) (Breed & Moore, 2012) (Pedersen, 2018). Humans are not born with a fully developed capacity to perceive mental states in others, which is why Theory of Mind research has focused on understanding when this psychological understanding about others emerges and how it changes as a child grows into a full adult (Lagattuta, et al., 2014). This perception has also been shown to be influenced by gaze cues, facial expressions, vocal cues, and other behavior related factors such as kinematics (Ansuini, Cavallo, Bertone, & Becchio, 2015).

Following the similarities between theory of mind and anthropomorphism, some researchers have chosen to study humans reaction to human-like machines by focusing on the perception of intention and therefore of a mind on these machines (Martini, Gonzalez, & Wiese, 2016) (Wiese, Wykowska, & Müller, 2014) (Wiese, Shaw, Lofaro, & Baldwin, 2017). In their studies on what leads to mind perception and its moral implications, Wegner and Gray argued that we can never be certain of the existence of others' minds (Wegner & Gray, 2016) and instead when we interact with others we infer the likelihood that they have a mind based on our perception of 2 dimensions: an agent's **capacity for agency** which includes the capability of planning and acting independently out of free will (i.e. emotion recognition, communication, planning, thought, etc.), and the **capacity for experiencing emotions** which refers to the capability to express emotions, inner life, and vitality (i.e. hunger, joy, personality, consciousness, etc.) (Gray, Gray, & Wegner, 2007) (Wegner &

Gray, 2016). In this sense, the authors argue, we are not limited to just arguing if an entity has a mind or not, and instead we can **view if an entity has some components of mind**. For example, a fully grown man could be said to have both high agency and high experience and therefore we could conclude that the person has a mind, but in the case of a baby while no one would debate the humanness, an individual might perceive the baby as having low agency but high experience creating a mismatch between the perceived mind and the humanness due to the baby not being completely developed. These dimensions can therefore allow us to perceive minds in robots and other technological devices, that could be perceived as having little experience, but a moderate degree of agency (Broadbent, Interactions With Robots: The Truths We Reveal About Ourselves, 2017).

2.2.1 Perceptions of Agency

Within the field of psychology, the attribution of mental and affective states to others has often been associated with the perception of agency in others (Gray, Gray, & Wegner, 2007) which is typically dependent on the detection of an intentional behavior. When humans perceive an entity as conducting an intentional behavior, they are also typically perceiving its source as being an agent capable of taking action for its own interests. This line of though comes from our understanding of the concept of **agency** which refers to the capability that an entity has of influencing their own functioning and the course of some events by performing an action (Bandura, Agency, 2017) and leading an individual to have a **sense of being the agent** or owner of an action (Schlosser, 2015). Agency is often characterized as consisting of 4 functions (Bandura, Agency, 2017) (Bandura, Toward a Psychology of Human Agency: Pathways and Reflections, 2018): First, people form intentions and plan to how to realize these intentions over-time. Secondly, people attempt to foresee what proper goals could be to realize their intentions and what the possible outcomes of their own actions could be. Thirdly, an agent self-regulates their own actions to align with their expectations. And finally, they execute functional self-awareness, where they reflect upon their efficacy at achieving their intended goals and make corrective adjustments as needed. In this sense, the extant literature has relied on the close relationship between agency and intention to measure the perception of agency on machines through both the direct measurement of the perception of agency, or through the direct and indirect measurements of the perception of intention.

Integral to the concept of the perception of agency is that of the Sense of Agency (SoA) or the sense that we have of doing something, being in control and being the agent or owner of the action (Schlosser, 2015). While an individuals' Sense of Agency had traditionally been defined and explored as a single construct, researchers now argue in favor of a model of the sense of agency consisting of 2 elements that work at different levels to provide us with our overall Sense of Agency (Synofzik, Vosgerau, & Newen, 2008): an individual's **Feeling of Agency (FoA)** which refers to the lower level non-conceptual and nonconscious feeling of being an agent, and a **Judgement of Agency (JoA)** which refers to the higher-level conceptual and conscious judgement of agency (Moore J. W., 2016). The theoretical development of the Sense of Agency and its components is explored This distinction can better be explained by looking at the historical development of research into how we perceive agency.

The Model of Apparent Mental Causation

The first model that attempts to explain the sense of agency is Wegner's "**model of apparent mental causation**" which indicates that the sense of agency or "experience of conscious will" arises when we interpret a conscious intention to perform an action as the cause of the action (Wegner & Wheatley, 1999) (Wegner D. M., 2002) (Schlosser, 2015). Therefore, this model argues that for a sense of agency to be perceived (i) the intention to carry out an action must occur before the action is observed (**priority**), (ii) the intention must be **consistent** with the action taking place such that, for example, the direction towards which a ball travels is consistent with the location where we hit the ball in the first place, and (iii) the intention must be the most likely cause of the action detected (**exclusivity**) (Wegner & Wheatley, 1999) (Moore & Obhi, 2012). In essence, Wegner's model examines the sense of agency as a reconstruction of perceived causes and effects which in turn allow for incorrect attributions of agency as demonstrated in an experiment by Wegner and Wheatley where by priming subjects with a though before they saw a cursor moving encouraged them to attribute the movements to themselves even when the movements were caused by another person (Wegner & Wheatley, 1999). While this model was the first to attempt to explain the functioning of the sense of agency, it quickly became rejected by most researchers as empirical evidence suggested that the sense of agency was more than just self-interpretation (Schlosser, 2015).

The comparator Model of Motor Control

An alternative model of the sense of agency was proposed shortly afterwards as an extension of the "**comparator model of motor control**". The comparator model was originally developed as a theory of motor control which proposes that for a movement to take place, the motor control system must first send a command to the necessary muscles to perform an action and at the same time it sends a copy of that command to an internal predictive model. The predictive model is constantly attempting to make predictions (called a forward model) of the trajectory of the movement based on the effect the command will have on the muscles and a sub-personal motor control system compares the intended movement against the predicted movement in order to make corrections. After the movement takes place and is perceived through sensory feedback, the sub-personal motor control system makes another comparison between the actual action and the predicted action in order to fine-tune subsequent movements which compensates for different states of the muscle and the environment that may be affecting the intended movement.

While the model is meant to explain motor performance, researchers have proposed that the same comparisons can help explain the sense of agency of an individual by bringing about feelings of control over our own actions (Frith C. , 2005). This is believed to happen whenever a positive match between the actual and intended actions is provided in the comparison (Synofzik, Vosgerau, & Newen, 2008). Alternatively, it can also disrupt the sense of agency whenever a mismatch between the action and intention takes place. The comparator model thus explains the sense of agency as an internal impulse-responding process and therefore it has been argued to be neither sufficient nor necessary to explain the Sense of Agency, after all, it can only explain behaviors that happen as a reaction to a stimulus where a comparison between actual and expected actions are possible based on feedback captured through sensory perception, but it lacks any mechanism through which it could explain attribution of agency in those situations where no sensory perception took place (Haggard, 2005) (Bayne & Pacherie, 2007) (Synofzik, Vosgerau, & Newen, 2008).

A Hybrid Model for the Sense of Agency

Finally, as the field continued to develop, researchers began to recognize the competition between the previous 2 models as being somewhat of an unnecessary dichotomy and instead argued for a third **"hybrid" model** that combines the main ideas of the previous theories. Proponents of the hybrid model view the sense of agency as being composed of a personal level that offers a post-act conscious evaluation of agency referred to as the "Judgement of Agency" (JoA) and a non-conceptual and phenomenologically thin sub-personal (nonconscious) level known as the "Feeling of Agency" (FoA) that rely on both internal sensorimotor signals and external situational information to develop the sense of agency in an individual (Moore & Fletcher, 2012) (Frankish, 2009) (Synofzik, Vosgerau, & Newen, 2008). Researchers argue that these cues influence the perception of agency differently based on how reliable they appear to be through a process of cue integration where the cues are weighted and integrated to reduce the variability of the estimated origins of an action (Moore & Fletcher, 2012). Researchers argue the comparator model is well suited to explain the basic Feeling of Agency whereas other theories of self-reflection like the model of apparent mental causation can be distorted in some scenarios (Synofzik, Vosgerau, & Newen, 2008) (Bayne & Pacherie, 2007) (Gallagher, 2007).

2.2.2 Measuring our Perception of Agency

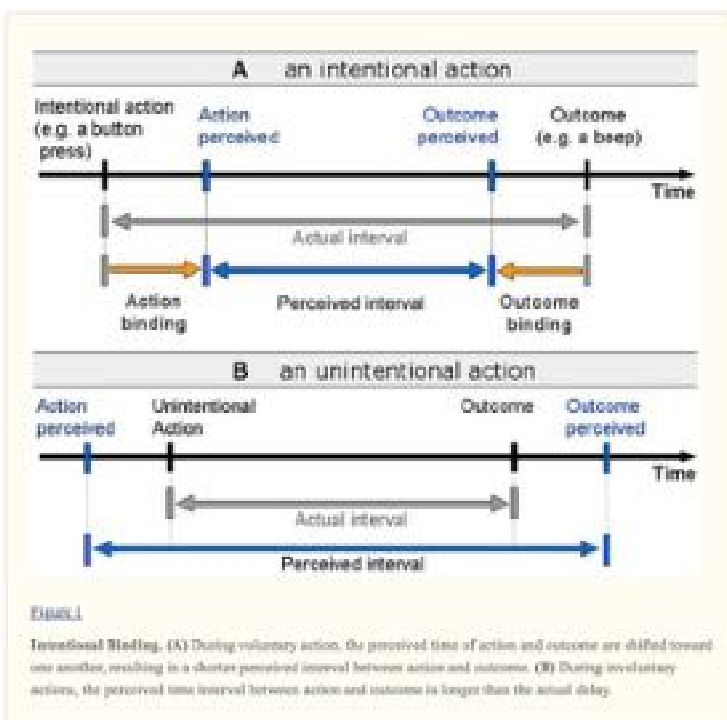
While research into the sense of agency has mostly focused on studies of the perception of agency of the self, these studies and their measuring methodology have also been tested to work on the perception of agency in others (Wegner & Gray, 2017) (Urquiza-Haas & Kotrschal, 2015) (Limerick, Coyle, & Moore, 2014) with recent studies going so far as testing their efficacy in virtual environments typical of HCI technologies (McEneaney, Agency Attribution in Human-Computer Interaction, 2009). These perceptions can be measured in multiple ways with different approaches existing for measuring the Feeling of Agency than for measuring the Judgment of Agency. Typically, the Judgement of Agency is experimentally measured either through a self-reported scale of agency, or by asking participants if they or the entity being studied are agents resulting in a binary response.

More interesting are the measures of the implicit Feeling of Agency which include both sensory attenuations paradigms (Blakemore, Wolpert, & Frith, 1998) and studies of the perceptions of the timing between an action and an effect called intentional binding (Haggard, Clark, & Kalogeras, 2002). The sensory attenuation paradigms refer to our differential perception of normal movements where an individual perceives identical sensory inputs differently depending on whether the movement was self-generated or generated by others (Burin, et al., 2017) (Macerollo, et al., 2015). Studies have shown that this type of paradigm can be used to measure the sense of agency or perception of agency in others as well as to measure impairments of the sense of agency (Macerollo, et al., 2015).

Intentional Binding

The second approach used to measure the Feeling of Agency consists of using the perceived time of intentional actions and their consequences as detected through sensory feedback as a measurement of the non-conscious sense of agency through a method called **Intentional Binding** (Haggard, Clark, & Kalogeras, 2002). In this methodology participants report the perceive time at which an action was initiated and the perceive time where the effects of said action took place, if the action was perceived to be intentional and we attribute agency to its source, research has shown that the timing between the initiation of the action and its effect will be reported as being bound closer together with the initiation of the action being reported as happening slightly later and its effects slightly sooner.

Figure 2 Intentional Binding as reported in Limerick, Coyle, & Moore (2014)



While Intentional Binding was originally described as happening due to the perception of intentionality by the source agent, recent research suggest that both intentional action and mechanical causes result in temporal binding suggesting that the binding actually happens due to the perceived causal relation linking actions with their consequences (Buehner, 2012).

2.3 NEUROLOGICAL BASIS FOR THE ATTRIBUTION OF MENTAL STATES

For the past couple of decades, the field of social cognitive neuroscience has been exploiting advances in brain imaging techniques that explore the biological roots of psychological phenomena typically explored in the social sciences. Early studies of human brain showed that they don't function as general-purpose machines, and instead are composed of multiple specialized networks and areas each of which possesses some specialized function related to human cognition such as perceiving faces, empathizing with others, perceiving mental states in others, among other functions (Kanwisher, 2010).

Additionally, studies have shown that information about the properties of objects and other perceived beings is stored within the same motor and sensory networks that were active when the information was first gathered suggesting that salient information on different categories of entities would be stored on different networks in the brain as implied by selectively impaired recollection of knowledge about animate objects and animals, and knowledge about inanimate and manmade objects such as tools (Martin A. , 2007) (Mahon, Anzellotti, Schwarzbach, Zampini, & Caramazza, 2009) (Chao, Haxby, & Martin, 1999) (Caramazza & Mahon, The Organization of Conceptual Knowledge: the Evidence from Category-Specific Semantic Deficits, 2003) (Caramazza & Shelton, 1998). Arguments about the differential processing and analysis of different categories of entities are further supported by the identification of two main networks in the brain that are pivotal in how humans process how we perceive and analyze our environment: The **Task Positive Network** and the **Default Mode Network** (Urquiza-Haas & Kotrschal, 2015).

Perceiving the Physical and Social Worlds

During the early days of social neuroscience, researchers attempted to identify specific areas of the brain correlated with known psychological processes as well as those correlated with the execution of specific task. While most functions where identified to be correlated to different areas of the brain, some regions showed correlation in their activation suggesting they were part of a network within the brain associated with certain functionality. One particular network of regions was found to become active whenever individuals performed attention demanding tasks such as focusing on the external environment in order to execute some tasks, when a person focuses on external or internal sensations, make plans for the future, or perform complex motor tasks such as interacting with tools and other objects. Because this network, known as the **Task Positive Network** (TPN), has been shown to become active when we interact with our environment it has been argued to form the basis for our physical cognition and our analysis of non-social tasks (Urquiza-Haas & Kotrschal, 2015). However, the TPN is not a single network of brain areas that work in conjunction all the time, and instead it contains within itself other subnetworks such as **the salience network** which determines which stimuli deserves our attention at any given time (Uddin, 2016), the **Dorsal Attention Network** which is believed to mediate guided voluntary allocation of attention (Vossel, Geng, & Fink, 2014), and the **executive networks** of the brain which is involved in maintaining working memory as well as problem solving and decision making (Menon, 2011) (Petrides, 2005).

As research into brain correlates of actions continued, Gordon Shulman and colleagues conducted an experiment aiming to study which brain regions would show increased activity whenever a person is not performing a cognitive, motor or visual task. This study led to the discovery of another major network of the brain referred to as the **Default Mode Network** (DMN) due to it becoming active by "default" when an individual is at rest (Shulman, Corbetta, Buckner, & Fiez, 1997) (Raichle, et al., 2001). While at first researchers were not certain what the increased activity in the DMN represented, newer studies have associated it with social cognition and higher-order tasks such as mind wandering, thinking about others and their intentions as well as their mental states thus leading some researchers to consider the DMN to be or at the very least contain the "**Social Network"** of the brain (Mars, et al., 2012) (Smith D. G., 2018) (Lieberman M. D., 2013). While studies have successfully shown that performing social cognitive tasks cause them to have increases in activity within their DMN, other studies have shown that the reverse is also possible as the automatic engagement of the DMN can prime individuals to engage in social cognitive activities (Spunt, Meyer, & Lieberman, The Default Mode of Human Brain Function Primes the Intentional Stance, 2015).

Researchers have also shown that activity in the TPN and the DMN are not independent of each other and instead they are anticorrelated as increases in activity in one network is typically followed with an inhibition in the other therefore suggesting that as an individual perceives other entities and implicitly perceives them as either objects or subjects the area of the brain that would handle the analysis and reasoning of the interaction would change significantly suggesting that while non-social analytical reasoning, and social analytical reason are subjectively perceived as being quite similar, they are actually fundamentally distinct from a physiological perspective (Lieberman M. D., 2013). While research into the activation of these networks has typically focused on social interactions between humans and other humans, recent research has suggested that these findings hold when interacting with other non-human entities as the DMN shows increased activity when a person interacts with an animal and animated objects such as anthropomorphic robot (Kaiser, Shiffrar, & Pelphrey, 2012) (Chao, Haxby, & Martin, 1999) (Gobbini, Gentili, Ricciardi, & Bellucci, 2011) (Shultz, Lee, Pelphrey, & McCarthy, 2011) (Kupferberg, Glasauer, & Burkart, 2013) (Cullen, Kanai, Bahrami, & Rees, 2014).

Perceiving the Mind of Others

As humans interact with others, the DMN becomes an indispensable component that supports basic social functions such as emotion recognition, self-other distinction, and understanding of others. The brain relies on these functions in order to solve two problems that enable social interactions: First, it must make an estimation of the mental state that other animated entities possess at a time, and secondly, it must use those estimated mental states to make predictions about how the other entity will behave (Lieberman M. , 2007) (Frith C. D., 2007). Of particular importance in solving these problems is our ability of mentalizing. Mentalizing refers to process that allows individual's to understand and manipulate their own as well as other people's mental states guiding their overt behavior while allowing them to perceive others as subjects (Frith & Frith, 1999) (Gage & Baars, 2018, p. 479). In particular, the top part of the DMN including the dorsal MPFC (dMPFC) subsystem and its connections with the temporo-parietal junction (TPJ) and the posterior cingulate cortex (PCC) appear to support our ability for mentalizing (Li, Mai, & Liu, 2014).

Three types of theories have been developed in order to explain why we mentalize. The first type of theory proposed is that of ***theory theories***. These theories propose that individuals develop implicit theories to explain the behavior of others and themselves, and that those theories changes as a person matures and gains new information gaining theory of mind abilities in the process (Carruthers & Smith, 1996) (Gopnik & Wellman, 2012). These theories suggest that major changes will take place in an individual's understanding of their own and others minds as they gained additional information such as exemplified on Piaget's conservation theory which explains that by gathering and understanding new knowledge children mature in a series ordered stages that cause a qualitative change in how they perceive the world around them (Piaget, The construction of reality in the child, 1955) (Piaget, 1965).

2.3.1 Module Theories of Mentalizing & Theory of Mind

A second type of theories consist of ***module theories*** that attempt to explain the mentalizing process by proposing that humans have a section of their brains dedicated to the attribution of mental states to oneself and others which that feeds from other mental abilities in order to develop a knowledge base of rules for social cognition (Baron-Cohen, Mindblindness: An essay on autism and theory of mind, 1995) (Gage & Baars, 2018). Researcher Simon Baron-Cohen proposed a theory of mind model of this nature composed of 4 components that enable individuals to understand and predict mental states: a detector of intention, a detector of eye direction, a mechanism for enabling shared attention, and a module for conducting the theory of mind functions (Baron-Cohen, Mindblindness: An essay on autism and theory of mind, 1995) (Schaafsma, Pfaff, Spunt, & Adolphs, 2015).

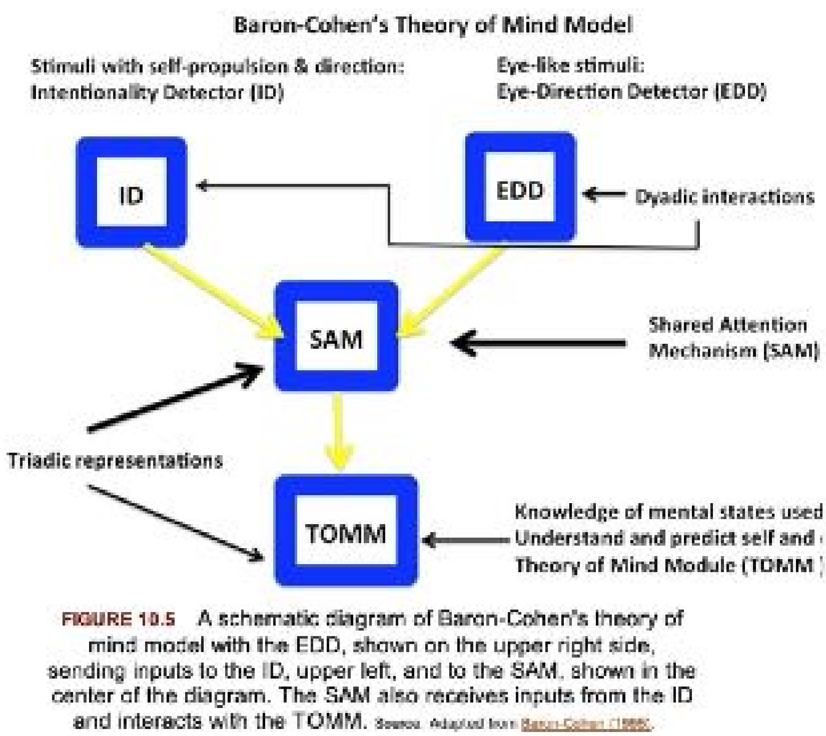


FIGURE 10.5 A schematic diagram of Baron-Cohen's theory of mind model with the EDD, shown on the upper right side, sending inputs to the ID, upper left, and to the SAM, shown in the center of the diagram. The SAM also receives inputs from the ID and interacts with the TOMM.

Figure 3 Source: Fundamentals of Cognitive Neuroscience: A Beginner's Guide

The first component identified by Cohen indicates that to achieve theory of mind, a person must first be able to **detect intention** in other entities regardless of the form that represents it. Studies about detection of intention on animals and humans using single-cell evidence, and neuroimaging respectively suggest that the posterior superior temporal sulcus (pSTS) is involved in this process of action interpretation. The intention detection component is thought to have a dyadic interaction with the **detection of eye direction** of the entity which is the second component proposed by Cohen. This detection of eye direction refers to the tendency that individuals have to detect eye and eye-like stimuli while determining the direction towards where it appears to be directed while interacting with others (Kawai, 2008). Through a combination of the perception of gaze direction and the detection of intentionality individuals can detect nonverbal information that may later lead to shared attention. Gaze direction has been observed to be correlated with activity in the anterior superior temporal sulcus (anterior STS) (Carlin, Calder, Kriegeskorte, Nili, & Rowe, 2011).

Cohen's model proposes the existence of a **shared attention mechanism** that by relying on inputs from the previous two components, enable individuals to notice that others may not simply be staring at an object or event, but rather may be paying attention to it and that said individual could also look too and join in the activity. Having shared attention shows that we can understand that others possess covert intention and mental states and thus it facilitates the attribution of mental states that takes place in the **TOMM** component of Baron-Cohen's theory of mind (Tipples, 2006) (Kawai, Attentional shift by eye gaze requires joint attention: eye gaze cues are unique to shift attention, 2011) (Abubshait & Wiese, 2017) (Shaw, Bryant, Malle, Povinelli, & Pruett Jr., 2017).

Finally, the **TOMM (Theory of Mind Module)** is believed to enable higher-order theory of mind activities that recognize that appearance and reality can differ as different individuals can possess a different understanding of the world around them as exemplified in the Sally-Ann Task that was develop to evaluate children's capacity to understand false beliefs (Wimmer & Perner, 1983) (Baron-Cohen, Leslie, & Frith, 1985). Recent brain imaging studies have given support to this theory by identifying various brain regions that show activation when we think about others and what they may be thinking, thus suggesting the existence of a mentalizing network in the brain (Lieberman M. , 2007) (Lieberman M. D., 2013).

2.3.2 Simulation theory & the Role of Mirror Neurons

The final type of theory for explaining why we mentalize are the ***simulation theories***. These theories argue that individuals understand the mental states of others by conducting internal simulations of their situations which allow individuals to adopt others' perspectives and perceive mental states as they resonate with their own (Goldman A. I., 1989) (Davies & Stone, 1995) (Davies & Stone, 1998). Simulation theories have risen in prominence after receiving partial support from the discovery of mirror neurons as a potential mechanism for enabling simulations (Gallese & Goldman, Mirror neurons and the simulation theory of mind-reading, 1998). Mirror neurons were first discovered serendipitously while studying activation of synapses on a neuron by neuron basis in Macaque monkeys' as they perform motor behavior (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Nevertheless, the researchers noticed that the some of the same neurons that showed activity when the monkey raised a peanut were also showing activity when the monkey witnessed the researchers pick up the peanut themselves (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996) indicating that contrary to other neurons that are activated in either action execution or action observation, mirror neurons seem to be capable of both while showing activation patterns specific to certain actions. This has been taken to suggest that the neurons being measured where not just perceiving an action or creating a motor response but instead were involved in detecting self and other agent initiated action and therefore providing a strong basis for the simulation theories of mentalizing (Rizzolatti & Craighero, 2004) (Rizzolatti, Fogassi, & Gallese, 2001) (McEneaney, 2009).

Nevertheless, the mirror neurons theory has been criticized for trying to explain many phenomena including action understanding, perception of intention, mentalizing and empathizing without providing much evidence to support the claims or even despite contradictory evidence (Kilner & Lemon, 2013) (Saxe, 2005). Additionally, most of the research conducted in humans has been carried out with imaging techniques that show activation of clusters of neurons and not at the neuron level itself and thus while researchers agree that a mirror system is likely to exist, scarce evidence has been provided to support the argument that it functions at the neuron level like in Macaques (Keysers & Perrett, 2004) (Hickok, 2009).

While the debate continues about what the most appropriate theory for mental state attribution may be, most researchers now agree that a complete explanation of mental state attribution will likely involve a combination of all 3 types of theories (Saxe, 2005) (Gage & Baars, 2018) (Lieberman M. D., 2013). As such studies have been conducted in order to identify the differential role that each system plays in the process of mental state attribution to others including identifying what others are doing, how they do it and why they are doing it (Lieberman M. D., 2013). These studies have found strong evidence the mirror system and the mentalizing system having complementary functions where the mirror system consistently detects intentionality in the perceived actions of others based on their visual characteristics regardless of whether a person was paying attention to them or not, while the mentalizing system has been shown to become active when a person reflects about the perceived intention (Lange, Spronk, Willems, Toni, & Bekkering, 2008).

Other studies have found that the mirror systems becomes active when we perceive and action and consider how it happened indicating that the mirror system is involved in understanding **what** other are doing and **how** they do it, while on the other hand the mentalizing system has been shown to become active when considering **why** others performed the actions (Spunt & Lieberman, 2012) (Spunt, Satpute, & Lieberman, 2011) (Spunt, Falk, & Lieberman, 2010).

Similar patterns of activation has been observed in other scenarios such as how we communicate where the mentalizing system becomes critical in planning communication by the sender, and in interpreting intention behind the messages received, as well as in how we understand and attribute emotion where the mirror system tends to activate while identifying overt emotional behavior like smiling and the mentalizing system activates when considering the cause of such behavior (Noordzij, et al., 2009) (Spunt & Lieberman, 2012).

Furthermore, studies exploring the activation of the mirror system and the mentalizing network in contexts varying in cognitive load found that while both networks showed activation under low cognitive load, the mentalizing network became more inhibited as the cognitive load increased while activation in the mirror system remained the same (Brass, Schmitt, Spengler, & Gergely, 2007) (Spunt & Lieberman, 2012).

These findings have led researchers to the argue that the mirror system and the mentalizing system work in conjunction. While the mirror system detects and combines perceived movement into perceived intentional actions such as interpreting the movement of fingers over a keyboard as ‘typing’, the mentalizing system reflects upon the meaning and motive behind such actions (Lieberman M. D., 2013). Finally, while these studies have focused on exploring how a person interacts with other humans, studies have provided evidence that they hold for interactions with human-like machines (Gazzola, Rizzolatti, Wicker, & Keysers, 2007) (Rizzolatti, Fogassi, & Gallese, 2001).

3.1 RESEARCH AND DESIGN

The aim of this chapter is to present the research methodology used to explore the research questions. In order to answer our research questions, this study relies on a qualitative analysis of the current theories and empirical results of the extant research related to the perception of socialness through the attribution of mental and affective states to others which is argued to lead to the social responses to technology under some situations. We will follow this analysis with a conceptual analysis of the implications it has for future research and for the development of new more sociable technology.

Data about the variables that have been studied empirically, their connection to the attribution of mental and affective states as well as their causal factors and effects are being collected for this analysis from the fields of information systems, human-robot interaction and social psychology and neuroscience. This chapter will outline the research approach for this study including its data collection methodology and data analysis approach as well as the philosophical assumptions that define what valid data is.

3.1.1 Research Questions

The purpose of this study is to understand the process through which individuals attribute socialness to technological artefacts, including its antecedents and effects and to develop propositions as to how it may impact the field. Therefore, this study aims to develop a model of the social perception of technology by answering the following questions:

3. What are the factors that encourage an individual to perceive technology as a social agent?
4. What effects does the perception of socialness on technology has over its users?

3.2 PHILOSOPHICAL ASSUMPTIONS

To set the boundaries of our research we must first define the 4 philosophical assumptions that function as the foundation for our research. These are the ontological, epistemological, axiological, and methodological assumptions (Creswell & Poth, 2018).

The first assumption we need to clarify are the ontological assumptions of the study which refers to what constitutes the nature of reality. Different researchers possess different realities based on their own (Creswell & Poth, 2018), and as such we must take care of reporting the multiple forms of evidence used in these studies and the variations in their themes and how they relate, especially since this study aims to combine results from multiple fields where researchers possess separate traditions and somewhat different terms for describing the same phenomenon.

Secondly, the epistemological assumptions refer to understanding and explaining what counts as knowledge. In this study, we are combining results from multiple fields of research, each of which handles their separate definition for the same phenomenon on how we perceive other entities as social entities and have different methodological preferences for testing their hypotheses (Creswell & Poth, 2018). These variations in themes range from anthropomorphism which represents the attribution of mental and affective states to non-human entities to mentalizing which is the application of Theory of Mind which consists of the ability to attribute mental and affective states to others. Because such differences exist, we must describe how they vary, describe all points of views and explain how they relate to one another as supported by the context of their studies and the extant literature supporting their approaches. In the context of this study, we follow the arguments of Airenti (2018) who argues that anthropomorphism is a modality of interaction and dependent on any given knowledge about the entity being anthropomorphized or a fundamental characteristic of it, and Urquiza-Hass and Kotrschal (2015) who argues that these constructs are not only conceptually similar, but also rely on the same fundamental mental processes and therefore should be considered to be part of the same phenomena.

Thirdly, the axiological assumptions argue that all qualitative research is affected by the values and biases of the nature of the information gathered and the view points of the researchers (Creswell & Poth, Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 2018). Therefore, as we analyze the data, we will discuss how these varied values and biases may affect the study’s results.

Finally, the methodological assumptions of the study need to be discussed. These refer to the research process we follow to answer our research question and its characteristics. In this study, we use inductive reasoning in order to first explore the data as described in other studies and then make the new model based on our analysis of the results and findings in those studies (Creswell & Poth, 2018).

3.3 RESEARCH APPROACH

Taking into account the need to integrate the findings from multiple disciplines on how we attribute mind and socialness to technology, it becomes apparent that before any hypothesis can be explored or propositions developed, there is a need to coherently aggregate the extant literature into a single theoretical model of social perception of technology from which we can develop these propositions and hypotheses about the impacts that sociable technology has. Therefore, we aim to approach this study in 3 phases that will enable us to comprehensively support our understanding:

First, we must identify the extant literature specifically the theoretical studies that support how humans attribute agency an experience to others while identifying what factors and effects have been empirically shown to be relevant for the phenomenon.

Secondly, taking into account that these factors are coming from different discipline and may offer different methods and levels of analysis as well as different names for similar constructs, we must group similar influences into named factors as we work on integrating them into a comprehensive conceptual model showing the human, technology and interaction related factors that affect this perception as well as the effects that they have shown to cause. Finally, we must analyze the role that these factors play on different theories within the field, and from there develop propositions as to how it may affect practice and future research. The following figure concretely summarizes our intended process.

Figure 4 Methodology.

3.4 DATA COLLECTION TECHNIQUE

In order to properly answer the research questions and achieve the goal of developing a comprehensive model for the social perception and interaction with technology we collected a comprehensive listing of the extant literature regarding anthropomorphism and the Computers are Social Agents (CASA) framework. For inclusion, each study had to meet the following criteria: (1) the study must focus on the interaction between anthropomorphic technology and users, (2) it must either evaluate the construct as an independent variable (IV) or as a dependent variable (DV), and (3) it must be published in a peer reviewed academic journal. 305 and 52 peer reviewed studies were located within the ABI/INFORM Collection and PubMed databases respectively for a total of 357 peer-reviewed studies. We used the following query to conduct the research:

> ("computers as social actors" OR "computers are social actors" OR Anthropomorphism) AND (robot OR computer)

In order to properly categorize these studies, we collected information about the (1) methodology used, (2) the sample size, (3) the source of the sample, (4) the average age of the sample (5) the proportion of each gender in the sample, (6) All IVs and (7) DVs available, (8) a summary of relevant findings, and (9) general notes about the study's purpose, methodology and/or implications.

3.5 DATA ANALYSIS APPROACH

In order to analyze the data collected, we decided to follow the coding guidelines of Grounded Theory as proposed by Strauss and Corbin (1998). This approach has been recommended when a theory is not available in the literature or models and theories are available but were developed and tested on populations different from the population of interest for the study or in the case the current theories are incomplete because they fail to address key variables (Creswell & Poth, Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 2018, p. 174). While the attribution of mental and affective states to others has been studied in different fields, each field has focus on different aspects of the interaction with the field of human robot interaction focusing mostly on the machine-related aspects that affects this perception and their effects, and social psychology and neuroscience focusing mostly on understanding the underlying process mainly within the context of human to human interaction. Therefore, by analyzing each of these studies as individual data points and developing a new theory for the interactions between humans and anthropomorphized machines we will be able to achieve a comprehensive model that represents the overall understanding of phenomenon that will function as a baseline for the developing of new propositions and hypotheses for how we can continue to expand our research in the field.

While our sample is limited to the available empirical peer-reviewed studies, the presence of distinct theories and models (i.e. Computers are Social Actors, Anthropomorphism, perception of mind, and Mentalizing) as well as representation of key factors (e.g. anthropomorphic appearance has ranged from the presence of a human-like body, to a realistic image of a face on a computer)as well as the fact that the methodology lends itself to the development of theories that include the causal, contextual and intervening conditions and consequences of a phenomenon (Creswell & Poth, Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 2018, p. 170) makes this coding strategy an appropriate match for this study's goals. Therefore, the coding scheme that we aim to follow possesses the following steps:

a) First, we must begin with an open coding approach by identifying the IVs and DVs being studied in the literature as well as any other themes that appear to repeat often relating to the influences of the attribution of mental and affective states or its underlying process. For each influencer and theme that we find a code is developed and recorded for use in the following stage.
b) Secondly, after multiple open codes are developed, themes and processes must be identified through a process of axial coding in order to group together codes based on their similarities into the different factors that will form our theory. For example, despite the multiple approaches to exploring the impact of the physical features of a machine including its face's characteristics and realism of its body into a theme for appearance.
c) Finally, after having identified the main themes of the study, a selective coding process will be carried out in order to identify the overarching themes that cover the relationship between these topics allowing for the development of propositions that support a story describing the interrelationships between the different factors of the theory (Creswell & Poth, Qualitative Inquiry and Research Design: Choosing Among Five Approaches, 2018, p. 172) (Creswell & Brown, 1992).

3.6 RIGOR

In order to ensure that our research remains credible and its conclusions transferable to other scenarios our data points must be reliable themselves and therefore we have chosen to limit our sample to studies that have been peer-reviewed in the past (Lincoln & Guba, 1985).

The **dependability** of our framework refers to how well the results of the study hold up over time and various contexts (Lincoln & Guba, 1985) and is ensured by the reliability of the studies that we analyze which shows the cumulative expertise of multiple researchers in various relevant areas to the interaction of users and sociable technology, this additionally has the benefit of strengthening its the **transferability** of the framework, allowing it to be applied or generalized to other relevant contexts (Graneheim & Lundman, 2004). We further promote the transferability of our findings by providing a clear description of our methodology, the context within which we interpret the available research, the characteristics of the studies we use as sample and the data collection and analysis approach in use (Elo & Kyngas, 2008).

The **credibility** of the study refers to how well the data source used in the study and its method of analysis help us address the intended goals (Graneheim & Lundman, 2004) and we ensure it by relying on a sample of studies that covers the overall process of the social perception of machines from a behavioral, a psychological and biological point of view while we analyze the studies with a comprehensive coding methodology that allow us to consolidate the results of these studies in a single framework. Additionally, we provide a detailed table of analysis for our framework development that includes our notes on the used variables in each study, their findings, and our notes on our interpretation of the findings and methodologies used.

The **confirmability** or objectivity of the findings are further supported by taking steps to minimize possible biases in our study (Guba & Lincoln, 1994). Our data source helps us ensure confirmability of the findings as our reliance on empirically tested studies means that each interaction has been thoroughly tested and further reviewed by peers. Additionally, by providing a table with our notes and summary information on each study we will bring support to our analysis and coding process making our framework transparent and allowing for other researchers to confirm its authenticity.

Additionally, the use of the constant comparative analysis through the grounded theory approach allows for a systematic approach to analyzing the current studies and developing a comprehensive framework. By using this approach, we can add **credibility** to the findings by providing a basis for the codes and relationships we identify. However, the study is not without limitations. First, relying on a secondary data source such as research studies means that we are not directly observing the phenomenon, though this is minimized thanks to the expertise of the researchers in charge of each study. Secondly, because each study follows slightly different conceptualizations and theories as basis, there is a risk on the credibility of the findings as minor variations in operationalizations could be the cause of discrepancies in results, though nevertheless our coding strategy should help minimize these risks. Finally, as any other qualitative study, the views and perspectives of the researchers are likely to influence the results of the study in some way and therefore we offer a comprehensive literature review in this study in order to minimize the risks associated with our understanding of prior theories over influencing our analysis of our results.

3.7 SUMMARY

A qualitative inductive approach was chosen to perform a comprehensive and transparent analysis of the prior studies, allowing us to develop a representative framework for the analysis of the social interaction between humans and machines. Afterwards, the relationships in this framework will be analyzed to offer propositions as to how the changing perception of technology from a tool towards a social agent can affect our current understanding of the interactions between human and machines, and how we can further manage the perceptions of this new type of technology in order to encourage desired behaviors and attitudes, or limit unintended effects on the users of our technologies.

CHAPTER 4: ANTHROPOMORPHISM IN INTERACTION

As a form of interaction with technology, the construct of anthropomorphism holds great promise for the field of Information Systems (IS). Nevertheless, research into anthropomorphism has been spread among multiple fields of research, with each field focusing on different aspects, and with few studies working towards a consolidation of the extant literature and its applicability towards human-computer interaction and business in general. In this chapter, we aim to explore the relevance of anthropomorphic research towards IS. The objective of this section is to: 1) present a conceptual model of antecedents and consequences of anthropomorphism, 2) present an integrated model of the empirical findings from the existing research into the anthropomorphization of technology based on the literature from the disciplines of IS, social psychology and social neuroscience that defines the nature of anthropomorphism in terms of its antecedents and consequences, and 3) to present a comprehensive review of the existing literature on anthropomorphism using our empirically based model as a framework through which we can understand the empirical results obtained so far.

In the following sections we will review our approach to identifying studies relevant for research into the anthropomorphization of technology and follow with an assessment of the state of research in the related fields. Afterwards, we will present our empirically derived model and review the state of the research into each theme under our model.

Identifying and Reviewing the Available Research

This chapters presents a comprehensive listing of the extant literature on anthropomorphism and technology. For inclusion, the studies had to: 1) the studies primary focus be on anthropomorphism or the social perception of technology, 2) the study must explicitly measure anthropomorphism as an Independent Variable (IV) or Dependent Variable (DV) of interest or it must develop a measurement of the Anthropomorphism, and 3) it was published in a recognized journal or conference proceedings.

Studies that were identified as mentioning anthropomorphism but not being focused on it or that were focused on anthropomorphism but in a context unrelated to the use of technology were excluded. Additional exclusion criteria included the removal of studies that explored anthropomorphism but did not measure it or any other proxy for the social perception of technology, as well as those studies or articles that were not published on recognized journals or conference proceedings.

During our search for relevant articles of anthropomorphism in the extant literature, we relied on a query to systematically review the literature within the databases of ABI/INFORM Collections and PubMed which provided us with a list of potential articles to review. Our initial search resulted in a total of 736 articles that mentioned either Anthropomorphism or the Computers are social actors paradigm (CASA) as well as the word Computer, Technology or Robot. We narrowed this list down to 234 relevant articles based on their focus on anthropomorphism and the social perception of technology (inclusion criteria number 1). In this phase, excluded articles discussed anthropomorphism in unrelated feels like its appropriateness as a tool for interpreting animal behavior.

Afterwards, we categorized each research study into either a study possessing direct measurements of Anthropomorphism or relying on indirect measurement. This led to a reduction of the list to 102 different articles adequate for inclusion. Within these studies, we identify key factors such as the explored hypotheses, Independent and Dependent Variables Used, whether mediators or moderators were considered, the authors and year of publication, the source journal, the nature of the task participants carried out, the findings, and the sample size, gender distribution and source.

Apart from the original set, additional studies were gathered from two sources. First, we identified other studies by the same authors that were primarily focused on anthropomorphism of technology or its social perception but were not identified during the initial search of the databases. Secondly, we identified other studies that were frequently cited by our initial set and were also primarily focused on anthropomorphism.

These studies could be classified in two categories. The first group measured anthropomorphism directly or measured a proxy variable of the social perception of technology. These studies were included in the analysis of the factors related to anthropomorphism and were combined with the list above to provide a stronger explanation of the phenomenon.

In the second group, the authors reported anthropomorphism as being the underlying mechanism that explained the relationship being explored but did not measured whether the technology was perceived as a social agent and therefore failed to meet inclusion criteria 2. Because of this constraint, we combined these sets of articles with those that indirectly explored anthropomorphism. We decided to include the set of studies that explored anthropomorphism indirectly for analytical purposes due to their potential explicative power of the phenomenon.

Model Development

To build our empirical model, initial factors for our model were gathered from the results of the anthropomorphism-related hypotheses tested empirically in our list of identified studies. Using a qualitative coding strategy based on grounded theory, we analyzed the content of each research study to capture the essence of the factors and relationships being explored and developed axial codes (referred to here as themes) and Selective codes (referred here as overarching themes) (Strauss & Corbin, 1998) (Creswell & Poth, 2018, p. 174). This approach was chosen so that new themes could be capture from the commonalities between studies that could have otherwise gone unnoticed. Below we report a full list of the antecedents and consequences found on the initial exploration of the databases, and a sample of the representative work that supports each construct of the model. The numbers match to the specific hypotheses testing these constructs in relation to anthropomorphism as reported in the appendix under table 10.

Table 2 Empirical Literature Supporting the Anthropomorphism Model

Antecedents	Representative Work	Consequences	Representative Work
Framing	11	Information Credibility Judgement	5
Emotional Priming	62	Attitudes Toward Company	14
Identity Cues [Name or social Labels]	44	Customer Satisfaction	15
Presence/Absence	1	Emotional Connection with Company	16
Handheld Device Viewing (opposed to Non-handheld Device Viewing aka "physical engagement")	76	Social Presence	38
Presence of Avatar (Visual Realism)	96	Perceived Homophily	39
Game Cognition Demand	144	Attitudes	40
Computer Efficacy (of User)	118	Behavioral Intention to Return to Website	41
Homophily [Perceived Group Membership]	156	Psychological Copresence	90
Visual Anthropomorphic Cues	63	Social Richness of Medium	91
Higher Fidelity (Visual Realism)	87	Interactant Satisfaction with Communication	92
Anonymity of Avatars (Visual Realism)	93	Co-Presence (Social Presence)	124
Agent Type	105	Closeness	125
Androgyny [of Avatar representing Participant]	116	Intention to Use	126
Interactivity	6	Brand Attention	144
Conversational Cue [Message Interactivity]	50	Recall	145
Back-channeling Cues (Attentiveness to a Speaker)	132	Recognition	146
Behavioral Realism	84	Decision Accuracy	163
Voice (audio vs text vs subtitled)	191	Task Time	166
Visual Cues	192	Answer Time	167
Paralinguistic Cues [Mindless read of essay vs mindless read of essay] (e.g., volume, pitch, rate of speech)	196	Confidence in Answer	168
Anthropomorphic Cues [Language Style, Name]	23	Expressed Trust in Aid	169
Linguistic Anthropomorphic Cues	64	Behavioral Trust	172
Head posture	79	Sensitivity	173
Paralinguistic Cues (Nonverbal Signals of emotional Responses)	129	Response Bias	175
Interpersonal Warmth	157	Conservation Behaviour	181
		Gambling Behaviours	183
		Gambling Outcomes	184
		Effectance Motivation	179
		Social Connection	182
		Emotional Experience	186

After analyzing the results, we found three overarching themes for the antecedents of anthropomorphism including 1) Individual, 2) Contextual, and 3) IT Technology-related factors, and seven overarching themes for its consequences including effects 1) on the perception of the technology and others, 2) on the perception of the self, 3) on the perception of the interaction, and its effects on 4) on intentions to use the technology and the users' performance.

Each of these overarching themes is composed of several subthemes which we explored separately. For example, the section on contextual factors as antecedents of anthropomorphism explores a) framing and emotional priming effects, b) cognitive load and awareness of an entity’s nature, and c) the type of interaction involved. The comprehensive lists of Overarching Themes, Themes, and Categories for antecedents and consequences can be found below.

Table 3 Coding of Antecedents of Anthropomorphism.

Overarching Themes	Themes	Categories
Contextual Factors	Impression Forming	Emotional Priming
		Framing
		Identity Cues [Name or social Labels]
	Physical Engagement	Handheld Device Viewing (opposed to Non-handheld Device Viewing aka "physical engagement")
		Presence of Avatar (Visual Realism)
		Presence/Absence
Individual Factors	Cognitive Load	Game Cognition Demand
	Computer Efficacy	Computer Efficacy (of User)
	Social Identity	Homophily (Perceived Group Membership)
Characteristics	Appearance	Agent Type
		Androgyny (of Avatar representing Participant)
		Anonymity of Avatars (Visual Realism)
		Higher Fidelity (Visual Realism)
		Visual Anthropomorphic Cues
	Cues	Back-channeling Cues (Attentiveness to a Speaker)
		Conversational Cue [Message Interactivity]
		Interactivity
	Behavior	Behavioral Realism
		Visual Cues
		Voice (audio vs text vs subtitled)
	Paralinguistic Cues	Anthropomorphic Cues [Language Style, Name]
		Head posture
		Interpersonal Warmth
		Linguistic Anthropomorphic Cues
		Paralinguistic Cues (Nonverbal Signals of emotional Responses)
		Paralinguistic Cues [Mindless read of essay vs mindless read of essay] (e.g., volume, pitch, rate of speech]

Table 4 Coding of Consequences of Anthropomorphism.

Overarching Theme	Theme	Category
Individual Performance	actual performance	Answer Time
		Task Time
	Confidence	Confidence in Answer
	Decision Making	Decision Accuracy
	User Performance	Gambing Outcomes
Of Usage of Technology	Intention to Use	Behavioral Intention to Return to Website
		Intention to Use
On Perception of Interaction	Empathy	Emotional Connection with Company
		Social Connection
	Enjoyment of Interaction	Customer Satisfaction
	Satisfaction	Interactant Satisfaction with Communication
	Social Presence	Closeness
		Co-Presence (Social Presence)
		Psychological Copresence
		Social Presence
		Social Richness of Medium
On Perception of Others	Attitude (Evaluation of Other)	Attitudes Toward Company
	Brand Awareness	Brand Attention
		Recall
		Recognition
On Perception of Technology	Affective Response	Emotional Experience
	Credibility	Information Credibility Judgement
	Attitude (Evaluation of Technology)	Attitudes
On the User	Mental Model (Elicited Agent Knowledge)	Response Bias
		Sensitivity
	Prosocial Behavior	Conservation Behaviour
	Social Identity	Perceived Homophily
	Understand Others	Effectance Motivation
	User Behavior	Gambing Behaviours
Perception of Others	Trust	Behavioral Trust
		Expressed Trust in Aid

In the following pages, we will present our findings for both the antecedents and consequences of anthropomorphism in the extant literature, including a model based on the results of the empirical studies identified, and a table with the reference studies and hypotheses that tested each factor mentioned.

4.1 Antecedents of Anthropomorphism

Research into the antecedents of anthropomorphism tends to focus on the components of an interaction from the point of view of a participant involved in the interaction. Namely researchers tend to explore the characteristics that encourage participants to anthropomorphize technology from the point of view of: 1) the individuals involved in the interaction and how they vary, 2) the perceived characteristics of the technology (i.e. the artificial agent), and 3) the relational context in which the interaction takes place. We will review each of these areas as we explore the extant literature on antecedents of anthropomorphism.

Table 5 Categories of Interest for Exploring the Antecedents of Anthropomorphism.

Antecedents	Sub-category
Individual Factors	• Demographics & Culture • Psychological Determinants • Beliefs and Mental Models
Context-related Factors	• Framing & Emotional Priming • Cognitive Load & Awareness • Type of Interaction

Technology-related Factors	• Agent Embodiment, Appearance, and behavior • Apparent Social Cues • Responsiveness and Interactivity • Discourse, Gestures, and Body Language • Paralinguistic Cues

4.2 INDIVIDUAL FACTORS

While anthropomorphism was first described as a non-conscious phenomenon that affect everyone homogeneously, the homogeneity assumption has come under challenge for the past couple of decades and the phenomenon is now though to vary significantly between individuals and be dependent on both conscious and non-conscious processes (Marakas, Johnson, & Palmer, 2000) (Chin, Sims, Clark, & Lopez, 2004) (Letheren, Kuhn, Lings, & Pope, 2016). Among these studies exploring how people differ in their social perception of technology, we seem two trends.

First, we have studies that explore how individuals' motivation affect their tendency to anthropomorphize a technology including factors such as how lonely a person feels, and their desire to understand the behavior of others (Epley, Waytz, & Cacioppo, 2007).

A second stream of research focuses on those factors inherent to the humans that alter their propensity to anthropomorphize, or in other words, lead to individual differences (Marakas, Johnson, & Palmer, 2000) (Johnson, Marakas, & Palmer, 2006) (Johnson, Marakas, & Palmer, 2008). These studies focused on factors that were more nuance to an individual such as the person's core beliefs and personality (Letheren, Kuhn, Lings, & Pope, 2016) (Wang W. , 2017). The differences in these streams of research are reflected in the themes we identified as appreciated in the model below.

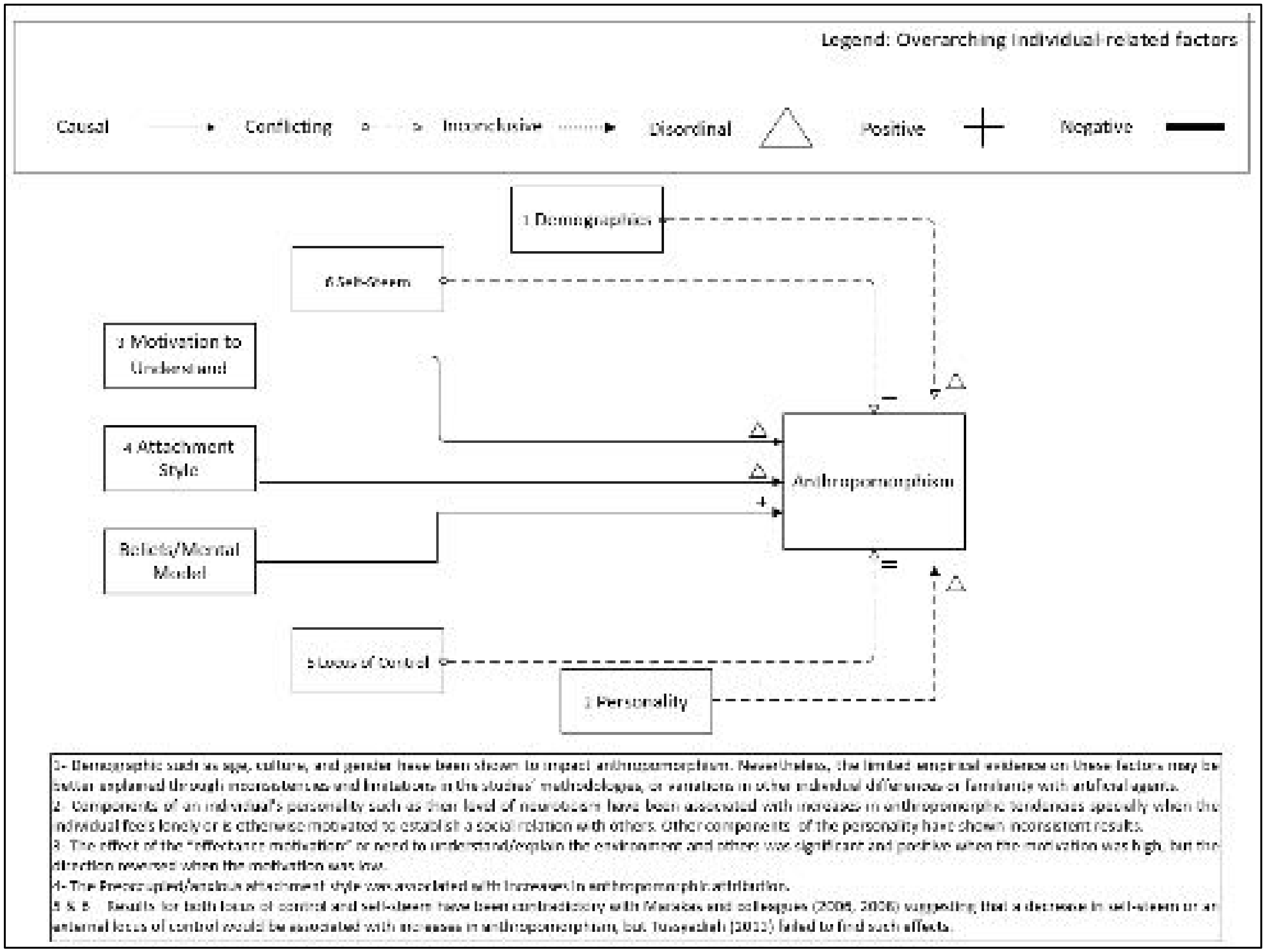
Table 6 Individual Factors Supporting the Anthropomorphism Model

Antecedents	**Representative Work**	**Reference Hypotheses**
Age	(Pak, Fink, Price, Bass, & Sturre, 2012)	162, 169
Gender	(Pak, Fink, Price, Bass, & Sturre, 2012)	163, 168
Computer Self-Efficacy	(Nowak & Rauh, 2008)	118, 119
Homophily	(Eyssel & Kuchenbrandt, 2012)	155, 156, 158, 159, 160,
Self-Awareness	(Sah & Peng, 2015)	72, 73

Culture	(Bartneck, 2008) (Yu & Ngan, 2019) (Salem, Ziadee, & Sakr, 2014) (Shahid, Krahmer, & Swerts, 2014)	*Hypotheses Not Listed Individually.
Tendency to Anthropomorphize (Continuum of Perspective [CP] & IDAQ)	(Marakas, Johnson, & Palmer, 2000) (Epley, Waytz, & Cacioppo, 2007) (Letheren, Kuhn, Lings, & Pope, 2016) (Waytz, Cacioppo, & Epley, 2010) (Severson & Lemm, 2016)	*Hypotheses Not Listed Individually.
Motivation to Understand	(Epley, Waytz, & Cacioppo, 2007) (Tam, 2015)	*Hypotheses Not Listed Individually.
Availability of Mental Models	(Epley, Waytz, & Cacioppo, 2007)	*Hypotheses Not Listed Individually.
Sociality Motivation	(Epley, Waytz, & Cacioppo, 2007) (Epley, Waytz, Akalis, & Cacioppo, 2008) (Bartz,	*Hypotheses Not Listed Individually.

	Tchalova, & Fenerci, 2008) (Bodford, Kwan, & Sobota, 2017)	
Self-esteem	(Johnson, Marakas, & Palmer, 2006) (Johnson, Marakas, & Palmer, 2008) (Tussyadiah, 2013)	*Hypotheses Not Listed Individually.
Locus of Control	(Johnson, Marakas, & Palmer, 2006) (Johnson, Marakas, & Palmer, 2008) (Tussyadiah, 2013)	*Hypotheses Not Listed Individually.
Beliefs	(Johnson, Marakas, & Palmer, 2006) (Johnson, Marakas, & Palmer, 2008) (Waytz, Cacioppo, & Epley, 2010) (Waytz, Cacioppo, & Epley, 2010)	*Hypotheses Not Listed Individually.

Figure 5 Model of the individual-related overarching themes influencing anthropomorphism.



4.2.1 Demographics & Culture

Age.

Out of the papers identified to have measured anthropomorphism directly, Pak et al (Pak, Fink, Price, Bass, & Sturre, 2012) was the only to make an explicit and direct comparison between age groups and the effects of anthropomorphism on a complex task. In their study, they compared the effects of a decision aid (anthropomorphic, vs a non-anthropomorphic vs no aid) on factors related to the decision making of the user and found that young adults reported significantly higher levels of trust on the anthropomorphic decision aid, than on the non-anthropomorphic aid or the scenarios with no aid, suggesting that young adults were anthropomorphizing the technology. While this effect was not observed for older adults, an analysis of the behavior of the participants during the experiment showed that both young adults and older adults exhibited significantly higher levels behavior associated with trust (referred to as “behavioral trust”) when interacting with the anthropomorphic aid than with any other group.

Another study by Vollmer et al (2018) showed similarly inconsistent results in different age groups when exploring social conformity. In their experiment, the authors relied on the Ash paradigm to test whether a group of adults tasked with evaluating the proper length of a line, would conform to the peer pressure of a group of robots answering incorrectly before them. While the adults showed no indication of conforming, a second experiment with a sample of children did achieve the expected results when the participants exhibited a tendency towards aligning with the groups’ predominant answer rather than sticking with what they considered to be the correct answer.

While these studies may seem to suggest that the age of participants was either an antecedent or a moderator of anthropomorphism as some researchers have argued before (Piaget, 1929), alternative hypotheses can be interpreted from these results. For instance, Vollmer and colleagues noted that while adults seem to attribute human-like qualities to machines, they appear to be able to inhibit the effects of normative influence. While no underlying mechanism was given for this explanation, this argument matches results from other studies that suggest cognitive dissonance between the non-conscious tendency to anthropomorphize and the conscious understanding of the nature of technology causes individuals to significantly alters their responses to compensate their tendency to anthropomorphize (Urquiza-Haas & Kotrschal, 2015). Therefore, the results discussed above could be the result of the older adults becoming uneased by the uncommon scenario of being placed among a group of humanoid robots in Vollmer's study, or becoming unease by the anthropomorphic agent in Pak's study.

In the case of the study by Pak and colleagues, the inconsistent results may simply be the result of individual differences in the individuals composing the young adults and the older adults. Whereas the study relied on university students to gather the sample of young adults, the older adults' group was composed of respondents to a newspaper advertisement. It seems reasonable to suspect that the older adults responding to the newspaper may be less familiar with this type of interfaces causing them to react with similar unease as we described above for Vollmer's participants.

Gender.

Multiple studies have explored the impact of an individuals' gender on their tendency to anthropomorphize technology. An early study relying on anthropomorphism as a theoretical basis on how humans interact with technology, showed significant effects of gender over how much individuals interacted with technology (Luczak, Roetting, & Schmidt, 2003). This study suggested that women interacted significantly more with technical devices than men. On the other hand, more recent studies have found no effects of gender on anthropomorphism (Kim, Cho, Ahn, & Sung, 2019) (Bartneck, 2008) (Chaminade, Hodgins, & Kawato, 2007) (Banks, Westerman, & Sharabi, 2017). In particular, even when considering combinations of gender of the participant and the perceived gender of the technology, results for the effect of gender over anthropomorphism remained non-significant (Kang & Watt, 2013).

Gender has also played a major role in the development of instruments to measure anthropomorphism and anthropomorphic tendencies. Early on, Chin and colleagues (Chin, Sims, Clark, & Lopez, 2004) developed a questionnaire for measuring individual's tendency to anthropomorphize and showed that gender led to differences in anthropomorphism of animals with women having a stronger tendency to self-engage in anthropomorphic behaviors. Nevertheless, this tendency did not translate into the anthropomorphism of artifacts where no gender effects were found. At the same time, researchers Johnson, Makaras, & Palmer engaged in a series of studies testing their Continuum of Perspective (PC) which aimed to predict differences in anthropomorphism tendencies among individuals (Johnson, Marakas, & Palmer, 2006) (Johnson, Marakas, &

Palmer, 2008). Within these studies, the authors found significant gender effects over and individual's Continuum of Perspective and their tendency to attribute human-like qualities to technology, with women being more likely to hold social beliefs of about the technology as well as perceive the technology as possessing a higher ability to control personal rights.

Culture.

Another area of interest in the literature has been whether the cultural orientation of an individual affect their perception of the technology and the likelihood that a person will anthropomorphize it (Marakas, Johnson, & Palmer, 2000). These studies recognized that variations in culture could affect how humans perceive and interpret information from their environment as well as how they respond to it altering the both the likelihood that they would anthropomorphize the technology and how they will respond to an anthropomorphized artificial agent (Culley & Madhavan, 2013) (Yogeeswaran & Dasgupta, 2014).

Early empirical results explored whether these topics, and consistently showed that different cultures would react differently to different types of robots altering how they anthropomorphize them (Salem, Ziadee, & Sakr, 2014). For example, Bartneck demonstrated that US participants would anthropomorphize more robots based on the human-likeness of their faces, but Japanese participants would anthropomorphize more humanoid and toy robots faces (Bartneck, Who like androids more: Japanese or US Americans, 2008).

Furthermore, studies that indirectly rely on anthropomorphism have supported these arguments. Yu & Ngan (2019) showed that variations in cultural orientation as exemplified by power distance can lead to different interpretations of a technology's apparent behavior as shown by variations of the perceived warmth of a technology. Similarly, other studies have shown that children from different cultures can interpret interactions with a social robot as being closer to interaction with toys or with other children (Shahid, Krahmer, & Swerts, 2014).

Nevertheless, other studies have shown that finer detail is needed in these studies. In his exploration of social disposition and anthropomorphism, Wang (Wang W. , Smartphones as Social Actors? Social Dispositional Factors in Assessing Anthropomorphism, 2017) showed that the cultural orientation of an individual in terms of how individualist or collectivistic that person is, is not a significant direct determinant of anthropomorphism and suggested that rather than the culture itself being the defining factor that leads to anthropomorphism, some underlying aspects of a culture that account for variations in attitudes, motivations, and behaviors may be at the root of the reported effects of cultural orientation on anthropomorphism.

While the number of studies exploring the relevance of culture for anthropomorphism is limited, the results tend to be consistent in that some aspect of a person cultural orientation can affect their that person's tendency to anthropomorphize. A major limitation of this stream of research is that it mostly focuses on exploring variations in tendency to anthropomorphize rather than whether anthropomorphism actually took place, and those studies that explore the actual phenomenon tend to imply that anthropomorphization took place (Shahid, Krahmer, & Swerts, 2014) (Yu & Ngan, 2019), or rely on variations in the country of origin of the sample as a proxy of culture rather than actually measuring the culture of the participants (Salem, Ziadee, & Sakr, 2014).

Apart from variations in interpreting signals, Waytz and colleagues argues that, just as Piaget once suggested, these cultural differences can be the result of different exposures to animals and religions which in turn change the mental models children possess about others which remain as they grow up and affect their tendency to anthropomorphize (Waytz, Klein, & Epley, Imagining Other Minds: Anthropomorphism Is Hair-Triggered but Not Hare- Brained, 2013) (Piaget, 1929). In other words, as we interact with other entities, whether they be animals or objects, we develop alternative explanations for their apparent behavior, and these models ultimately affect our values, practices, and beliefs which can trigger the anthropomorphization of a given technology (Waytz, Klein, & Epley, Imagining Other Minds: Anthropomorphism Is Hair-Triggered but Not Hare- Brained, 2013).

4.2.2 Psychological Determinants of Anthropomorphism

Anthropomorphism and the Computing Technology Continuum of Perspective

Following Nass and colleague's demonstration of the pervasiveness of social responses to media and technology (Nass, Steuer, & Tauber, 1994), multiple researchers have questioned the homogeneous nature of the phenomenon. Marakas, Johnson and Palmer (Marakas, Johnson, & Palmer, 2000) first hypothesized that the social response to technology described by Nass would be influenced by situational and dispositional factors of the interaction. One such key factor proposed by Marakas and colleagues is that of an individual’s core self-evaluations. A person’s core self-evaluations have been defined as those fundamental evaluations about ourselves and our relationship to our environment that differentiate us from each other (Judge, Locke, & Durham, 1997).

Judge, Erez, Bono, and Thoresen (2002) further argued that a person’s core self-evaluations is a personality trait composed of a person’s self-reported believe that they can achieve a needed behavior (generalized self-efficacy), their view of themselves as worthy of respect (self-esteem), their beliefs of whether they are in control of a situation rather than an external force (locus of control), and the extent of their emotional stability including their propensity to be optimistic or have doubts and worries (emotional stability/neuroticism) (Judge & Kammeyer-Mueller, 2011).

In two separate follow up studies, Johnson and colleagues provided support for the effects of core self-evaluations over research on the social perception of technology. First, they tested the relationship between the core self-evaluations as a construct and both the social perception of technology, and on the continuum of perspective (Johnson, Marakas, & Palmer, 2006). They found significant support for both relationships with the core self-evaluations positively influencing the social perception of technology directly, and indirectly through an individuals’ continuum of perspective.

Interestingly, the authors also explored whether the nature of the relationship may change for individuals at the extreme sides of the Continuum of Perspective (CP). The results show that for individuals on both extremes of the Continuum of Perspective, the Continuum of Perspective fully mediates the effects of the core self-evaluations on the social perception of technology as the direct effects of the core self-evaluations dissipate

(Johnson, Marakas, & Palmer, 2006, p. 454). In the final study of the series on the continuum of perspective, the authors expanded on the conceptualization of the Continuum of Perspective to include factors related to a person's believes about the intelligence, socialness, control, and control rights of the technology (Johnson, Marakas, & Palmer, 2008). Once more, the results showed the significant effects of an individual core self-evaluations on a person's Continuum of Perspective and, through it, on the social perception of technology.

General Computer Self-Efficacy

Following Bandura's (1997) argument that domain specific measures of self-efficacy are more predictive, Marakas and colleagues argued that focusing on a person's General Computer Self-Efficacy (GCSE) would lead to improvements in predictive power when compared to measuring a person's general self-efficacy (Marakas, Johnson, & Palmer, 2000). The authors defined the construct of General Computer Self-Efficacy as a person's perceived capacity in performing tasks while using a computer (Marakas, Yi, & Johnson, 1998). While the GCSE was not tested directly to confirm its influence on the social perception of technology, as mentioned above, when included as a component of a person's core self-evaluations, it was found to have a significant influence over the social perception of technology and that individual's Continuum of Perspective (Johnson, Marakas, & Palmer, 2006) (Johnson, Marakas, & Palmer, 2008).

Other studies have explored the influence of self-efficacy on anthropomorphism and the social perception of technology more directly. Wang explored this very relationship on his dissertation (Wang W. , 2015) as well on an article published from it in Computers in Human Behavior (Wang W. , 2017). Wang takes on the attributional process model developed by Marakas and colleagues and their continuum of perspective, and attempts to expand it by exploring the relevance of other dispositional factors while conducting an exploratory analysis of the role that smartphone self-efficacy plays on the anthropomorphization of technology. Smartphone Self-efficacy was a specific computer self-efficacy adapted from Marakas, Johnson, and Clay (Marakas, Johnson, & Clay, 2007). Interestingly, the exploratory analysis suggested that neither the history of smartphone ownership, nor the reported self-efficacy were relevant to the attribution of anthropomorphism (Wang W. , 2017, p. 339).

Nowak, and Rauh (2008) expanded on these findings by exploring whether an increase sense of self efficacy due to higher usage of an instant messaging application, could result in a decrease in the perceived anthropomorphism of an avatar representing the other person they were interacting with. While their hypothesis was **not supported** as the increased self-efficacy failed to significantly affect the attribution of anthropomorphism directly, they found that the increase in computer efficacy led by higher usage of instant messaging and an increased in perceiving avatar androgyny, which in turn interacted with the frequency of usage of instant messaging to significantly affect the anthropomorphization of the avatar. In other words, the study seems to suggest that computer efficacy by itself alters the perceptions of the appearance of the technology, which in turn may lead to changes in the anthropomorphization of the technology depending on other contextual factors.

Finally, Banks and colleagues (Banks, Westerman, & Sharabi, 2017) add to the complexity of the results shown by Nowak and Rauh by showing that anthropomorphism and self-efficacy can be influenced in the same direction by the perception of physical engagement that holding a device brings to the user. In their study, Banks and colleagues argue that such "mere holding effect" can lead users to perceive a sense of psychological ownership (PO) over the device that can reduce their assessment of personhood of potential partners based on their online profile. Because the components of psychological ownership need not be correlated, the authors explore the impact of holding the device on each separate component including self-efficacy.

The result showed that self-efficacy was significantly affected by whether the device was handheld or not, but contrary to what was hypothesized the handheld condition led to a lower perceived self-efficacy rather than an increase on it. This is interpreted as the physical engagement resulting from holding the device negatively affecting the assessment of self-efficacy of the user, and thus suggesting a correlation between self-efficacy and anthropomorphism in the opposite direction than hypothesized by Marakas et al. (Marakas, Johnson, & Palmer, 2000).

Locus of Control, and Self-esteem

Research into other components of a person's core self-evaluations have been significantly limited. The role of the locus of control, or an individual's beliefs that he or she has control over his or her environment (Rotter, 1990), as well as that of a person's self-esteem, or his or her self-evaluation that he or she is worthy of respect, have been mostly ignored by the extant literature. Johnson, Marakas and Palmer found support for both factors as having both direct effects on the attribution of social roles to technology as well as indirect effects on it through the construct by affecting an individual's Computing Technology Continuum of Perspective (Johnson, Marakas, & Palmer, 2006). However, the locus of control and self-esteem appeared to influenced different components of the Continuum of Perspective (Johnson, Marakas, & Palmer, 2008). In this study, individuals with a higher locus of control were more likely to ascribe intelligence, socialness, control, and control rights to the technology. On the other hand, those participants with a high self-esteem were only significantly influencing the ascription of socialness, control, and control rights, but not intelligence (Johnson, Marakas, & Palmer, 2008, p. 177).

The influence of a person's locus of control on the attribution of social roles towards computing technology was further explored by Tussyadiah (2013). Tussyadiah adapted the Computing Technology Continuum of Perspective to fit the context of smartphone usage and renamed the construct "Mobile Technology Continuum of Perspective" or MTCP. In her study, she aims to explore why some tourists tend to make social attributions towards their mobile devices when they travel. While the study found significant effects of the social characteristics of the mobile phones, and the purpose of the travel of the users (as a contextual factor representing circumstance attribution), the study failed to support the hypothesis that the core self-evaluations of the tourist would influence those social attributions of the mobile devices. Although the component of self-esteem was not considered, none of the other three components of self-evaluations used by Marakas and colleagues (namely General Computer Self-efficacy, locus of control and Neuroticism) achieved significance. The author argues that the lack of support for the core self-evaluations may reflect the strong power of the anthropomorphic design of the smartphones which overpowered the effects of the users' core self-evaluations.

The data from the study also suggest further considerations. For instance, the author notes that the core self-evaluations of the participants did not fall into a normal distribution, and after revising the data, it seems that most participants were high on self-efficacy (feel capable of taking the needed actions), low on neuroticism (emotionally stable), and low on external orientation (feel they are the capable of changing their environment), and therefore they should fall into a locally simplex attitude which would suggest low likelihood of attribution of social characteristics, yet this results were not observed. This could be explained by something as uninspiring as an issue of the data collection, but it could also be the case that the measurements used may need to be refreshed to reflect the changing nature of technology. After all, key studies offering explanations of the social nature of the technology, and anthropomorphism date back to the 90s and mid 2000s when not even smartphones as we know them today were available, much less virtual assistants or autonomous technology.

Tussyadiah (2013) also explored the social attribution towards mobile phones. While the components of Perceived Intelligence, and Perceived Socialness of the Continuum of Perspective had significant effects in increasing social attribution to mobile devices, the influence of the Perceived Control of the technology was not supported. Additionally, neither were any of the core self-evaluation factors including the locus of control, though self-esteem was not considered for this study.

Research into the locus of control and anthropomorphism has been very limited. While our literature review could not find other studies that address the locus of control and anthropomorphism, multiple studies do focus on the perceive control over the interaction, or the desire for control of the user. These studies typically follow the motivational determinants of anthropomorphism presented by Epley and colleagues and will be further discussed in a separate section.

Neuroticism and the Big 5 Personality Traits

The final core self-evaluation proposed by Marakas and colleagues is that of emotional stability also referred to as Neuroticism (Marakas, Johnson, & Palmer, 2000). Neuroticism refers to how emotionally stable an individual is, including how susceptible she is towards anxiety, and feelings of dependence and helplessness or prone to optimism and free of doubts (Costa & McCrae, 1988) (Judge & Kammeyer-Mueller, 2011). As mentioned above, Marakas and colleagues found significant direct effects of neuroticism on the social attributions made to technology by aggregating it into the construct of core self-evaluations, as well as significant indirect effect through the influence of the core self-evaluations on the individual's Computing Continuum of Perspective (Johnson, Marakas, & Palmer, 2006). In addition, neuroticism was found to be related to all four dimensions of the Continuum of Perspective: Perceived Intelligence, Socialness, Control, and Control Rights (Johnson, Marakas, & Palmer, 2008). Nevertheless, contrary to these results, Tussyadiah found no direct effects of Neuroticism on the social attribution towards mobile devices by tourists, though indirect effects were found through Neuroticism influence on the Continuum of Perspective in turn influencing the social attribution (Tussyadiah, 2013).

The importance of Neuroticism in influencing social responses to computing technology is further signaled by other researchers. Luczak, Roetting and Schmidt (Luczak, Roetting, & Schmidt, 2003) showed similar effects as participants reported their experiences engaging with multiple technologies in their everyday life. In particular, the authors found similar results to Marakas et al. (Marakas, Johnson, & Palmer, 2000) as they found that participants that reported being highly neurotic also reported perceiving themselves as being less technically competent, a factor related to the self-efficacy construct. While these traits were not reported in conjunction with actual social attributions, the effects on technical competence do suggest an indirect effect on the social attribution of the technology. The authors expanded on this trait by exploring the relevance of two more personality traits on the social attribution to the technology based on the big five personality traits (Rothmann & Coetzer, 2003). A low level of agreeableness, or the level of individual concern for social harmony and altruistic behavior that a participant reported, led to similar results as a high neuroticism in participants, being associated with significantly lower levels of technical competence of the user. Furthermore, an analysis of the participants extraversion trait (representing how social, assertive, and active the participant reported themselves as being) was reported as being associated with significantly higher levels of interaction with the technology.

In their study exploring the persuasive effects of androids, Ogawa, Bartneck, and Sakamoto argued that the matching of the personality of the participant and the personality of the robot were critical in order to make the persuasive appeals effective (Ogawa, Bartneck, & Sakamoto, 2009). As part of the study, the authors reported that the personality traits ascribed to the artificial agent could be significantly influenced by the personality of the users themselves. Specifically, they noticed that the level of **openness** of the participant significantly influenced the ratings of extraversion given to the artificial agent and thus could influence the social attributions given to the technology. While the nature of this relationship is not discussed, it does make a point that even the level of openness of a person can affect the social attributions made to a technology.

Letheren, Kuhn, Lings, and Pope (2016) noticed the limited research into the relationship between personality traits and anthropomorphism, and hypothesized that both a person’s openness to experience as well as her agreeableness would correlate positively with their anthropomorphic tendency. In particular, the authors argued that since anthropomorphism is a creative process that benefits from being open to others’ way of seeing the world, a person who rated highly on openness will make that person specially sensitive to inferring humanness and perceive social connections to those non-human others and therefore they would be specially prone to making anthropomorphic attributions.

On the other hand, the authors argue that an individual with a high level of agreeableness would be prone to take the perspective of others and feel sympathy and empathy for them. Since these characteristics have led other researchers to study the correlation between agreeableness and theory of mind (Nettle & Liddle, 2008), the authors argue that it’s likely that it will lead to an increase likelihood of anthropomorphism.

The results of the study showed a positive correlation between openness to experience and anthropomorphic tendencies but failed to support the hypothesis that agreeableness and anthropomorphic tendencies were related. The authors argue that these findings suggest that people with high openness do not suppress their anthropomorphic tendencies as much as others increasing the likelihood that an anthropomorphic attribution will take place. On the other hand, the authors argue that since personality can be applied different depending on the context of an interaction, the expected relationship between agreeableness and anthropomorphic tendencies may have failed to be supported due to the influence of factors related to the context of the interaction that were not taken into account.

Finally, Salem and colleagues (Salem, Lakatos, Amirabdollahian, & Dautenhahn, 2015) explored the role that extraversion personality traits and emotional stability played in influencing anthropomorphic tendencies. The authors argued that the participant's extraverted and emotionally stable personality would enable the anthropomorphization of social robots and affect a person's willingness to collaborate with it.

While the big 5 and the core self-evaluations overlap to an extent, Judge and Kammeyer-Mueller (Judge & Kammeyer-Mueller, 2011) noted that other researchers have shown even when considering all these personality factors, they remain statistically significantly independent from one another. Therefore, there is value in considering the importance of all of them at once.

Inductive Thinking & Motivational Determinants

A second stream of research exploring the psychological determinants of anthropomorphism developed in parallel within the field of social psychology. Epley, Waytz, and Cacioppo (2007) noticed that only a small set of studies focused on the psychology behind anthropomorphic perceptions, and proposed a theory based on motivation and inductive thinking that attempts to explain why anthropomorphism takes place. They propose that anthropomorphism was likely an inductive process and therefore it must work through similar means as other inductive processes. Specifically, the authors argued that an anthropomorphic inference must be contingent on the mental model a person holds during an interaction which would be dependent on:

1) the likelihood of activating knowledge about interactions with other humans,

2) the likelihood of correcting the mental model brough by said knowledge to reflect the non-human knowledge about the nature of the interaction partner, and

3) the likelihood that the person will apply these models on the other agent during an interaction.

This inductive process of anthropomorphism, which the authors called "**Elicited Agent Knowledge**" due to its theorized reliance on human mental models when interacting with perceived agents, was argued to **interact with a person's motivations** to produce anthropomorphic attributions of non-human entities. Two types of motivations were said to be especially significant. First, an individual's motivation to interact effectively with the environment and explain complex phenomena while also being able to predict and entity's future behaviors. By anthropomorphizing other entities, humans gain an increased ability to explain or make sense of that entity's perceived actions. They referred to this as "**Effectance Motivation**". Secondly, the authors argue that individuals' need and desire to relate to others and establish social connections with them, or "**Sociality Motivation**", would also significantly affect their likelihood to anthropomorphize (Epley, Waytz, & Cacioppo, 2007). By anthropomorphizing a perceived entity, humans transform the entity into another human with which they can relate. We discuss the available support for each component in the following pages.

Elicited Agent Knowledge

Direct research into the role of the **elicited agent knowledge** factor as a source of anthropomorphic attributions has been limited. Some researchers have chosen to explicitly explore this factor and attempt to operationalize it by testing whether the design of a technology encourages social responses and biases from the user (Eyssel F. , Kuchenbrandt, Hegel, & de Ruiter, 2012), while others studies have carried out similar experiments but made little to no reference to an inductive process being the source of this perception (Hertz & Wiese, 2018). Finally, a third group of researchers has shown a strong linkage between anthropomorphism and neurological processes involved in the social perception of other humans, suggesting that we do rely on at least similar mental processes for both forms of interactions (Chaminade, et al., 2010) (Urquiza-Haas & Kotrschal, 2015).

Within the **first group**, Eyssel, Kuchenbrandt, Hegel, and de Ruiter (2012) attempted to vary the accessibility of human mental models by varying the characteristics of a robot. Specifically, the authors operationalized the elicited agent knowledge factor by assuming that an increase in the use of human-like vocal cues such as the human-likeness of the voice (as opposed to a robot-like voice) would encourage the anthropomorphization of the robot as evidenced by a person interacting with the robot responding to it as if it were a human, applying biases and social judgements to the robot. These findings are also supported by earlier studies by Powers and Kiesler (Powers & Kiesler, 2006) that explore whether the mental models a person held about a robot could mediate the relationship between its physical characteristics and the participant's intention to take the robots advice. While the study was not meant to explore anthropomorphism or attribution of mental states, it did show that the design and use of different humanlike characteristics of the robot could influence the mental model the participants held about the robot including and, through it, their impression of it as a sociable robot (i.e. activated non-social categories such as machine, or social categories like "nice people") resulting in significantly different intentions to follow its advice.

Furthermore, Eyssel and Kuchenbrandt (2012) continued on to suggest that the original arguments made by Epley and colleagues on the nature of elicited agent knowledge needed to be expanded. They proposed that individuals use of mental models would include knowledge structure associated with other human-related characteristics such as nationalities and culture as well as the originally proposed anthropocentric knowledge (e.g. knowledge about oneself and others). Therefore, experimental investigation seems to support the argument that inductive reasoning is a critical process through which anthropomorphism takes place.

The **second** set of studies follows a similar operationalization to the first set, with varying levels of the human-likeness of physical characteristics of the entity as well as of its behavior in order to produce a social response from the individual interacting with the entity. However, these studies differ in that they do not explicitly explore the role of inductive reasoning or changing mental models in the relationship between the varying levels of human-likeness and the social effects the authors aim to explore. Instead, these studies tend to either imply that anthropomorphism will take place (Go & Sundar, 2019) or rely on a different argument for why anthropomorphism should happen (Urquiza-Haas & Kotrschal, 2015). Since the focus of these studies tend to be on the effects of the design characteristics of the technology rather than on how anthropomorphism takes place, we will continue their discussion under the Technology-related factors section below.

Finally, studies exploring the neurological correlates of anthropomorphism have also consistently shown correlations between activation in brain networks associated with the anthropomorphization of non-human entities and those used when humans interact with other humans. While these studies provide some support for the argument that technologies are anthropomorphized as mental models of humans are applied to them (i.e. inductive reasoning), the majority of the studies focus on either implicit and automatic mechanisms for the perception of other, or on mechanism associated with causal reasoning. Therefore, it seems likely that while anthropomorphism has some inductive component to it, it also possesses properties of causal reasoning, and implicit and automatic perceptions.

An early study was carried out by Chaminade and colleagues (Chaminade, Hodgins, & Kawato, 2007) that aim to explore how the appearance of a virtual character affects the perception of its actions. The authors conducted an experiment where they asked participants to characterize a virtual character's motion as either biological or artificial while they varied the character's appearance from least to most human-like, and its motion between captured biological motion data and motion designed by an animator. The results of the experiment showed significant effects of both the character's appearance and motion on its anthropomorphic perception with the more human-like its appearance and behavior, the more human-like the character was perceived.

In the 2nd part of the study, the authors put the same participants through a fMRI analysis while they took a similar experiment as before. The results showed significant effects of the character's appearance on the perception of motion having a biological origin, and significantly higher activity in brain areas associated with the Mentalizing system of the brain as the appearance became more human-like. Since the mentalizing system is well regarded as the system that allows humans to attribute inner mental states such as emotions, thoughts and intentions to other humans (Geiger, et al., 2019), Chaminade's findings (Chaminade, Hodgins, & Kawato, 2007) provide some support for Epley and colleagues (Epley, Waytz, & Cacioppo, 2007) theory in favor of human mental models being used as humans interact with anthropomorphized entities. These results are further extended by a separate study by Chaminade and colleagues (Chaminade, et al., 2010) where the authors, through the use of fMRIs, found similar brain structures being used by humans to read emotions in other humans and in anthropomorphized non-human entities. Nevertheless, neither study clarifies whether inductive reasoning is the actual cause of anthropomorphism, or whether other processes such as causal reasoning may be at play.

Contrary to the results found by Chaminade and colleagues, Kühn, Brick, Müller, and Gallinat (2014) found no activation in the Temporoparietal Junction (TPJ) and the Medial Prefrontal Cortex (MPFC) of the Mentalizing network when participants were exposed to car fronts and asked for adjectives that characterized the car fronts while undertaking an fMRI. Nonetheless, the study did find that looking at the car fronts led to activation in the Fusiform Face Area (FFA), a specialized area of the visual system responsible for discrimination that requires expertise such as facial recognition (Sergent, Ohta, & Macdonlad, 1992) (Isabel, Tarr, Anderson, Skudlarski, & Gore, 1999). This suggests that car fronts were recognized as faces, but not attributed cognitive abilities.

Other studies have provided additional support for individual differences in how these attributions are made. While dealing with anthropomorphization of animals rather than technology, researchers Spunt, Ellsworth, and Adolphs (2017) found that participants undertaking an fMRI who observed facial displays of humans and non-human animals while judging the acceptability of emotional and facial descriptions showed similar brain activation in the prefrontal and anterior temporal cortices which are regions associated with causal explanations. Since the similarity in brain activation seemed to vary depending on the participants' self-reported beliefs in the mental capacities of the non-human animal, it seems that, at least in the case of anthropomorphism of animals, causal reason also plays a significant role in anthropomorphism.

Finally, Cullen, Kanai, Bahrami, and Rees (2014) found that while the mentalizing system is activated non-consciously, individuals still show significant differences in their likelihood to anthropomorphize which correlate to the volume of gray matter available in the left temporo-parietal junction, a key area associated with the Mentalizing system.

Motivational Determinants: Effectance & Sociality

Epley and colleagues (Epley, Waytz, & Cacioppo, 2007) argued that the key motivational determinants of anthropomorphism were effectance motivation, or an individual's motivation to master her environment by increasing its predictability and controllability (Harter, 1978), and sociality motivation which refers to humans' fundamental need to connect socially with other humans. In a study following the original proposal of the model, Epley Waytz, Akalis and Cacioppo (2008) conducted two separate experiments to test each determinant empirically.

The first experiment aimed at exploring how individuals' sociality motivation can influence their anthropomorphic attributions. In this experiment, Harvard University undergraduate students completed a 20-item loneliness scale and were then asked to consider and rank from most descriptive to least descriptive 14 traits of their pets. As hypothesized, the participants who reported feeling more lonely ranked anthropomorphic traits of their pets significantly higher providing support to the argument that chronic loneliness encourage individuals to create agents for social support (Epley, Waytz, Akalis, & Cacioppo, 2008, p. 148).

In the second experiment, the authors aimed to test the role of an individual's effectance motivation on anthropomorphism. To do so, they had visitors to the Decision Research Lab at the University of Chicago take a questionnaire on desirability of control after which they viewed a video clip of two dogs interacting with one another while exhibiting varying levels of predictability in their behavior. Finally, the participants were asked to evaluate both dogs on items representing their anthropomorphism: the extent to which each dog was aware of its emotions, possessed a conscious will, possessed a personality, and their similarity to other life forms. The results showed that participants were significantly more likely to anthropomorphize the unpredictable dog, especially if the participants' desire for control was high, thus providing additional support to the sociality determinant of anthropomorphism.

These results were further supported by Tam (2015) who built on the motivations explored by Epley and colleagues to test the effectiveness of anthropomorphic persuasive appeals in the context of environmental persuasion for environment preservation. Their results matched those found by Epley, Waytz, Akalis, and Cacioppo (Epley, Waytz, Akalis, & Cacioppo, 2008) with anthropomorphic persuasive appeals being more effective and motivating more conservation behavior than non-anthropomorphic persuasive appeals when participants possessed high need for social connection, or effectance. However, the effect of anthropomorphic appeals reversed for participants with low need for social connection or effectance with anthropomorphic appeals leading to a decrease in conservation behavior under those conditions.

Effectance Motivation

The concept of effectance motivation is further developed by Waytz, Morewedge, Epley, Monteleone, Gao, and Cacioppo (Waytz, et al., 2010) who conducted a series of 5 experiments to show the importance of increasing effectance on increasing the anthropomorphic attributions. These experiments included 1) asking participants to describe the computer they typically used and rate it on the extent it appears to have a mind of its own, or behavior as if it possessed its own beliefs an desires, 2) asking participants to evaluate devices they were not familiar with, 3) analyzing the brains of participants with an fMRI as they carried out experiment 2, 4) examining the effects of the predictability of a robots' behavior on its anthropomorphization, and 5) exploring if motivating individuals to explain the behavior of a robot could enhance the effects of the effectance motivation, and 6) exploring whether anthropomorphizing an agent (dog, robot, alarm clock, or shape) could satisfy a person's need for mastery and control of the environment. The results of the experiments consistently showed that the more unpredictable the behavior of the technology being considered, the more it was anthropomorphized and provided fMRI scans showing increased activation in the Mentalizing network to support the argument that the technology was indeed being anthropomorphized rather than simply participants using mind as a metaphor to describe its behavior. The fifth and sixth studies were of interest as they expand on our prior understanding from the literature. The fifth study showed that encouraging participants to make accurate predictions increases the effectance motivation and encourages anthropomorphism, providing a way of controlling this phenomenon. The 6th experiment showed that only does effectance motivation encourages anthropomorphism, but anthropomorphizing a technology satisfies the need for effectance of the participant.

Sociality Motivation

Other studies have focused instead on expanding the understanding of the Sociality Motivation. Epley, Akalis, Waytz, and Cacioppo (2008) conducted 3 experiments to explore the effect of chronic loneliness on anthropomorphism while varying the agent of interest in each (Gadgets, God, and Animals). Through these studies, the authors noted that not only are chronic individuals more likely to anthropomorphize others, but inducing participants to feel lonely by asking them to think about loneliness was enough to increase their tendency to anthropomorphize. Similar results were also found by Bartz, Tchalova and Fenerci (Bartz, Tchalova, & Fenerci, 2008) who replicated the results found by Epley, Akalis, Waytz, and Cacioppo (2008), but expanded them in two significant ways. First, the study showed that not only can a desire to connect lead to anthropomorphism, but simply reminding others of their existing social connections was enough to attenuate their tendency to anthropomorphize. Secondly, the study also measured the role of attachment style in anthropomorphism, and noted that individuals that showed attachment anxiety (i.e. intense desire and preoccupation with maintaining a feeling of closeness, as well as a fear of being abandoned) was a stronger predictor of anthropomorphism than loneliness. Finally, Wang (2017) also explored the role of chronic loneliness and attachment style on anthropomorphism in a survey. The results showed that similarly to the previous studies, both chronic loneliness and a preoccupied attachment style were significant predictors of anthropomorphism.

Other studies on attachment style showed similar results. Bodford, Kwan, and Sobota (2017) explored whether individuals with an anxious attachment style would be more likely to develop both an anxious attachment to their smartphones, and to anthropomorphize it. After conducting a survey with 262 respondents, they found that attachment style to other humans was a predictor of both attachment style to the smartphone and an individual’s anthropomorphic beliefs. Moreover, when they conducted a mediation analysis, the authors founds that anxious smartphone attachment fully mediated the relationship between anxious human attachment and anthropomorphic beliefs suggesting that humans with an anxious attachment style develop similarly anxious attachments to their smartphones which in turn are what influences their beliefs about the technology.

Finally, studies by Neave, Tyson, McInners and Hamilton (2016) as well as by Norberg, Crone Kwok, and Grisham (2018) have both shown significant associations between anxious attachment styles and anthropomorphism. Neave and colleagues (2016) asked participants to complete a questionnaire exploring their attachment style, attachment to objects, anthropomorphic tendencies, and hoarding behaviors. The results showed significant positive effects of anxious and avoidant attachment styles and anthropomorphism on Hoarding Behaviors. A mediation analysis further revealed that when controlling for the effect of the attachment style, the role of anthropomorphism on hoarding behaviors disappears, suggesting that it is attachment style which is influencing both anthropomorphism and, through it, hoarding behaviors rather than anthropomorphic tendencies being influencing hoarding behaviors themselves. This represents significant evidence for the relationship between anxious and avoidant attachment styles and anthropomorphism. Norberg, Crone Kwok, and Grisham (2018) provides further evidence for this argument as it also showed a significant effect of anxious attachment style on anthropomorphism, and a significant effect of both factors on excessive buying behaviors, a proxy of excessive acquisition and hoarding.

4.2.3 The Social Role of Technology: Beliefs & Mental Models

Studies into the role of beliefs and mental models on anthropomorphic attributions have been carried out since the social perception of technology has been explored (Nass, Steuer, & Tauber, 1994) (Nass & Moon, 2000). Early on, Marakas and colleagues argued that the social perception of technology was likely not homogeneous among individuals, but was bound to show individual variability (Marakas, Johnson, & Palmer, 2000). Among the factors that would determine the social perception of technology, they proposed the generalized beliefs humans hold about the social role and capabilities of technology would significantly influence their tendency to perceive the technology as a social agent. They named this factor the Computing Technology Continuum of Perspective (CP). Johnson, Marakas, and Palmer carried out two separate studies to test components of this model. In the first study (Johnson, Marakas, & Palmer, 2006), the authors conducted a laboratory study to empirically test the model first proposed by Marakas and colleagues (Marakas, Johnson, & Palmer, 2000). The results supported the hypothesis that where the individuals fell on the Continuum of Perspective's range as defined by their general beliefs would significantly influence their tendency to perceive the technology as a social agent. Moreover, Johnson, Marakas and Palmer (2008) explore the components that compose this Continuum of Perspective and identified through an empirical examination that the individual's beliefs about the intelligence, socialness, locus of control, and specific control over rights and freedoms of the technology were the key beliefs that affected the social attribution towards technology.

Around the same time Schectman and Horowitz (2003) explored the role a person beliefs about the nature of a "partner" they are interacting with (whether it appeared to be another person, or a computer program) affected how they responded to it. As a result, participants who believe they were interacting with another person showed more behaviors associated with establishing an interpersonal relationship such as flattery, connection, advice, and yielding. While not specifically about anthropomorphism, this study shows that the beliefs a person held about the system could affect the way they experienced and responded to it in a significant and measurable way. Additionally, Lemaignan, Fink, Dillenbourg, and Braboszcz (2014) argued that these mental models were far from static, and rather developed throughout the life cycle of the interaction with the mental model a person holds at the beginning of the interaction going through three phases of development. These results were supported by Kiesler and Goetz (2002) who developed a technique to measure the richness and content of people's mental models of a robot and discovered these models grew and changed as the interaction progressed.

The beliefs held about other agents has also formed the basis of the Individual Differences in Anthropomorphism Questionnaire (or IDAQ) (Waytz, Cacioppo, & Epley, 2010), one of the main questionnaires used to explore anthropomorphism and anthropomorphic tendencies across fields. Bodford, Kwan, and Sobota (Bodford, Kwan, & Sobota, 2017) relied on the IDAQ questionnaire to explore the impact that attachment style towards other humans, and towards smartphones would have on the individual differences in tendencies to anthropomorphize. Our extant literature review shows this to be one of the most popular methods for measuring anthropomorphism based on the studies found on our initial query-based search through PubMed and ABI/Informs Collections.

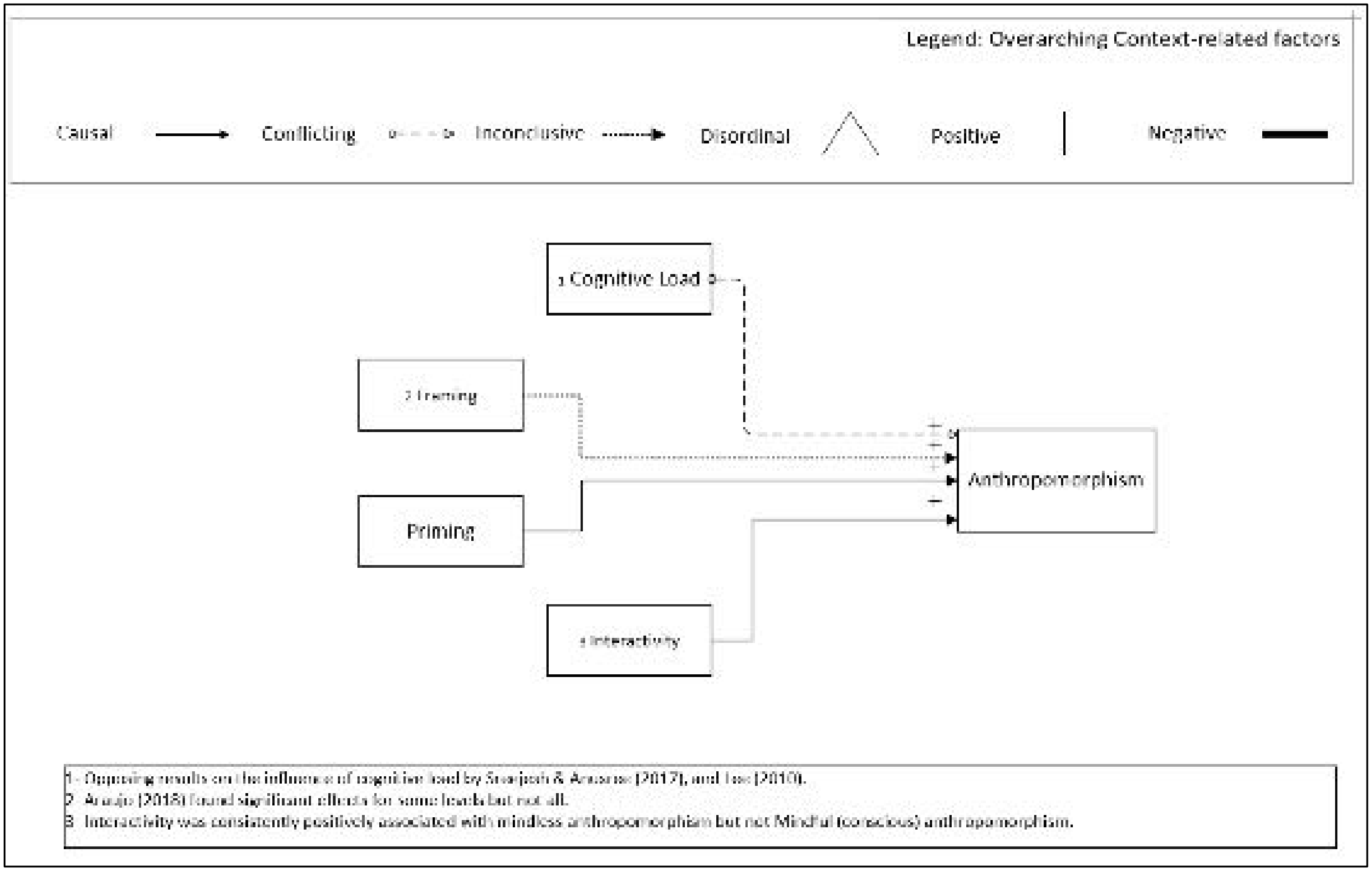
4.3 CONTEXT-RELATED FACTORS INFLUENCING ANTHROPOMORPHISM

The context in which the interaction with technology takes place has also been shown to have significant effects over anthropomorphism and the social perception of technology. Studies exploring these factors have focused on the constructs of how the technology is presented (i.e. framing and priming), the cognitive load the individual is going through, and the type of interaction taking place. We review the extent of our knowledge about the influence of these factors below.

Table 7 Contextual factors Supporting the Anthropomorphism Model

Antecedents	Representative Work	Reference Hypotheses
Framing Effects	(Araujo, 2018) (Pak, Fink, Price, Bass, & Sturre, 2012)	11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 164, 171
Priming Effects	(Pak, Fink, Price, Bass, & Sturre, 2012) (Tam, 2015)	164, 165, 166, 167, 175, 176, 177, 178,
Cognitive Load	(Sreejesh & Anusree, 2017)	135, 136, 137, 144, 145, 146
Group Membership (as priming)	(Eyssel & Kuchenbrandt, 2012)	155, 156, 158, 159, 160,
Interactivity	(Kim & Sundar, 2012) (Go & Sundar, 2019)	6, 7, 8,9, 10, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61,

Table 8 Model of Overarching Context-related Themes



4.3.1 Influencing Initial Perceptions: Framing & Emotional Priming

As research into the antecedents of anthropomorphism has progressed, researchers have begun to question whether individuals can be encouraged to perceive technology as a social agent prior to their initial interaction with it. A study by Riva, Sacchi and Brambilla (2015) on the use of anthropomorphic agents within the gambling industry explored whether the humanlike characters in slot machines used in casinos could encourage potential users to anthropomorphize the machines and increase gambling behaviors and earnings for the casino, resulting in worse returns for the user. Riva and colleagues conducted multiple experiments within this study to explore different aspects of the presentation of the machines, and concluded that presenting these machines with humanlike terms within an initial description (for example "The slot machines can decide whether you will win or lose" (Riva, Sacchi, & Brambilla, 2015, p. 319)) was enough to encourage users to increase gambling behaviors and loose more money due to increases in its anthropomorphic perception.

Cha and colleagues (Cha, et al., 2020) have also shown the impact that presenting our technology in multiple ways has over its perception as a social actor. Specifically, the authors explored how individuals react when their distinctiveness is threatened by a technology that becomes capable of performing some typically uniquely human characteristic as represented by the moment when Google's AlphaGo computer managed to beat the human Go champion Lee Sedol in Go, a abstract strategy game often considered too complex for computers (Koch, 2016) (Silver, et al., 2016). To achieve this, Cha and colleagues conducted multiple experiments in which they primed participants with pictures of the AlphaGo against Lee Sedol encounter, or through different explanations of the encounter varying between framing it as an inter-group comparison, a control condition, and an inter-individual comparison with the expectation that the framing would make participants feel their distinctiveness to be threatened due to changes in their self-evaluations and changing intragroup judgments as argued by Schmitt, Silvia and Branscombe (Schmitt, Silvia, & Branscombe, 2000) based on social identity theory. The results of the study showed that the priming had the intended effect of making participants feel threatened which altered their reported factors that represented human uniqueness as reported first in the IDAQ questionnaire (an indicator of tendency to anthropomorphize), and later as social creativity through superiority ratings (indicator a human uniqueness).

The results by Riva and Cha provide support that priming the interaction can affect anthropomorphism both directly as represented by Riva (Riva, Sacchi, & Brambilla, 2015), or by influencing the tendency to anthropomorphize as shown by Cha (Cha, et al., 2020). Nevertheless, not all studies have shown positive results. An early study by Bartneck (Bartneck, 2008) aimed to explore how differing cultures tend to anthropomorphize technology differently by presenting them with pictures of robots varying in human likeness. In the study, Bartneck included a sample of pictures of humans as part of the range since the original data included a highly realistic robot called "Geminoid" that replicates the appearance of the real human shown. Despite testing the effect of framing the pictures of the Geminoid by telling participants which one the robot and which the human, no significant effects were found by the framing. This could be because the participants did not perceive it to be a relevant factor as they were rating the likeability of the two by their appearance which didn't differ much, or they could tell the difference without the picture needing to be framed beforehand. Whichever is the reason, the study provided contradictory results in the understanding the effects of framing and priming on anthropomorphism.

Finally, Aggarwal and McGill (2012) explored the effects of priming brands that are typically anthropomorphized by users. The authors argued that priming individuals with brands that are perceived positively vs negatively can have differing effects over the individual's behavior, encouraging to, for example, take the stairs rather than the elevator. While the priming effects were found to be significant for brands typically anthropomorphized, the same was not true of non-anthropomorphized brands. While the study does not provide support for the effects of priming over the tendency to anthropomorphize, it does show that priming typically anthropomorphized brands can enhance their social effects suggesting a possible interaction between priming and the social perception of technology rather than a causal role.

4.3.2 Cognitive Load & Awareness of Nature of Agent

In their theoretical study on the nature of anthropomorphism Urquiza-Haas and Kotrschal (2015) reasoned that multiple non-conscious and conscious processes affect human's tendency to anthropomorphize. Following the iterative reprocessing model by Cunningham and Zelazo (2007) which argues that both the attitudes towards an stimulus (e.g. individuals, objects, or in this case anthropomorphize technology) and the evaluations or current appraisals of said stimulus affect humans response to the stimulus. The model proposes that early evaluations are more automatic as they depend significantly more on implicit cognitive mechanisms, while later evaluations become increasingly more detailed as various cycles of evaluation take place due to the involvement of reflective processes.

Based on this model, Urquiza-Haas and Kotrschal view anthropomorphism as being affected simultaneously by both implicit non-conscious processes and reflective conscious processes which leads them to argue that variations in the cognitive load a person is going through are bound to affect the anthropomorphic process differently depending on how the anthropomorphic attribution is triggered in the first place.

The authors argue that if anthropomorphism is being triggered by sensory information (i.e. **triggered through Bottom-Up** processing), a high cognitive load would interfere with the suppression of the social network of the brain, that is, a high cognitive load would hamper with the reflective processes (i.e. inductive or causal reasoning) that attempt to suppress the automatic tendency to anthropomorphize leading to higher anthropomorphization. On the other hand, if anthropomorphism is being triggered through conscious reflective processes such as inductive or causal reasoning (i.e. **triggered through Top-Down** processing), a high cognitive load would prevent the those processes from taking place in the first place and thus deter anthropomorphism, that is, it would prevent a person from anthropomorphizing an entity through inductive or causal reasoning. In other words, the authors argue that the origin of the trigger of anthropomorphism will moderate the relationship between the Cognitive Load and the Attribution of Mind with a high cognitive load encouraging anthropomorphism when it is activated through non-conscious processes, while suppressing it if it is being triggered though reasoning. This view seems to be supported by the extant empirical studies available.

In testing how games that integrate advertising to promote products can lead to brand recognition, Sreejesh and Anusree (2017) hypothesized that highly interactive encounters with brand messages within the videos games that required high cognitive loads, would lead to higher brand attention, recall and recognition. The authors also argued that these relationships would be moderated by the level of anthropomorphism attributed to the brand with participants exposed to high brand interactivity, high cognitive demand, and an anthropomorphic representation of the brand developing higher levels of brand attention, recall and recognition due to the application of humanlike mental models to the interaction with the brand as suggested by the construct of Elicited Agent Knowledge proposed by Epley and colleagues (2007).

To test these arguments, Sreejesh and Anusree conducted an experiment with a between-subjects design where they asked participants to play a game while varying the levels of **anthropomorphism** (high vs low), **cognition** demand (high vs low) and **interactivity** (game interactivity/interactive features vs brand interactivity/message interactivity vs no interactivity). The results of the study showed that as initially hypothesized, exposure to highly anthropomorphic brands in conditions of high cognitive demand and high brand interactivity lead to statistically significant increases in brand attention, brand recall, and brand recognition and thus the authors conclude that high cognition demands interact with high anthropomorphic cues resulting in increases in mindless social attributions. Therefore, this study **provides support to the argument that higher cognitive load increases the tendency to anthropomorphize**.

On a separate study, Lee (2010) explored how the cognitive load a person undergoes while using it influences the extent that person applies social attributes to technology. The author argued that since the social response to technology was likely to be a mindless response to an apparent social stimulus (Nass & Moon, 2000), an increase in cognitive load would leave less cognitive resources to rationalize the stimulus increasing the effects of the mindless attribution (Lee E.-J. , 2010, pp. 193-194). To test these arguments, Lee conducted an experiment where participants would play an interactive trivia game consisting of 3 parts. The participant would first answer a question, after which the computer would provide either a generic or a flattering answer that the participant was told was random. The assignment of the participant was to answer whether the provided answer was correct or not, after which the trivia moved to the next question. To vary the cognitive load, a group of participants was asked to also memorize a string of numbers as they played the trivia. Finally, the social effects were measured as variations in the tendency to conform to the answers provided by the computer with a higher conformity rate (i.e. agreeing that the answer provided was correct) being interpreted as an increase in social conformity. Interestingly, the results showed that participants who were involved in only one task were more likely to conform to the generic comments, while participants who were involved in the two tasks showed no statistically significant difference in their conformity.

A posthoc analysis was carried out to explore whether those individuals showing higher conformity in the single task scenario were doing so because they possessed suspicions about the validity of the computer's output. Specifically, Lee explored whether the computer comments and the number of tasks affected the perception the perceived likelihood of the computer presented the correct answer and found that those flattered by the computer thought that the computer was less likely to present the correct answer than those who received the generic comments thus suggesting that **contrary to the expected results from the mindlessness hypothesis, there were more flattery (i.e. social) effects in the group with the lower cognitive load**.

While the results from Sreejesh and Anusree (2017) and Lee (2010) appear to contradict each other, looking at anthropomorphism as a tendency that can be initiated through both conscious and non-conscious processes as suggested Urquiza-Haas and Kotrschal (Urquiza-Haas & Kotrschal, 2015) could help us explain these results. Whereas both Sreejesh and Anusree (2017), and Lee (2010) could be argued to have implicitly encouraged the social perception of technology through an anthropomorphic appearance and high interactivity in the case of Sreejesh and Anusree, and flattery in the case of Lee, the fact that Lee asked participants to evaluate the believability of the messages could have moved the source of anthropomorphism from the implicit effects of flattery, to the rational evaluation of the truthfulness of the message. The changing source of anthropomorphism resulting in contradicting results in both studies. This view becomes clearer if we observe the work of Krcmar and Eden.

Krcmar and Eden (2019) offer strong indications that favor this view of anthropomorphism possessing both conscious and non-conscious origins at its core that can encourage the attribution of mental states either independently or in conjunction. The authors aimed to explore the relative impact of cognitive load and moral salience on the feelings of aggressions and guilt (i.e. social effects) that a person could feel while playing a video game. Similarly to Lee (2010), Krcmar and Eden based their hypotheses on the dual-process theory of cognitive experiential self-theory (Epstein, 1994) (Epstein & Pacini, 1999), which argues that humans possess two information processing systems representing an experiential, intuitive, automatic and non-conscious system referred to as “system 1”, as well as an rational system that is conscious, relatively analytical and intentional referred to as “system 2”. Following the view that anthropomorphism was a mindless or non-conscious process, Krcmar and Eden argued that that the perceptions of the realism of the characters (i.e. anthropomorphism) and the environment would increase as the automatic processes in the brain (system 1) dominated the interactions in the virtual environment over the reflective processes (system 2). Therefore, they argued that as the cognitive load increased, the effects of anthropomorphism would be enhanced resulting in larger social effects in the form of reduced in-game aggression and higher feelings of guilt during appropriate in-game stimuli. They operationalized this by conducting an experiment in which participants were asked to play a video game for 5 minutes as they memorized either 2 digits (low cognitive load) or 7 digits and after completing the game filled-in a questionnaire about their experience.

The results of the study were mixed. While no statistically significant effects were found for the effects of cognitive load on neither anthropomorphism nor feelings of guilt, cognitive load led to statistically significant lower in-game aggression. At the same time, an exploratory analysis of the results indicated that the mean-difference of the effects of cognitive load on anthropomorphism were on the expected direction in favor of more anthropomorphism with higher cognitive load, and an analysis of anthropomorphism as a potential mediator between the cognitive load and the lower in-game aggression using a bootstrap technique (Hayes, 2017) (Krcmar & Eden, 2019, p. 8) suggested that anthropomorphism was a significant negative predictor of aggression and guilt though it showed no influence of cognitive load on aggression through anthropomorphism. **The authors concluded that anthropomorphism was likely a significant predictor of aggression and guilt but that it was likely only slightly influenced by the cognitive load**.

Apart from these results, the methodology of the experiment can tell us more about the nature of anthropomorphism than what the results suggest. A key factor that should have received more consideration was the video game use, or more specifically the mission used called “No Russian”. No Russian was one of the most famous missions from the game “Call of Duty Modern Warfare 2” and it asked players who though were infiltrating a terrorist group in order to stop it, to participate in a massacre of random civilians in an airport as part of the terrorist group. According to one of the key developers of the mission, it was explicitly designed to force players to question their actions in a type of game in which they would normally move through without much thinking (Senior, 2012). This is important to explain the results of the study since many players reported to have done just that, stopping on their tracks and refusing to shoot the civilian avatars just as the participants in the experiment decrease in aggression (Parsons, 2010). The game showed immediate non-conscious responses as shown by a developer refusing right away to play that mission despite being willing to play the rest of the game (Evans-Thirlwell, 2016). But it also showed anthropomorphism through rationalization as suggested by players continuing to reject the mission over a decade after it was published (Smith E. , 2017).

Because of the popularity of the game, it would be feasible to argue that the experiment was biased because some participants might be familiar with the mission prior to the experiment. However, Krcmar and Eden controlled for the experience users had playing video games, so we think that explanation is unlikely. Alternatively, we would argue that the publicly reported experience of players matches well with the impressions of the participants. If participants in the experiment had an initial strong anthropomorphic reaction to what they perceived but followed it through with a rationalization of the wrongness of participating in a civilian massacre, the experiment might have encouraged anthropomorphization from both non-conscious and conscious processes. Assuming the game was a strong enough rational source of anthropomorphism, the cognitive load may have only switch from one source of anthropomorphism to the next arguably leading to similar responses from participants with high or low cognitive load.

The role of cognitive load in anthropomorphism remains inconclusive. The nature of anthropomorphism as a conscious or non-conscious process seems to be the key determinant in this, though even this question remains under debate (Kim & Sundar, 2012) with some researchers arguing in favor of it being a form of reasoning (Epley, Waytz, & Cacioppo, 2007) while others argue it is a non-conscious response (Nass & Moon, 2000). We argue the empirical evidence suggests that it is both, and, as Urquiza-Haas and Kotrschal (2015) proposed, the effects of cognitive load will differ depending on the source of anthropomorphism.

4.3.3 Type of Interaction/Relationship

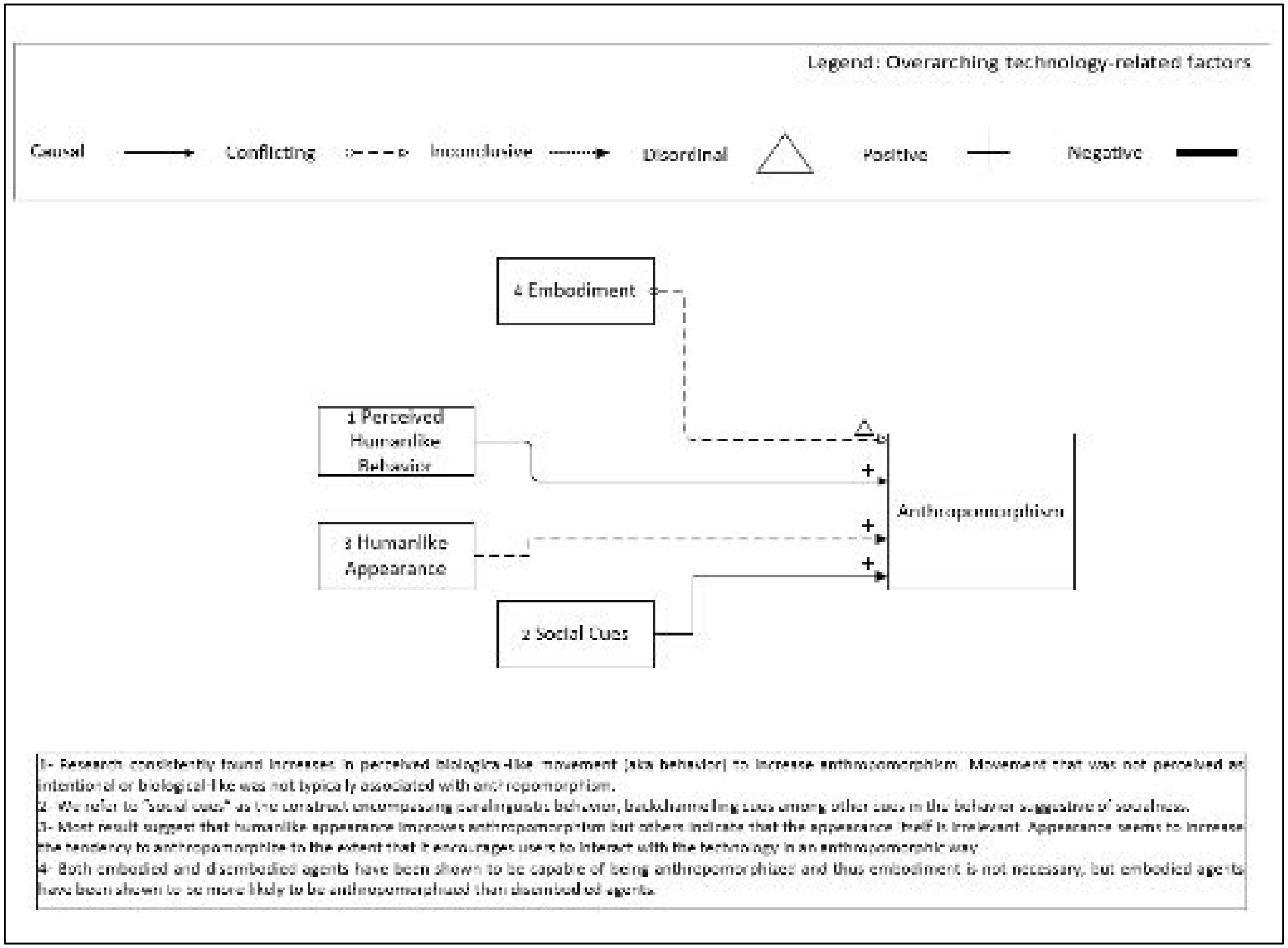
In their model of the Dynamics of anthropomorphism, Lemaignan, Fink, Dillenbourg, and Braboszcz (2014) propose that the process of anthropomorphization will varies based on how the interaction with a non-human entity is progressing. The authors propose that three cognitive phases with distinct implications can be distinguished. First, a pre-cognitive phase which describes the initial moments when an observer first engages with the entity which builds upon initial baseline capital or potential for the entity to be anthropomorphized based on factors such as individual differences and its appearance or behavior. The second phase is based on building familiarity and it describes how a person gets familiarized with the entity building upon the initial model. Finally, the adapted phase of anthropomorphism describes how after some time passes, the mental model used to perceive the entity becomes stable.

4.4 TECHNOLOGY-RELATED FACTORS: IT CHARACTERISTICS

A significant portion of the studies using anthropomorphism have taken place within the field of social robotics where humanlike appearance and behavior have long been among the predominant factors used in designing social robots (Hancock, et al., 2011) (Schaefer, Chen, Szalma, & Hancock, 2016), though multiple others were gathered from the fields of scial neuroscience, social psychology and human-computer and predominantly explored the relevance of multiple factors and characteristics of the technology on the overall interaction with individuals with appearance and the apparent behavior of the technology being the 2 most common factors.

Technology factors appear to revolve around the interaction style of the artificial agent, its appearance and visual cues, and its apparent behavior and social cues related to it. At the same time, researchers have explored variations on the perceived characteristics of the agent such as its personality, and credibility. These behaviors can be separated into 2 categories: it could promote behavioral markers that suggest intention and volition leading to mental agency rather than plain animism (Levillain & Zibetti, 2017), or it could demonstrate social cues that there is something "inside" encouraging the perception that it can feel as shown on Kory-Westlund experiments with children's in the classroom (Kory-Westlund, 2019).

Figure 6 Model of technology-related overarching themes associated with anthropomorphism.



4.4.1 The Role of an Agent's Embodiment & Appearance

A key characteristic that has been under research for the past couple of decades is whether the embodiment of a technology affects how human perceive it and whether it can affect humans' tendency to anthropomorphize and the social presence perceived from the technology (Deng, Mutlu, & Matarić, 2019). The construct of embodiment refers to more than the physical body a technology possesses and often includes factors such as proxemics, oculesics, and gestures used by an artificial agent to enhance communication (Deng, Mutlu, & Matarić, 2019, p. 2) (Pransky, 2019). Nevertheless, within this section we limit our scope to the role that the physical body of the technology has over its social perception as indicated by the extant empirical literature. These studies typically suggest that the physical embodiment of a technology can have significant effects in encouraging the social perception of technology as measured through anthropomorphism and social presence. We discuss three studies that have made significant contributions in our understanding of the relationship between physical embodiment and the social perception of technology.

An early study by Lee, Jung, Kim & Kim (2006) explored the role that the embodiment of a technology (e.g. a social robot or a virtual character) could have on the feeling of presence the technology evoke and, through it, the effects it had on an individual's perception of the technological artifact and the interaction. The authors conducted two experiments to explore these relationships. In their first experiment, participants interacted with either a physical "Aibo" social robot or a virtual recreation depending on their experimental treatment. Participants in both treatments could engaged with their respective robot either through physical touch in for the physically embodied robot, or through mouse clicks in the virtual robot group. Both robots responded to touch with the same behavior and after 10 minutes, the interaction was stopped and the participants were asked to rate their general evaluation of the robot, its social attraction, their evaluation of the interaction, and how other people would evaluate the robot.

The results provided statistically significant support to the researchers hypotheses with the physically embodied robot being positively related to improvements in all the factors just mentioned while the robots' social presence fully mediated the social attraction to the robot and partially mediated the general evaluation of the robot, their evaluation of the interaction and their assessment of the public's evaluation of the robot. This experiment **showed significant effects of embodiment in the social perception of technology**, but a possibility remained that the observed effects were the result of the mode of interaction rather than the embodiment and therefore the authors carried a second experiment with limited tactile contact participants could have with the technology so that all observed effects were the result of the embodiment of the robot.

In this second experiment, participants were exposed to a different social robot named April that was either physically embodied or virtually recreated similarly to how Aibo was presented. However, this time participants were explicitly asked not to touch the robot leaving them as onlookers while both the robot sang depending on the treatment (physical or virtual). The results showed that physical embodiment without touch was a significant negative predictor of social presence resulting in the virtual robot having significantly higher social presence and, through it, the participants reported significantly higher general evaluations and social attraction of the robot, as well as significantly higher evaluations of the interaction with the robot and assessment of others evaluations of the robot. In both studies, **the embodiment of the robot had significant effects on the social presence and thus social perception of the robot**, though the amount of tactile interaction with the robot seems to alter the direction of this relationship.

Kiesler and colleagues (Kiesler, Powers, Fussell, & Torrey, 2008) extended this research by exploring whether humans' would anthropomorphize more a physically embodied robot more than a software agent, and whether the robot being collocated, compared a remote robot projected on a screen, would also have a significant effect in increasing anthropomorphic attributions. In their experiment, participants were exposed either a physical robot or a virtual agent on a monitor which could be either located in the room with the participant or projected on a screen for a 2 by 2 factorial design. The participants were told to discuss health habits with the agents with the robot speaking, and the participant replying by typing on a keyboard. The robot asked questions on social desirability and after the experiment, the experimenter reentered the room, asked the participants to complete a questionnaire and offered them snacks on a bowl.

Supporting the initial hypotheses, participants disclosed less information to the physical robot than the virtual agent, attributed it more and stronger personality traits, said it was more lifelike, liked it better, and spent more time with it. All these results were taken by the authors as indicators that the participants interacted with the robot as more like a person than an object **supporting the argument that participants anthropomorphize physically embodied agents significantly more than virtual agents**.

Finally, Kwak and colleagues (Kwak, Kim, Kim, Shin, & Cho, 2013) expanded the results above and conducted to experiments to test how the physical embodiment of a robot (experiment two) and its level of agency (experiment one) affected individuals tendency to empathized with the robot. In the experiment testing physical embodiment, the authors relied on the robot as a mediator for communication with another person and therefore showed children who were participating in the study a picture of the person they were told was managing the robot. Then, the children drew a piece of paper to determine whether they would be the teacher (i.e. torturer) or the assistant-teacher (observer) in a modified version of Milgram's experiment on obedience to authority using two treatments: a physical robot or a disembodied robot shown on a screen (Milgram, 1974). Following Milgram's approach, the authors made sure the children always selected the teacher piece, giving them the responsibility of giving an electronic shock to the robot if it answered question on a learning task incorrectly. After each shock, the robot would show increased bruising and voiced its suffering. The results showed that participants in the physically embodied condition reported significantly more empathy towards the embodied robot supporting the argument that a **physical embodiment can increase the social perception of and attribution of affective states to the technology**.

These results consistently support the important role that the embodiment of technology has on its likelihood of being anthropomorphized though as Lee, Jung, Kim & Kim (2006) showed the effect seems to change depending on its level of interactivity. As Sah and Peng (2015, p. 399) argued later on, it seems reasonable to consider that the effects of the technology's appearance and physical embodiment lead to priming effects and as

Levillain and Zibetti (Levillain & Zibetti, 2017, p. 9) proposed whether the technology fulfills our initial expectations can have major effects on our impressions of it.

However, the fact that virtual agents were also anthropomorphized (though to a lesser degree in most studies) shows that physical embodiment, while potentially helpful, is not a necessary factor for anthropomorphism to take place. It is important to know that while other studies have explored the role of the physical presence of an artificial agent on anthropomorphic attributions (Kim & Sundar, 2012) (Araujo, 2018), they don't consider alternative representations and thus make it difficult to separate whether the observed effects were the result of the physical presence of an agent rather than a different type of representation (i.e. avatar or virtual agent) or simply because an agent existed. Therefore, we excluded these articles from this section.

4.4.1.1 Technology's Humanlike Appearance

The human likeness of an artificial agent's appearance, together with its apparent behavior, has been one of the most studied factors in the social perception of technology (Fink, 2012, p. 201) (von Zitzewitz, Boesch, Wolf, & Riener, 2013). Researchers have argued that to encourage mind perception and social attribution, non-human entities ought to display signs of agency and intentionality through its appearance (Kiesler, Powers, Fussell, & Torrey, 2008) (Abubshait & Wiese, 2017) which in turn promotes the application of humanlike mental states on those entities (Epley, Waytz, & Cacioppo, 2007). Some researchers have gone so far as to develop a typology of signals and cues for HRI that can encourage whether the appearance will be perceived as more humanlike or machinelike (Hegel, Gieselmann, Peters, Holthaus, & Wrede, 2011).

Table 9 Empirical Literature on Human-like Appearance & Anthropomorphism.

Representative Work	Antecedents	DV	Significance
(Bartneck, Reichenbach, & Breemen, 2004)	embodiment	Perceived Intensity of Emotion, Recognition of Emotion	Not Significant
(Gong, 2008)	Humanlike Appearance	Homophily; Social Influence	Significant [1P]
(Nowak & Rauh, Choose your "buddy icon" carefully: The influence of avatar androgyny, anthropomorphism and credibility in online interactions, 2008)	Anthropomorphic Appearance of User's Avatar; Androgyny of User Avatar;	Credibility; Anthropomorphic Perception	Significant [P]
(Riek L. D., Rabinowitch,	Humanlike Appearance	Tendency to Empathize with Robot	Significant [1P]

Chakrabarti, & Robinson, 2009)			
(Lee E.-J. , 2010)	Presence of Character	Social Influence	Significant [P]
(Hinds, Roberts, & Jones, 2004)	Humanlike Appearance	Anthropomorphism	Significant[1P]
(Sah & Peng, 2015)	Visual Anthropomorphic Cues	Social Perception	Not Significant
(Go & Sundar, 2019)	Anthropomorphic Visual Cues	Social Presence; Perceived Homophily	Not Significant
(Kang & Watt, 2013)	Anthropomorphism of Avatar (Visual Realism)	Psychological Co-presence	Significant[1P]
(de Visser, et al., 2017)	Anthropomorphic appearance of agent	Trust; Compliance; Performance;	Significant[1P]
(Chaminade, Hodgins, & Kawato, 2007)	Anthropomorphic Appearance	Sensitivity, Response Bias	Neuro, Brain Areas used for anthropomorphism overlapped with

			those for theory of mind
(Pak, Fink, Price, Bass, & Sturre, 2012)	Anthropomorphic Appearance	Decision Accuracy, Task time, Expressed Trust in Aid;	Mixed results of social effects, no direct measure of anthropomorphism
(Riva, Sacchi, & Brambilla, 2015)	Anthropomorphic Appearance of Machine	Gambling Behaviors	Significant[1P]
(Broadbent, et al., 2013)	Human likeness of Robot Face	Perception of Mind	Significant [P]
(Hertz & Wiese, 2017)	Anthropomorphic appearance (through still image)	Social Facilitation	Not significant
(Hertz & Wiese, 2018)	Anthropomorphic appearance (through still image); Cover story about agent;	Social Conformity	Significant
(Abubshait & Wiese, 2017)	Human likeness of Appearance	Judgement of Mind (attitudes);	Significant[1P]

(Syrdal, Dautenhahn, Walters, & Koay, 2008)	Human likeness of Robot	Proxemic Expectations	Significant[1P]
(King & Ohya, 1996)	Human likeness of Geometric Shapes	Perception of Agent; Assessment of Potential Intelligence;	Significant[1P]
(Hegel, Krach, Kircher, Wrede, & Sagerer, 2008)	Human likeness of Appearance	Perceived Intelligence;	Significant[1P]
(Khan P. J., et al., 2012)	Human likeness of Appearance	Accountability of Robot	Significant[1P]
(Zlotwski, Sumioka, Bartneck, Nishio, & Ishiguro, 2017)	Human likeness of Appearance	Reverse of Dehumanization [Uniquely Human Dimensions; Human Nature Dimensions];	Not Significant

[1] Implied relationship based on empirically tested social effect; [P] Positive Relationship; [N] Negative Relationship.

While most of the studies identified above on human likeness and anthropomorphism either explicitly or implicitly showed significant positive effects (Hinds, Roberts, & Jones, 2004) (Broadbent, et al., 2013) (Abubshait & Wiese, 2017), a significant portion continued to provide contradictory results (von der Pütten, Krämera, Gratch, & Kang, 2010) (Zlotwski, Sumioka, Bartneck, Nishio, & Ishiguro, 2017). Out of these, one study was focused on the relevance of the construct of dehumanization and its subcomponents to anthropomorphism and thus focused only on a subset of categories for perception of mind (Zlotwski, Sumioka, Bartneck, Nishio, & Ishiguro, 2017), while the other studies achieved null results. Multiple explanations have been offered to explain the inconsistency of results.

Sah and Peng (2015) argued that these discrepancies could be the result of how the artificial agents used were framed. The authors explained that while Lee (2010) managed the expectations of participants by describing the agent as a mere computer program, Kim and Sundar (2012) personified the agent by giving it a name raising expectations about its capabilities in the minds of participants which were not met resulting in a lower overall social perception of the agent that contradicts Lee's results despite the similarities in methodology. This view matches Levillain and Zibetti's argument that social expectations are significantly affected by the human likeness of an artificial agent and that a mismatch between these expectations and the actual behavior of the entity can lead to unintended effects (Levillain & Zibetti, 2017). By refraining from personifying the agent, Sah and Peng found significant effects of the visual cues (i.e. pictures of physicians) on both the public and private self-awareness of participants suggesting some social effects, however the social perception remain non-significant. The authors argue that this was probably because the lack of specification of an interaction entity led participants to see the picture as a graphical component of the interface rather than the entity with which they were interacting with and hence the presence of the pictures did not affect whether participants felt as if they were interacting with a human.

This last argument by Sah and Peng can also help us explain the result from other conflicting studies found on our search. While most of the studies we identified specified an entity such as a moving avatar or a robot as the interactant that participants would engage with, the studies by Sah and Peng (2015), Go and Sundar (2019), and Pak, Fink, Price, Bass and Sturre (2012) relied on a chatbot displaying a static pictures of a human or an object to convey variations in the level of human like appearance of their artificial agents. Following the proposal of Sah and Peng, it is certainly possible that participants perceived these images as design elements rather than a representation of the virtual embodiment of the agent participants were interacting with thus negating its usefulness in invocating human like mental models as proposed by Epley and colleagues (Epley, Waytz, & Cacioppo, 2007).

The final two studies with conflicting non-significant results for the role of appearance were by Bartneck, Reichenbanch and Breemen (2004), and Zlotowski, Sumioka, Bartneck, Nishio and Ishiguro (2017). Neither of these studies showed any of the limitations discussed above as rather than comparing static images of humans both studies employed moving robots in their comparison. Bartneck and colleagues compared an expressive robot called I-CAT to a movie representing the same robot and asked participants to rate the intensity and other factors of the expressions shown.

On the other hand, Zlotowski and colleagues compared the Robovie robot, which possessed both arms and a head but remained otherwise machine-like in appearance, to the Geminoid robot, a humanoid robot that looks almost indistinguishable from a human. Differing from Bartneck's approach, Zlotowski and colleagues asked participants to play "Acchi muite hoi" (i.e. a game played between two people using their hands akin to rock-paper-scissors) with the robot. Two possible explanations exist for why no significant was found in these studies.

First, Zlotowski and colleagues (2017) proposed that seems participants engaged in a long interaction with the robot, any initial impression gained from the appearance of the robot was probably minimized by the time they had finished playing and only the effects of the interaction itself remained by the time participants recorded their impressions. This explanation could also be relevant for Bartneck and colleagues (2004) as the participants in their study still engaged with the robot for a relatively long period of time. However, the interaction between participants of Bartneck's study was much more limited than for the participants of Zlotowski and therefore we offer an alternative explanation for the non-significant results of Bartneck and colleagues study (2004).

Secondly, rather than focusing on the perception of human like appearance and social perception of the robot, Bartneck's study (2004) explores the embodiment of the robot and whether it affect the participant's recognition of the robot's emotions. This is significant because while the physical presence of the robot may vary, both the embodied and disembodied versions possess the same overall appearance and capabilities. Additionally, recognizing expressed emotions, while related, is a different process than attributing those emotions to the entity and thus many not be a representation of anthropomorphism. Therefore, asking participants for their perception of different qualities of the emotions displayed by either an embodied or disembodied robot may neither explore the influence of the human likeness of its appearance nor its anthropomorphization.

Taking these arguments into consideration, the conflicting results seem to suggest that for appearance to be effective the participant must recognize the operationalization as part of the entity they are interacting with, and that a person's initial impressions from the appearance can rapidly change as the person continues to engage with the entity.

The extant literature is consistent in showing that the appearance of an agent increases human's tendency to make social attributions to that entity. Nevertheless, the embodiment literature tells us that such embodiment is neither sufficient, nor necessary for anthropomorphism to take place. Rather, how an artificial agent's responds to us and behaves seem to be more critical factors involved in human's anthropomorphization of technology (Airenti, 2018) (Sah & Peng, 2015).

4.4.2 Artificial Agents' Apparent Behavior

The second most common factor under anthropomorphism research has been the perceived behavior of an artificial agent (Fink, 2012, p. 201). Contrary to research into embodiment or the human likeness of an agent, research into the behavior of technology has taken many forms with diverse outcomes (Kim & Sundar, 2012) (Araujo, 2018). Factors related to how technology engages with users (Go & Sundar, 2019), the qualities of its apparent behavior (Wang, Lignos, Vatsal, & Scassellati, 2006), and the social cues that it communicates (Lee, Lee, & Sah, 2019). We discuss these in the sections below.

Table 10 Literature on Movement/Behavior of an Entity and Anthropomorphism

Representative Work	Antecedent	DV	Significance
(Chaminade, Hodgins, & Kawato, 2007)	Biological Movement vs Artificial Movement	Response Bias	Mixed (Interacted with Appearance with significant differences between the groups a) ellipse and robot character, and b) monster, clown, and jogger. However, not significant within each group)
(Eyssel, Kuchenbrandt, & Bobinger, 2011)	Predictability of Robot Behavior	Anthropomorphic Inferences	Significant [N] (low predictability increased tendency to anthropomorphize)
(Wang, Lignos, Vatsal, & Scassellati, 2006)	Head movement	Perceived Intentionality	Significant[P] (with increases in avoidance and unsmooth tracking)
(Abubshait & Wiese, 2017)	Behavior	Social-Cognitive Performance;	Significant[1P]

(Kim & Sundar, 2012)	Interactivity	Mindful Anthropomorphism; Mindless Anthropomorphism;	Mindful: No Significance Mindless: Significant[P]
(Bracken, Jeffres, & Neuendorf, 2004)	Feedback Type (Praise vs Criticism)	Perception of Computer as Social Entity	Significant[P]
(Lee, Lee, & Sah, 2019)	Paralinguistic Cues; Back-channeling Cues;	Closeness;	Partial Support** (Significant when Mind Perception is High)
(von der Pütten, Krämera, Gratch, & Kang, 2010)	Behavioral Realism	Social Perception	Significant[P]
(Miwa & Terai, 2012)	Perceived Behavior	Influence over Strategy Selection	Significant[1P]

(Kang & Watt, 2013)	Behavioral Realism	Psychological co-presence;	Not Significant
(Mara & Appel, 2015)	Head Posture	Perceived Human likeness	Significant[P] (head tilts increased the attributed human-likeness of the robot)
(Sah & Peng, 2015)	Linguistic Anthropomorphic Cues	Social Perception	Significant[P]
(Go & Sundar, 2019)	Interactivity	Social Presence	Significant[P]
(Araujo, 2018)	Language Style (Anthropomorphic Cue)	Mindful Anthropomorphism; Mindless Anthropomorphism; Social Presence;	Mindful & Mindless: Significant[P]; Social Presence: Not Significant;
(Kim & Sundar, 2012)	Interactivity	Mindful Anthropomorphism; Mindless Anthropomorphi	Mindful Anthropomorphism: Not Significant; Mindless Anthropomorphism: Significant[P]; Social Presence: Significant[P] among

		sm; Social Presence;	not exposed to anthropomorphic character with High Interactivity (Direction not hypothesized)
(Fasola & Mataric, 2012)	Relationship Building Behavior (praise and relational discourse)	Effectiveness; Enjoyableness; companionship; User preference;	Exploratory: Suggest positive implications of relationship building behavior on all DVs;
(Salem, Ziadee, & Sakr, 2014)	Politeness of Artificial Agent	Anthropomorphism; HRI experience;	Significant when controlling for Culture;
(Heider & Simmel, 1944)	Movement	Perception of Others' Behavior;	Exploratory;
(Sreejesh & Anusree, 2017)	Brand Interactivity	Brand Attention; Brand Memory; Brand Anthropomorphism;	Significant on all DVs;

(Salem, Lakatos, Amirabdollahian, & Dautenhahn, 2015)	Reliability of Behavior	Assessment of robot reliability; assessment of robot trustworthiness; Interaction choices; willingness to cooperate with robot;	Assessment of robot reliability -> Significant; Assessment of robot trustworthiness -> Significant; Interaction choices -> not significant; willingness to cooperate with robot -> not significant;

Research into the role of observed behavior on the attribution of mind to technology and its social perception can be traced back to Heider and Simmel's original experiment of apparent behavior (Heider & Simmel, 1944). Heider and Simmel developed a film showing multiple two-dimensional geometric figures moving around a square and asked participant to describe what they saw. Participants responded by personifying the figures. They described stories on how the figures interacted with one another and perceiving movement as intentional actions. Some described birds engaging with one another, others an enraged man finding a girl he likes with another man. The study has been accepted as a prime representation of humans tendency to see the world in terms of intentional actions and agents (Durayappah-Harrison, 2011) (Goldman J. G., 2013).

4.4.2.1 Theoretical arguments for the influence of apparent behavior on anthropomorphism

Levillain and Zibetti (2017) built on the conclusions made by Heider and Simmel (Heider & Simmel, 1944) as well as other similar studies (Castelli, Happe, Frith, & Frith, 2000) (Kassim, 1982) (Morris & Peng, 1994) to develop a theoretical framework that explains how humans perceive movement and which properties of the movement lead to humans to attribute of mental agency to the entity being observed. The authors argue that humans can infer agency through three mechanisms.

Firstly, they can infer that a transfer of energy took place when they observed two moving entities touching each other and then moving away. Secondly, humans tend to interpret extended movements as an indication that the action took place in order to achieve a goal (referred to as extended goal-directed actions). Finally, as humans attempt to explain the context of the actions, they tend to construe a narrative based on social routines or mental models.

Based on theories of behavior from the field of biology [cites], Levillain and Zibetti emphasize humans may perceive an entity's movement as a behavior if 1) the changes in the environment resulting from said movement appears to be generated by the entity rather than a result of an external influence or mechanisms, and 2) those changes appear to possess meaning in the context they took place.

Levillain and Zibetti refer to these objects capable of exhibiting apparent behavior as behavioral objects and argue that rather than simply being projected human attitudes or believes, the behavior they exhibit is sufficiently complex to be implicitly considered a recipient of mental attributes (Gaudiello, Lefort, & Zibetti, 2015). Finally, the authors propose that the nature of the apparent behavior can provide behavioral cues suggestive of different levels of interpretation with the most basic behaviors suggesting whether the entity may be alive (i.e. animism), going through whether it appears to have intentions (i.e. Agency), and finally whether it can take into account others goals in its own actions similarly to how theory of mind functions for humans (i.e. Mental Agency). The range presented by Levillain and Zibetti is provided below for reference.

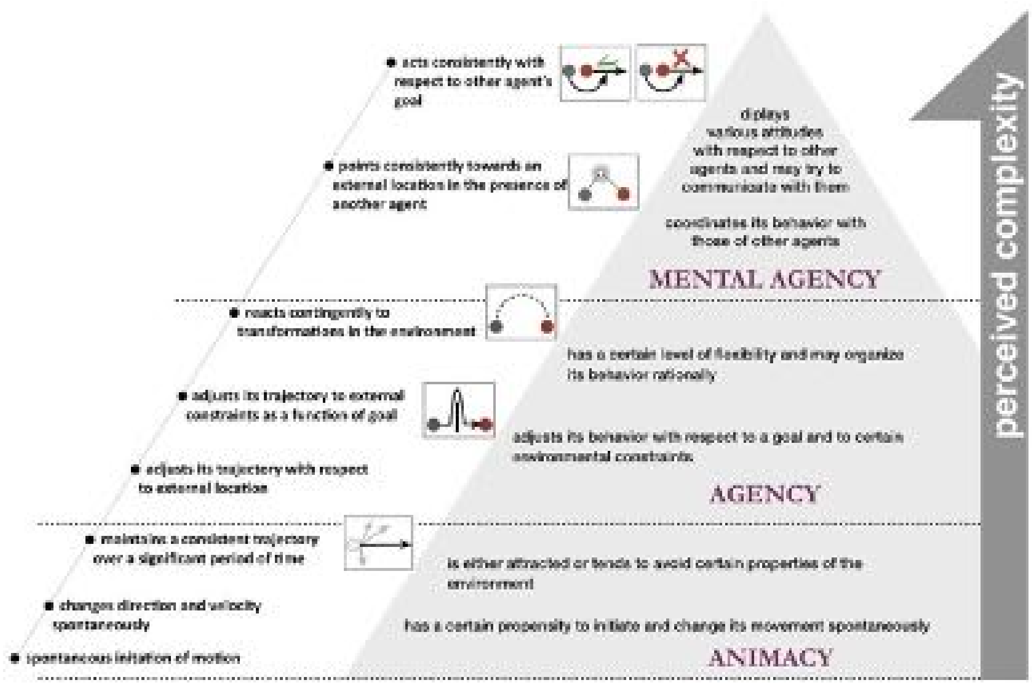


Figure 7 Levillain and Zibetti framework of the role of behavioral cues on mental agency attribution (Levillain & Zibetti, 2017, pg. 14).

Empirical Results Supporting the Role of Behavior

Empirical studies on the influence of artificial agents' behavior on human's tendency to anthropomorphize the agent seem to support this view. Eyssel, Kuchenbrandt and Bobinger (2011) conducted a study to explore the main and interaction effects that the predictability of an agent's behavior and the participants' expectations of having a human-robot interaction with the agent would have on its anthropomorphization. Participants were presented with a short silent video clip of the Flobi robot illustrating its movable facial features. A short text was given to participants to manipulate their perception of the robot's predictability which either presented Flobi as a) having different action programs for each individual action activated by following a random principle that makes it unpredictable (low predictability), or b) having different action programs that Flobi activates by following a predefined principle that makes it absolutely predictable.

The results of the study show interaction effects where the robot was significantly more anthropomorphized when participants expected to interact with it and considered Flobi to be unpredictable. This matches the arguments made by Levillain and Zibetti that for a movement to be consider a behavior and have the necessary effect of encouraging the attribution of agency and mental agency, the entity exhibiting the movement must appear to be executing it by its own volition.

Kang and Watt (2013), as well as von der Pütten, Astrid, Krämer, Gratch, and Kang (2010) have further shown the importance of the exhibited behavior being realistic for the agent to be anthropomorphized. They define realism of behavior as exhibiting behaviors associated with humans (von der Pütten, Krämera, Gratch, & Kang, 2010, p. 1643) or behaviors that exhibits kinetic conformity to what is expected in the context while remaining socially appropriate (Kang & Watt, 2013, p. 1170). In their study, von der Pütten and colleagues introduced participants to the equipment to be used, and instructed them about the interaction partner and the task at hand. The participants sat in front of a screen that displayed the agent which them proceeded to ask them questions after which the participants filled out a questionnaire and were debriefed. The construct of behavioral realism would be operationalized by the use of breathing, eye blinking, and posture shifts for the low behavioral realism, and by breathing, eye blinking, posture shifts, and two kinds of head nods to communicate that the agent is paying attention to the participant (refered to as backchanneling cues).

On the other hand, Kang and Watt asked participants to imagine that they were in an hypothetical interaction where they would be students interested in knowing if the interaction partner was a good match to share an apartment and build a potential friendship with. Participants' used a laptop with a mock-up mobile phone with avatars displayed on it and used a hands-free head-set to engage in communication with the potential partner. The avatar would be represented by a video or animation in the high behavioral realism treatment, or alternatively a photo or drawing for the low behavioral realism.

Results from von der Pütten and colleagues showed significant positive effects of behavioral realism on the social perception of the agent as shown by increases in the use of words by participants in the high behavioral realism treatment, as well as by significantly higher reported feelings of social presence and person perception. Results from Kang & Watt were mixed. While the increased behavioral realism lead to higher feelings of Social

Richness of the Medium (a component of social presence representing the appropriateness of the medium for social interaction), no significant effects were found for psychological co-presence (the feeling of being present with another). Taking into account the results mentioned before on the lack of effect for humanlike appearance when using static images in a chatbot (Sah & Peng, 2015) (Go & Sundar, 2019) (Pak, Fink, Price, Bass, & Sturre, 2012), it seems reasonable to assume that the lack of significance for social copresence regardless of the level of behavioral realism may be a result of the participant not perceiving the avatar as being a component of the entity they are interacting with. This is especially notable in this experiment as participants communicated with the entity through a hands-free device rather than from the computer chat box in front of them putting further psychological distance between the image and the participant's conceptualization of the entity.

Additionally, other perceived qualities of the movement appear to be significant. Chaminade, Hodgins and Kawato (Chaminade, Hodgins, & Kawato, 2007) show that typical individuals are capable of detecting minute differences in how movements take place to recognize which are likely to be originating from a biological rather than an artificial source. After exposing participants to a moving agent whose movements were designed by either an animator or through motion capture, the authors found that those exposed to the motioned captured movement would be significantly more likely to report the movement being biological in nature and would show increased activity in the mentalizing network of the brain suggesting that the participants were anthropomorphizing the artificial agent. Therefore, it seems that participants can easily detect minor social cues that signal the nature of the agent.

4.4.2.2 Artificial Agent’s Exhibited Social Cues

One of the key arguments in Nass and colleagues original conceptualization of the perception of computers as social actors is that minimal social cues were sufficient to encourage individuals to perceive technology as a social agent (Nass C. , Steuer, Tauber, & Reeder, 1993) (Nass, Moon, Fogg, Reeves, & Dryer, 1995) (Fogg & Nass, 1997). However, the nature of the phenomenon has proven to be considerably more complex than initially thought with multiple researchers exploring the existence and nature of individual differences in the social perception of technology emerging from a multitude of factors (Marakas, Johnson, & Palmer, 2000) (Epley, Waytz, & Cacioppo, 2007) (Urquiza-Haas & Kotrschal, 2015) (Airenti, 2018). Therefore, researchers have chosen to explore **whether the types of social cues exhibited by an agent** can have a significant effect over the social perception of said agent.

From a purely theoretical point of view, some researchers have argued that social cues can enhance the likelihood of an entity being anthropomorphized but are **neither necessary nor sufficient for mental and affective states to be ascribe to the entity** (Marakas, Johnson, & Palmer, 2000) (Gabriella, 2015) (Airenti, 2018). In particular, Airenti (Airenti, 2018) argues that since individuals can anthropomorphize entities on a multitude of different scenarios while objectifying the same entities in others, the social cues the entities exhibit can only serve to enhance the likelihood of engaging with them but are neither necessary nor sufficient for attribution of mental and affective states to take place. In this way, Airenti (Airenti, 2018, p. 8) proposes that anthropomorphism represents a means to engage with an entity, biological or not, which is rooted in an individual’s attempt to establish a relation with the entity by dealing with it as if it were an interlocutor.

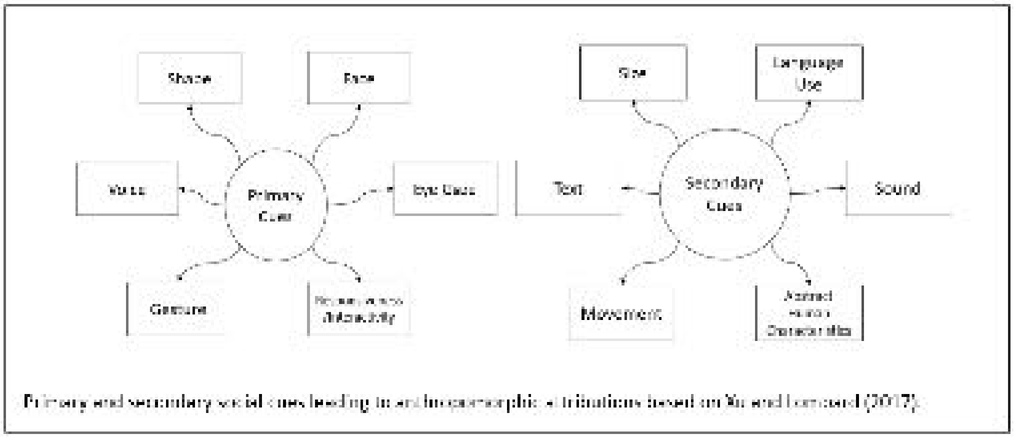
Xu and Lombard (2016) chose a different approach to explain the role of these social cues on the social perception of technology. Seeing that the extant literature displayed a variety of different media types being used in CASA research with each relying on different types of social cues to encourage the anthropomorphic process, Xu and Lombard saw it appropriate to expand the CASA paradigm beyond traditional computers to also explain how other technologies, including tablets and smartphones, can use social cues to promote its social perception. The authors choose to rename this expanded conceptualization as the Media are Social Actors (MASA) paradigm and emphasized that to better understand the intricacies of this attribution of different technologies, we must improve our understanding of how the different social cues it display can encourage the anthropomorphization process of a given technology. Specifically, the authors argue for the importance of considering the role of both primary and secondary social cues separately to better explain and predict how users will respond to new technological developments.

Xu and Lombard defined **primary social cues** as those that **are sufficient but not necessary** to evoke social responses to media because of human's bias towards other humanlike or animal-like characteristics. They argued that this included factors such as an entities shape and face as individuals will be sensitive to technology with human-like appearance, as well as key characteristics typical of human interaction like the technology's eye gaze, its perceived voice, and the non-verbal gestures it exhibits (such as the positioning of body parts), and the level of responsiveness or interactivity the technology displays.

On the other hand, they propose **secondary social cues** as encompassing those social cues that are **neither sufficient nor necessary to evoke social responses**. These are argued to play a smaller role in human's perception of others as social agents and thus are less likely to bring forth humanlike or animal like mental models. Xu and Lombard propose these to include factors such as the size of the entity, the language it uses, the way it communicates through text if relevant, the sounds it emits, the movements it displays, as well as other human-related characteristics such as abstract concepts like companionship, personality, identity, among others.

Whether the social cues evoked by technology's appearance and behavior can be sufficient to cause the anthropomorphization of technology remains under debate. Our observation of the role of the human likeness of the appearance and physical presence of a technology seem to suggest that neither is necessary or sufficient to ensure anthropomorphism though their effect remain significant and positive (Lee E.-J. , 2010) (Khan P. J., et al., 2012) (Broadbent, et al., 2013). While these studies seem to weaken Xu and Lombard's argument (Xu & Lombard, 2016, p. 10) that the appearance and shape of the technology constitutes primary cues that are sufficient for the social perception of technology, the results could be explained by different primary cues having separate effects on the perception of technology. For example, Abubshait and Wiese (Abubshait & Wiese, 2017) have shown that the appearance and behavior of a technology can operate in isolation causing distinct effects over the interaction with the appearance having stronger effects over the attitudes towards the technology and the apparent behavior of the technology having stronger effects over the perceived performance. We explore the role of major types of cues in the following pages.

Figure 8 Primary and secondary social cues leading to anthropomorphic attributions based on Xu and Lombard (2017).



4.4.3 The Role of Agents' Responsiveness & Interactivity

One of the earliest primary social cues to be explored under the CASA paradigm was that of the technology's level of interactivity (Burgoon, et al., 2000). Burgoon and colleagues conducted a series of studies as part of a program of research into human-computer interaction that included exploring how different components of interactivity affect the anthropomorphic perception of technology and, through it, altered its perceived credibility, understanding, and influence (Burgoon, et al., 2000, p. 554).

Table 11 Representative Work for the Role of Responsiveness & Interactivity

Representative Work	Antecedent	Dependent Variable	Significance
(Burgoon, et al., 2000)	Mode of Interaction; richness of interaction;	Mode of Interaction: Credibility; Influence;	<u>Mode of Interaction (Contingent)</u> -> Credibility: Mixed (only affected the

	Anthropomorphic Interface vs Anthropomorphic Interface with text;	Richness of Interaction: Credibility; Understanding; Influence; Anthropomorphic features (differences rather than direction of relation) interacting with text presence: Credibility; Understanding; Influence;	subcomponent "expertise"); Influence: Not significant; Richness of Interaction -> Credibility: Mixed (Significant on dominance, and close but not significant on other attributes); Understanding: Not significant; Influence: Not Significant; Anthropomorphic Interface -> Not Significant differences for any DV;
(Kim & Sundar, 2012)	Interactivity	Mindful Anthropomorphism; Mindless Anthropomorphism; Social Presence; Information	Mindful Anthropomorphism -> not significant; Mindless Anthropomorphism -> Significant; Social

		Credibility Judgement;	Presence -> Inconclusive; Information Credibility Judgment -> Significant;
(Salem, Lakatos, Amirabdollahian, & Dautenhahn, 2015)	Reliability	Assessment of robot reliability; assessment of robot trustworthiness; Interaction choices; willingness to cooperate with robot;	A. Of robot reliability -> Significant; A. of robot trustworthiness -> Significant; Interaction choices -> not significant; willingness to cooperate with robot -> not significant;
(Sreejesh & Anusree, 2017)	Mode of Interactivity	Brand Attention; Brand Recall; Brand Recognition;	Mixed for all DVs (effects appear to be contingent on cognition demand);

(Go & Sundar, 2019)	Interactivity	Social Presence; Perceived Homophily; Perceived Contingency; Perceived Dialogue;	Significant for all DVs;

In exploring the role of interactivity, Burgoon and colleagues (Burgoon, et al., 2000) asked participants to play a desert survival game with either a male confederate or a computer. The experiment varied between five **modes of interaction** (text-only, text and voice, text, voice and picture, finally a text, voice and lip-synced animation, and finally a voice and lip-synched animation condition) which allowed the experimenters to measure both the effect of the **mode of interaction** and the **richness of the interaction** as measured by the quantity of modes of interaction. The experiment also offered a minimally **contingent condition** where the partner's answers did not reflect consideration for the participant's answers and a **highly contingent** face to face interaction characterized for the responses being contingent or dependent on the past interactions with the participant. Results varied by the component of interaction.

First**, interaction richness** represented by the quantity of modalities present in a condition had no significant effects on the influence of the agent over the participant or on the understanding of the information presented. Interaction richness **achieved mixed results** with **significant positive effects only in a sub-component of credibility** by showing significant positive effects on the **perception of the partner as being more dominant** when using speech and text compared to text only interaction.

Secondly, **variations in modality** of the interaction showed **no significant differences** between interactions with text to interactions without text. Other comparisons of modality were not presented during this study and thus it provides no further insights into the importance of modality type on the social perception of technology.

Finally, the **contingency of the interaction** showed **no significant effects over the influence of the partner agent** and a technical error cause loss of information on the effects on the understanding of the information provided. Nevertheless, the results showed some **significant effects of higher contingency over the credibility of the partner** though it was limited to the subcomponent of perceived expertise rather than on factors related to its competence, dominance, trust, task-partner attraction or sociability (Burgoon, et al., 2000, p. 555) (Burgoon, et al., 2000, p. 566).

While anthropomorphism was not measured directly as part of the experiment it was explicitly assumed to be the root cause behind the expected effects of the level of interactivity on credibility, understanding and the influence of the agent. Therefore, the results provide some indirect support to the argument that interactions that are **contingent** on past engagements, meaning that evolve in response to past interactions, as well as those that are **rich** are likely to increase the chances of anthropomorphizing the technology while the mode of interaction appears to have no effects over it.

Research into the effects of interactivity continued in later years when Kim and Sundar (2012) conducted an experiment where participants were asked to browse a sunscreen company's website and give their reaction to new products. The website either showed a humanlike character or showed no character at all, and would vary between **low interactivity and high interactivity as operationalized through higher number of modality tools** on the screen such as the presentation order of information akin to what Burgoon and colleagues referred to as **Interactivity Richness**. The results of the study favor the positive effects of higher interactivity on the social perception of technology with the higher levels of interactivity leading to significantly **higher mindless anthropomorphic attributions** as shown by ratings of the appropriateness of humanlike adjectives to describe the website (i.e. attractive, exciting, pleasant, etc.). No significant differences in mindful anthropomorphism were discovered as operationalized by participants responses to being asked whether the website was human-like or machine-like, life-like or artificial, among other anthropomorphic ranges. These results match the hypothesized positive effects of level of interactivity on the anthropomorphic perception of technology. The lack of differences on mindful anthropomorphism were expected by the authors based on the argument that participants would consciously refuse their anthropomorphic perception when explicitly confronted with them. Additionally, participants also reported significantly **higher levels of social presence** under the higher interactivity condition when the human like character was not present though it turned not significant when the character was present thus providing some additional albeit partial support to the initial argument.

Later on, Sreejesh and Anusree conducted a study to explore how cognition demand and the mode of interactivity would interact with brand anthropomorphism to affect a user's perception of the brand (Sreejesh & Anusree, 2017). The authors conducted an experiment in which they asked participants to play a video game. Conditions were created for varying the level of apparent anthropomorphism (appearance), cognition demand and mode of interactivity. The mode of interaction varied between **game interactivity** where the participant could alter aspects of the game itself (such as background settings, skipping stages, and choosing a language), and **brand interactivity** where participants could interact with various aspects of the brand displayed (such as choosing it design and choosing brand elements like its logo and preferred color). The results showed a clear interaction between the anthropomorphic appearance of the brand, the cognitive load of the participant, and the mode of interaction that led to higher brand recall, attention, and recognition which the authors recognized as mindless social responses. While these results showed no direct evidence, it does suggest that the mode of interaction plays a role in anthropomorphism though it may be as a moderator for other factors.

Finally, Go and Sundar expanded on past results and explored how the level of interactivity of a chatbot influenced the perceived social presence evoke by the agent leading to multiple social effects (Go & Sundar, 2019). Go and Sundar asked participants to choose the best digital camera to purchase as a birthday gift for a friend based on pre-defined preferences by navigating on a pseudo-website and interacting with a chatbot. The level of interactivity was operationalized as **variations in the contingency of the interaction** with a low contingency scenario where the chat-bot would not acknowledge the participant's responses and a high contingency scenario where the chat-bot responses reflected consideration to the comments by the participants such as acknowledging what the participant asked for by rephrasing it back to the participant (Go & Sundar, 2019, p. 308). The results showed a significant positive effect of increased contingency on the participant's perception of social presence evoked by the agent when it displayed increased contingent behavior providing additional direct support to the argument made by Burgoon and colleagues (Burgoon, et al., 2000) that the interaction contingency was a significant factor in anthropomorphizing the technology.

These results suggest that while variations in the level of interactivity are effective in inducing social actor effects, not all interactivity appears to be created equal. Variations in the mode of interactivity had mixed effects with the results by Burgoon and colleagues (Burgoon, et al., 2000) contradicting the results shown by Sreejesh and Anusree (2017), while interaction richness and contingency consistently showed positive significant effects over the perception of technology as a social actor (Burgoon, et al., 2000) (Kim & Sundar, 2012) (Go & Sundar, 2019).

4.4.4 Discourse, Gestures, and non-verbal Communication

Apart from the mode, richness, and contingency of an interaction maintained by a technology other factors related to how it communicates have also been examined as potential enablers of anthropomorphism. These factors have been shown to significantly change the user's perception of the technology through variations in the content of the discourse (Nass & Sundar, 1994), the style in which it is presented (Salem, Ziadee, & Sakr, 2014), and the perception of the non-verbal cues that accompany each interaction (Abubshait & Wiese, 2017) (Wang, Lignos, Vatsal, & Scassellati, 2006).

Table 12 – Studies on the role of non-verbal communication on Anthropomorphism.

Representative Work	Antecedent	Dependent Variable	Significance
(Nass & Sundar, 1994)	Praise;	Perception of Agent	Significant[1]
(Nass, Moon, Fogg, Reeves, & Dryer, 1995)	Type of Language	Personality	Significant[1]
(Fogg & Nass, 1997)	Type of Feedback (i.e. Flattery, No Flattery)	Affect for computer; Performance; Evaluations of Interaction; Regard for Computer;	Significant[1]
(Kiesler & Goetz, 2002)	Exhibited Personality;	Mental Model Richness; Cooperation with robot;	Significant
(Lee E.-J. , 2010)	Flattering Feedback;	Evaluation of Computer; Social Conformity (i.e. Acceptance of Suggestions);	Significant
(Fasola & Mataric, 2012)	Relational Status;	Perceived Value of Interaction; Enjoyableness of Interaction;	Significant[1]
(Salem, Ziadee, & Sakr, 2014)	Politeness Level	Anthropomorphism[2]	Exploratory Study[1P]

(Araujo, 2018)	Anthropomorphic Cues (Language Style, Name)	Mindful Anthropomorphism; Mindless Anthropomorphism; Social Presence;	Mindful & Mindless: Significant[P;] Social Presence: No Support

1 Implied relationship; 2 Anthropomorphism measured as inverse of Dehumanization based on Eyssel, & Kuchenbrandt (2011).

4.4.4.1 A Technology's Discourse & Anthropomorphic Perceptions

The importance of an artificial agent's **discourse** to whether it is perceive as a social agent or not has been the focus of research since the early studies by Nass and colleagues that built up to become the Computer Are Social Actors paradigm (CASA) (Nass & Sundar, 1994). In these studies Nass and colleagues showed through multiple experiments that computers that engage in discourse with their users can encourage the users to perceive them as agents with human like qualities which in turn lead the users to engage with them in interactions reminiscent of human to human interactions despite their better knowledge that the computer was not alive (Nass & Sundar, 1994) (Nass, Moon, Fogg, Reeves, & Dryer, 1995). Such effects have included the perception of personalities on the agent (Nass, Moon, Fogg, Reeves, & Dryer, 1995) (Kiesler & Goetz, 2002), the elicitation of users' biases (Nass & Sundar, 1994, p. 76) and changing attitudes and mental models towards the technology (Fogg & Nass, 1997) which while not specifically measuring anthropomorphism, imply significant positive effects of the technology's discourse on the social perception of the technology.

Other studies on the role of discourse point towards the same conclusion. Fasola and Mataric (Fasola & Mataric, 2012) conducted two exploratory studies in which they asked participants to interact with a robot exercise coach in one phase where the robot showed no relational discourse, and one phase with the robot using praise and relational discourse to promote increased exercise. The use of praise and relational discourse increased how much exercise they conducted and led to higher preferences for the robot both suggesting significant social effects of the style of discourse. Additionally, Araujo (2018) asked participants to interact with a chatbot as if they were in Facebook messenger and varied the language style between informal language (i.e. using cues like Hello and Good Bye) and formal robot-like language (i.e. using language based cues such as the phrases “start” and “quit”). Araujo used different measures for conscious and non-conscious perceptions of anthropomorphism and his data showed that the language style of the artificial agent let to significantly higher levels of both. Finally, both Lee (Lee E.-J. , 2010), and Salem and colleagues (Salem, Ziadee, & Sakr, 2014) achieved similar results by either varying level of flattery or politeness of a robot respectively. While these studies show a consistent story on the effects of discourse, the study by Lee shows significant interaction effects between the personality type and the flattery exhibited by a robot resulting in participants becoming suspicious of the flattery and low rational individuals (as opposed to highly rational individuals) doubting their choices which suggests social conformity effects and therefore that the while significant, the effects of discourse can be both positive or negative depending on the context at hand.

4.4.4.2 Gestures, Body Language, & Anthropomorphism

The gestures and body language exhibited by an artificial agent show a different story. An early study by Wang, Lignos, Vatsal, and Scassellati (2006) examined how the perception of a robot would be affected by obvious and non-obvious differences in the behavior of the robot during an interaction. The researchers expected that changes in the non-verbal behavior of the robot as operationalized by whether and how it follows participants with its head would result in significant differences in its social perception and conducted an experiment to test this. Participants in the experiment interacted with a robot called "Nico" and were exposed to one of four conditions: 1) a robot that looked straight ahead and showed no movement in its head, 2) a robot that smoothly followed any human that pass in front of it with its face, 3) a robot that would track humans with its head by would show small oscillatory movements of the head as it tracks the person, or 4) a robot that would look away from humans. In a series of questionnaires filled in directly after the interaction, participants who interacted with the robot were significantly more likely to report it as being anthropomorphic than a control group who did not interact with it but also filled in the questionnaires.

The results of the study showed low scores on measures of positive affect, contingency, and enjoyableness on the no tracking condition, while the smooth tracking condition showed significantly higher scores. Nevertheless, the unsmooth tracking condition as well as the avoidance condition showed significantly higher scores than the other conditions in all measures of positive affect, contingency and enjoyableness and participants reported it as being more intentional. Researchers argued that the variation of the avoidance condition was likely the result of participants perceiving the avoidance behavior as the artificial agent playing a game with them. Regardless, the non-verbal behavior of tracking or avoiding the participant let to significantly higher social effects than the straight looking robot **implying a higher level of social perception and anthropomorphism**.

Figure 9 Literature on the role of body language on Anthropomorphism.

Representative Work	**Antecedent**	**Dependent Variable**	**Significance**
(Wang, Lignos, Vatsal, & Scassellati, 2006)	Head Tracking Behavior (head Avoidance vs no tracking vs smooth tracking vs unsmooth tracking);	Interaction Experience;	Correlations: Effect varied by category with avoidance and unsmooth tracking leading to higher perceptions of intentionality and in turn enjoyableness of interaction;
(Szafir & Mutlu, 2012)	Immediacy Cues (Gestures);	Attention; Learning Performance (Recall); Motivation; Rapport; Perceived Learning;	Attention -> Significant; Learning Performance -> Significant; Motivation -> Mixed (significant for females but not males);

			Rapport -> Mixed (significant for females but not males); Perceived Learning -> Mixed (significant for females but not males)
(Mara & Appel, 2015)	Nonverbal behavior (Head Tilt [anthropomorphic] vs straight head)	Human likeness; cuteness; spine-tinglingness; warmth; eeriness; attractiveness; dominance;	Human likeness -> Significant; cuteness -> Significant; spine-tinglingness -> Significant; warmth -> not significant; eeriness -> not significant; attractiveness -> not significant; dominance -> not significant;
(Xu, 2018)	Gestural Movement	Likeability; Motivation for future interactions; Perceived Social Presence; Perceived Social Attraction;	Significant for all DVs;

(Abubshait & Wiese, 2017)	Gaze following	Attitudes toward agent; Socio-Cognitive Performance;	Significant[1P]

[1] Implied; [P] Positive; [N] Negative;

This is supported by studies by Mara and Appel (2015), and Xu (2018). Mara and Appel expanded on the role of non-verbal behavior by exploring the role that head posture (i.e. tilting the head sideward rather than upright position) plays on the perceived experience of human-robot-interaction. The authors conducted two experiments with similar procedures but different degrees of tilt of a robot’s head, as well as different dependent variables. In both experiments, each participant rated an image of a robot. Mara and Appel chose three different robots of varying appearances that represented the prevalent types of robots at the time, and edited the pictures to change the degree of tilt of their heads (i.e. varying by 10 degrees each picture starting with 20 degrees tilt to the left and ending with 20 degrees tilt to the right on the first experiment, and limiting to only 20 degrees to the left, upright, and 20 degrees to the right on the second experiment).

Participants were exposed to a single image and rated their **perception of the robot in terms of Human likeness, eeriness, spine-tingling effect, attractiveness and dominance** in the first experiment, and interpersonal warmth and perceived cuteness of the robot in the second experiment. Results showed that participants **rated tilt heads significantly more human-like** than an upright head posture. **The other variables showed mixed results** with cuteness also being significantly affected by head tilts in a positive way, but no effect being found for other variables that would suggest the social perception of the technology like dominance and interpersonal warmth (personality), and attractiveness of the robot (social effect). Similar to the results discussed in the section on humanlike appearance, these trends could be the result of using static images which offer lower perceived social presence. Furthermore, this suggests that showing a tilt in a picture may be less effective in encouraging the social perception of technology than interacting with an actual moving robot that suggests intentionality by reacting to the user as was the case for Wang and colleagues (Wang, Lignos, Vatsal, & Scassellati, 2006).

On the other hand, Xu (Xu, 2018) explored how the gestural movements that robot's exhibits affect users' perception of the robot. The author compared the effects of a robots' gestural movements as well as its voice by conducting an experiment in which a robot would introduce itself to participants and explain both its basic functionalities and its past experiences with other humans. The experiment possessed four condition with two levels of voice and two levels of gestural movement for a 2 by 2 factorial design. After being exposed to one of the conditions, participants would fill a questionnaire with demographic information, perceived social presence, perceived social attraction, and intention to use in the future. The results showed that the robot displaying highly gestural movements was **rated significantly higher in likeability** than the robot with non-gestural movements and participants reported to **be significantly more motivated to have future interactions** with the robot suggesting some social effects due to the gestural movements, though the level of **social presence was not significantly different** for the highly gestural robot than for the non-gestural robot.

4.4.4.3 Voice, Tone, and Pitch: Verbal Paralinguistic Cues & Anthropomorphism

As technologies have progressed, multiple researchers have wondered if the arrival of new more humanlike modes of interactions such as voice controls and verbal responses have the potential of redefining how we perceive technology (Nass & Brave, 2005). Initial studies by Nass and colleagues look at this question from the point of view of flattery in textual responses in computer screens (Fogg & Nass, 1997), as well as from minimal verbal cues in their exhibited voices (Nass, Moon, & Green, 1997) (Nass & Brave, 2005). However, the effects of the presence of a voice in an interaction have not been consistent and multiple researchers have gone so far as to argue that the mere presence of a voice is not enough for anthropomorphism to take place (Schroeder & Epley, 2016) and we must rather pay attention to other paralinguistic cues associated with the voice to make better predictions of how users will respond to it (Hoenen, Lübke, & Pause, 2016) (Kory-Westlund, et al., 2017).

Figure 10 Role of Verbal paralinguistic cues on anthropomorphism.

Representative Work	**Antecedent**	**Dependent Variable**	**Significance**
(Fogg & Nass, 1997)	Feedback Type (Flattery vs sincere praise vs generic feedback);	Social Conformity;	Significant;

(Lee E.-J. , 2010)	Speech Type (Synthetic vs Recorded Speech); Feedback type (Flattering vs generic feedback);	Social Conformity; Self-Evaluation;	Recorded Speech on conformity -> significant but Interacts with Feedback type (negative effect in flattering computer); Feedback Type on Conformity -> Significant only in synthetic speech; Speech Type on self-evaluations -> Not significant; Feedback Type on Self-evaluations -> Mixed (significant effects found, but direction changed based on rationality style);
(Schroeder & Epley, 2016)	Exp 4: Paralinguistic Cues;	Judgement of Script Creator	Experiment 4: Significant;

(Kory-Westlund, et al., 2017)	Story Telling Style (Flat vs Expressive);	Children Concentration; Emulation of Storytelling; Identification of Vocabulary;	Significant (expressive condition led to more positive results) for all DVs;
(Xu, 2018)	Synthetic vs Human Voice;	Perceived Social Presence; Perceived Social Attraction; Intention to Use in the Future;	Significant (moderated by prior experience with robot);

Lee conducted one of the early studies in the role of the humanness of a technology's exhibited voice on an user and social responses to it including exploring whether it could lead to social conformity effects (Lee E.-J. , 2010). In his experiment, he asked participants to play an interactive trivia game with a computer where after the participant gave an answer the computer would provide a supposedly random answer to the question presented and the participant had to guess whether the computer was providing the correct response or not and submit the answer to the question accordingly. The results showed an interaction effect where participants that were categorized as a low rational would be significantly more willing to switch their answers in response to the computer's feedback being made with a humanlike voice when compared to the synthetic voice suggesting social conformity effects taking place in the experiment for this group.

Nevertheless, participants considered as high rational or experiential would not show these effects. Lee explained this effect by arguing that high experiential individuals were less likely to switch their answers because presumable they trusted their initial gut feeling and thus were less willing to give up their initial picks. Despite no direct evaluation of anthropomorphism or social presence, **the presence of social conformity strongly suggests that the reliance on human voices had significant positive effects** over the social perception of the agent.

Xu conducted a similar study exploring whether primary cues were more likely than secondary cues in evoking users' attachment for a robot (Xu, 2018). Xu compared the effects of a robot's gestural movement and human or synthetic voices on the social perception of the agent, the user's perceive attraction to the robot, and the intention to use it in the future. Xu ran an experiment where participants were led to a table with a robot called Alpha which would proceed to make a self-introduction providing information about where it was made, its name and basic functions followed by introduction of what it could do, and its experience communicating with humans. Four conditions were setup with 2x2 factorial design composed of two levels of voice (human voice vs synthetic voice) and two levels of gestural movements (gestures vs non-gestural movements). Finally, participants were asked to fill in a questionnaire with their demographic information and measures of social presence, perceived social attraction, and the intention of future use. The results of the study were **not significant for main effects of voice on the social presence of the robot** suggesting no significant difference was present between the synthetic and human voices. However, further analysis of the results suggested that **the effect of the nature of the voice on the participant was moderated by their prior experience with robots** with those who had no prior experience with robots perceiving the robot with human voice as possessing significantly higher social presence, while those with prior experience with robots perceiving the robot with human voice as significantly less present than the synthetic voice. The author argues that the prior experience interacting with robots likely led participants to favor robots that showed consistency between its appearance and voice resulting in the observed effects.

Finally, Schroeder and Epley conduct a series of experiments to explore how verbal cues could affect the perception of mental experiences in a person affecting the likelihood of mistaking a person for a machine, or a machine for a person (Schroeder & Epley, 2016). To achieve this, they conducted a series of four experiments comparing the humanizing effects of voice vs pure text compared to those of human visual cues. In all experiments, a script was presented and participants were tasked with identifying whether it was created by a human or a machine regardless of how it was presented (i.e. in text, read out loud by a person, etc.). The authors hypothesized that the paralinguistic cues presented in the voice, rather than the voice itself, would increase the likelihood that participants would regard the script as being created by a human and each experiment represented a step towards testing their hypothesis.

In the **first experiment**, the authors created two videotapes where they expressed both positive and negative emotional experiences from their life. Participants were asked to judge whether the creator of the speech and not its presenter was a human or a computer, and were separated into conditions with the script being presented through voice or no voice (i.e. audio vs text vs audiovisual vs subtitled video of human without sound while watching speaker conditions) and with varying valance (discussion of a positive vs negative emotional experience). To control for the potential effect that any human like cue may lead observers to judge the script as being man made, the authors also added a human vs no human present condition in the form of a video of a human reciting the script based on the argument that if the voice, rather than any human cue, was leading to the assessment that the script was human made, significant effects would be seem under the voice condition but not under the human presence condition. Neither the valence of the script nor the presence of the human lead to significant effects on the judgement of the script creator. Regarding the presentation of the script, as hypothesized, the text and the subtitle video showed no significant differences while the audio of the human reciting the script led to significantly higher judgements that the script creator was a human **supporting the argument that removing voice from a human-generated speech can lead humans to perceive it as being made by a machine**.

The **second experiment** followed a similar procedure to experiment one, but aims to explore whether adding voice to a machine generated speech rather than taking voice from a human generated speech could lead users to perceive judge the creator of the speech to be human. To achieve this, the authors relied on a script created by the "Postmodernism Generator" application which creates realistic looking random text with appropriate grammar (Bulhak, 1996). This experiment had four types of stimuli including pure audio, video with voice and human present, text, and video of human with subtitles. Similarly, to the first experiment, **adding voice to the script increased the tendency to anthropomorphize** the script making it more likely that participants would judge its creator to be a human. No significant differences were noted between the other experimental conditions.

The **third experiment** aimed to controlled for potential confounding effects of adding voice to a computer made script or removing voice from a human made speech. To achieve this, a human generated both a spoken speech and a written stimulus ensuring both conditions possess the same type of source. To avoid problems due to variations in semantics from the speech and the written script, participants were also asked to evaluate a transcription of the speech. This experiment took a more practical approach with the voice condition showing a speaker representing a job candidate presenting an elevator pitch to encourage a company to hire them and the written (text) condition being operationalized as a letter to a prospective employer. Just like in the prior experiments, the participants evaluated whether the creator of the speech was a human or a machine. The results match the prior two experiments, with the participants exposed to the speech (voice) being significantly more likely to attribute the script's origin to a human.

Finally, the **fourth experiment** aimed to distinguish the specific factor within the voice that led to the observed effects in the previous three studies. To achieve this, Schroeder and Epley manipulated the paralinguistic cues conveyed by a voice including characteristics such as its volume, pitch, and rate of speech in order to test whether these cues mediated the effect of voice over the judgement of the creator of the script. Participants were exposed to an actor reading a statement in a mindful voice (i.e. being expressive and evoking emotions), an actor reading a statement in a mindless voice (i.e. a monotone voice) or read the original essay themselves. The results showed that the reading the text and listening to the speech with a mindless (monotone) voice showed no significant differences. At the same time**, listening to the speech with the mindful voice led to significantly higher tendencies** to attribute the speech creation **to a human** rather than a machine.

While Lee (Lee E.-J. , 2010) suggested that the use of voice by a technology was a significant factor in its social perception and Xu (Xu, 2018) showed mixed results with a robot's voice only showing significant positive effects on social presence when moderated by the users' prior experience with robots, Schroeder and Epley take the analysis a step further (Schroeder & Epley, 2016). Schroeder and Epley's first three experiments show clearly that the results implied by Lee are consistent and applicable towards other types of agents, and they also make it evident that the paralinguistic cues expressed in the speech rather than the presence of absence of a voice, were the cause of higher tendencies to anthropomorphize artificial agents.

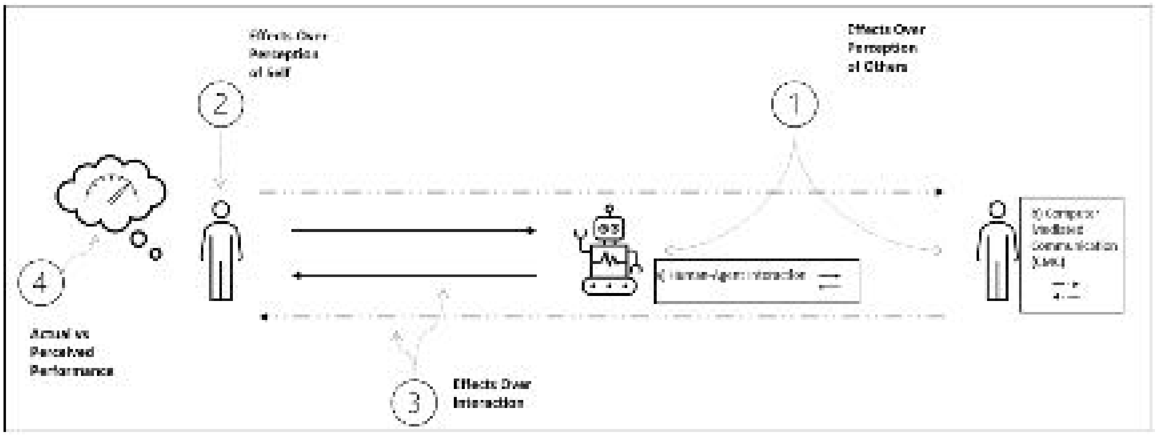
CHAPTER 5: CONSEQUENCES OF ANTHROPOMORPHISM

The consequences of the social perception of technology have been under research since the early studies on the Computer Are Social Actors (CASA) paradigm conducted by Nass and colleagues and its importance has only grown due to the advances in artificial intelligence that enable technology to exhibit apparent autonomy and intentionality (Lee, Kim, Lee, & Shin, 2015). While Nass and colleagues' original conceptualization argued that responses to technology exhibiting social characteristics would be equal to the response humans have when interacting with other humans (Nass & Moon, 2000), the extant literature suggest how people interact with these technologies is a much more complex phenomenon than first believed (Severson & Woodard, Imagining Others' Minds: The Positive Relation Between Children's Role Play and Anthropomorphism, 2018). Studies have shown variations in the effects of these technologies when compared to how humans interact with other humans including changes in the interaction taking place depending on the source of anthropomorphic cues (Abubshait & Wiese, 2017), variations in the size and direction of social effects depending on contextual factors (Burgoon, et al., 2000) (Lee E.-J. , 2010) (Tahiroglu & Taylor, 2018), as well as unexpected consequences that differ from how humans interact with other humans that surface when they are exposed to varying levels of cognitive load or their expectations are mismanaged leading to cognitive dissonance effects that changes the reaction to the technology (Urquiza-Haas & Kotrschal, 2015).

Nevertheless, the social effects first reported by Nass and colleagues remain supported with multiple studies showing how the anthropomorphization of technology can lead to the perception of personalities evoking from it (Kiesler & Goetz, 2002) (Mayer & Panek, 2016), biases sprouting from simple social cues (Nass, Moon, & Carney, 1999), and slight changes in behavior being recorded from the participants regardless of their understanding of the nature of the technology (Mou & Xu, 2017).

The consequences explored in the extant literature have taken multiple forms representing the approaches that researchers from multiple fields have taken to explore the phenomenon. In order to be comprehensive, we expanded the original set of identified articles that explicitly relied on anthropomorphism in testing their hypotheses to also include studies implied, and/or explicitly based their assumptions on anthropomorphism or the social perception of technology. As a result, we have aggregated the results of the extant literature, and developed multiple models showing how each area of an interaction is affected by anthropomorphic attributions. These representations are presented below in their corresponding subsections corresponding to the identified overarching themes which include: 1) effects over the user (the self), 2) effects over the perception of other agents (including the artificial agent itself and other human agents who may be using the technology as a form of mediated communication), 3) effects over the users' perception of the interaction, and 4) effects over the actual and perceived performance of the user and the technology. These themes represent different components of the interaction between a human and an artificial agent that are affected by the anthropomorphic attribution as shown below.

Figure 11 Components of an Interaction affected by anthropomorphism.



5.1 EFFECTS OVER THE PERCEPTION OF THE TECHNOLOGY AND OTHERS

How individuals' perception of a technology changes as they anthropomorphize it has been a critical component of the social perception of technology for the past several decades. Studies on this area tend to focus on either effects on the perception of the technology itself as an artificial agent (Kiesler & Goetz, 2002) or the effects over the perception of another entity that is either interacting through the technology (Kwak, Kim, Kim, Shin, & Cho, 2013) or represented by the agent itself (Sreejesh & Anusree, 2017) such as an individual or organization. These effects have typically been associated with factors related to the adoption and usage of technology, its credibility and trustworthiness, and its perceived similarity with the user also referred to as homophily (Rocca & McCroskey, 1999).

5.1.1 Attitudes Toward Artificial Agents

Initial studies in the social perception of technology showed how minimal verbal cues such as changes in the style of communication or the voice used by a computer can alter the personality users of the technology perceive (Kiesler & Goetz, 2002) and these alterations can in turn change the users' preference for the technology (Mayer & Panek, 2016). Multiple studies have expanded on these findings by testing the role that anthropomorphism plays on individuals' attitudes towards interaction with, using, or adopting a technology.

5.1.1.1 Theory of Planned Behavior & Social Cognitive Theory

A key study on this topic is that of Maartje de Graaft, Ben Allouch, and Jan van Dijk (2019) who developed a model of the acceptance of domestic social robots by relying on an analysis of the extant literature on adoption of social robots through the lens of the Theory of Planned Behavior (TPB) by developed by Icek Ajzen (Ajzen, 1985) (Ajzen, The Theory of Planned Behavior, 1991). The TPB argues that individuals' actions and behavior are predominantly determined by their intention to conduct said actions and behaviors. This intention is in turn determined by each individual's positive and negative attitudes and evaluations towards performing the behavior, their perception of others' expectations and acceptability surrounding performing the behavior, and their capacity to carry out the behavior which is also referred to as the individual's behavioral control (Eagly & Chaiken, 1993).

The theory of planned behavior has been one of the most influential psychological theories in various fields used to explain numerous types of behavior owing to its high explanatory power and parsimony (Manstead & Parker, 1995) (Taylor & Todd, 1995). In their study, de Graaft and colleagues argued that the TPB could be used effectively to explain the results found on the extant literature on adoption of social robots, however, they recognized that the theory's focus on cognitive processes was at the detriment of affective processes which were typically studied in the field of human-robot interaction such as enjoyment, attractiveness and anthropomorphism (Bagozzi, Lee, & Van Loo, 2001). Because of this, the authors expanded the attitudes construct of the TPB to include both Utilitarian and Hedonic (i.e. in relation to influencing a person's pleasures and pains) attitudes with anthropomorphism being considered an important hedonic attitude. The model was further expanded through the use of the Social Cognitive Theory (SCT) by Albert Bandura (Bandura, 1986) (Bandura, 1999) (LaRose & Easting, 2004) to support the expected effects of control beliefs in the form of an individual's self-efficacy on the utilitarian and hedonic attitudes as well as on the intention to use the robot.

The authors tested their model through an online survey with two parts. The first part collected demographic and trait measures related to the individual's control beliefs (i.e. measures of personal innovativeness and anxiety towards interacting with robots), while the second part collected qualitative data on how individuals conceptualized robots, presented a definition by the authors on what social robots and domestic robots were, and presented participants with statements on the factors included in the model based on a 7-point Likert and a semantic differential scale. While the authors did not specify how they operationalized the construct of anthropomorphism within the hedonic attitudes construct, they included measures of both animacy and social presence which has been used by other researchers for as a proxy for anthropomorphism (Airenti, 2018) (Nowak & Biocca, 2003). The survey revealed **mixed results of hedonic attitudes** influence over participants' **Intention to use** the robot as well as over the **utilitarian attitudes** held towards it (i.e. perceived ease of use, usefulness, and adaptability). These results included:

- Significant effects of the **expected enjoyment resulting from having the social robot at home** as well as **expected low sociability of the robot** on the participants intention to use it.

- Significant effects of the expectations of **enjoyment of having the social robot at home**, and the **expectation of the robot as being more sociable but offer low companionship** on an increase in the perceived adaptability of the robot to the participants' needs (utilitarian attitude).

While these results implicitly support the argument that the social perception of the technology can affect both the perceived utilitarian value of the robot (i.e. ease of use, usefulness and adaptability) and the intention to use it as suggested by other authors (Go & Sundar, 2019) (Lee, Lee, & Sah, 2019), the factors of animacy and social presence achieved no significance. This is despite these factors being more closely related to the social perception of technology through anthropomorphism. Three possible explanations for the apparent contradiction could be gathered from these results.

The **first** potential explanation would be that anthropomorphism **has indirect rather than direct effects** over attitudes towards technology and intention use it. In such an scenario, the effects of anthropomorphism would be limited to the extent that it influence other important predictors of the key dependent variables just mentioned such as a person's perceived social norms, and control beliefs as suggested by the significant effects found by de Graaf and colleagues (2019) (i.e. effects over enjoyment, expectations of sociability, and companionship). Nevertheless, such a conclusion would contradict the results of other students which empirically show the significant direct positive effects of anthropomorphism over the users' attitudes toward the technology (Araujo, 2018), its adoption (Eyssel & Kuchenbrandt, 2012), and the intention to use it (Chandler & Schwarz, 2010) (Sundar, Jung, Waddell, & Kim, 2017).

Secondly, the conceptualization of anthropomorphism as an attitude mirrors the research on individual differences (see section 4.2 for more information on this) rather than anthropomorphism itself. Considering anthropomorphism as an attitude is equivalent to considering an individual psychological factor which contradicts the conceptualization used more recently on the extant literature of anthropomorphism as an attribution or perception of an external entity (Epley, Waytz, & Cacioppo, 2007) (Airenti, 2018). Moreover, while the measurements used for animacy and presence have been used effectively to measure anthropomorphism in other studies (Bartneck, Kulic, & Croft, 2009) (Biocca, Harms, & Burgoon, 2003), these studies did conceptualize anthropomorphism as an attribution and operationalized the measurement accordingly. Therefore, there is an incongruency between the operationalization and the conceptualization of anthropomorphism in the study which could be impacting the overall results.

Thirdly, the methodology of the study may be affecting the results in a couple of different ways. First, asking the participants directly about their thoughts on social robots calls forth a conscious top-down perception of expected social interactions (Urquiza-Haas & Kotrschal, 2015). If anthropomorphism has been achieved through a non-conscious perception, Urquiza-Haas and Kotrschal suggest it can lead participants to a cognitive dissonance state in which they overcompensate their initial impulses increasing the likelihood they will respond with low anthropomorphism scores despite anthropomorphism actually taking place. Secondly, while de Graaf and colleagues presented participants with a definition of what social robots were, their survey lacked an agent that could be anthropomorphized. This leads participant's to depend entirely on their own mental model of social robots as a reference likely resulting in low scores of perceived social presence, animacy and anthropomorphism since there is no physical or virtual agent to anthropomorphize that could lead to a perception of "being there with another" (Nowak & Biocca, 2003) (Bartneck, Kulic, & Croft, 2009).

Other studies using similar methodologies have achieved significant results by relying on priming and framing effects from an introductory message prior to participant's starting the survey. Nevertheless, it seems reasonable that the lack of such an introductory message or an agent to anthropomorphize could be the reason for the lack of significance in de Graaf's study.

Table 13 Consequences of Anthropomorphism on Perceptions of Technology.

Representative Work	Form of Anthropomorphism/Social Perception	Dependent Variable	Significance
(Goudey & Bonnin, 2016)	Human likeness	Acceptance of Technology; Perceived Usefulness; Perceived Ease of Use; Use Intention;	No Significance on Acceptance;
(Araujo, 2018)	Social Presence; Mindful Anthropomorphism; Mindless Anthropomorphism;	Attitudes Toward Company; Customer Satisfaction; Emotional Connection with Company;	Attitudes toward company -> not supported; customer satisfaction -> not supported; Emotional connection -> significant;
(Go & Sundar, 2019)	Social Presence; Perceived Homophily	Attitudes; Behavioral Intention to Return to Website;	Attitudes -> Significant; Behavioral

	(proxy); Perceive Contingency (proxy); Perceived Dialogue (proxy);		Intention -> Significant;
(Abubshait & Wiese, 2017)	Human-like Appearance; Behavior;	Attitudes (Judgement of Mind); Social Cognitive Performance;	Implied: Both Appearance and Behavior had positive effects on attitudes and performance, though the effects varied in strength by the source; While no distinction, it does provide support to a lower extent;
(Salem, Ziadee, & Sakr, 2014)	Politeness Strategy	Perception of Robot; HRI Experience; Politeness;	

	(verbal Behavior);	Competency; Extroversion; Warmth; Psychological Closeness; Assessment of Task Performance; Perception of Task Effectiveness;	
(Eyssel & Kuchenbrandt, 2012)	Perceived Homophily; Mind Attribution;	Contact Intentions; Design Preference;	Contact Intentions -> Significant; Design Preference -> Significant;
(Kim & Sundar, 2012)	Social Presence; Mindful Anthropomorphism; Mindless Anthropomorphism;	Information Credibility Judgement;	SignificantP1(Implied from Mindless Anthropomorphism through Interactivity);
(Wu & Kraemer, 2017)	Valence;	Preferred Interaction Partner;	Significant;

(Bracken, Jeffres, & Neuendorf, 2004)	Direction of Feedback (Criticism vs Praise as Proxy);	Perceived Ability to Complete Tasks; Intrinsic Motivation; Recall; Perceived Intelligence; Perceived Niceness;	Perceived ability to complete tasks -> Not supported; intrinsic motivation -> not supported; recall -> not supported; perceived intelligence -> not supported; perceived niceness -> Significant;
(Nowak & Rauh, 2008)	Androgyny of Avatar; Humanlike Appearance of Avatar;	Credibility of Avatar; Credibility of Participant; Androgyny Perception of Participant;	Human-likeness of Appearance on Credibility -> Significant;
(Gong, 2008)	Human-likeness of Appearance;	Social Judgement of Technology; Homophily; Social Influence; Competence; Trustworthiness;	Social Judgement -> Significant; Homophily -> Significant; Social

			Influence -> Significant; Competence -> Mixed (significant for most levels of Human likeness except medium to high level); Trustworthiness -> Significant;
(Miwa & Terai, 2012)	Partner's Perceived Behavior; Participant's Strategy Selection;	Participant's Strategy Selection; Impressions About Partner;	Partial Support;
(Kang & Watt, 2013)	Anthropomorphism of Avatar; Presence of Avatar;	Interactant Satisfaction with Computer;	Anthropomorphism of Avatar -> Significant; Presence of

			Avatar -> Partial Support;
(Kiesler & Goetz, Mental Models and Cooperation with Robotic Assistants, 2002)	Robot Exhibited Personality (Caring vs Serious);	Richness of Mental Model of Robot;	Significant;
(de Graaf, Allouch, & Dijk, 2019)	Represented as Hedonic Attitudes	Utilitarian Attitudes; Use Intention	Mixed Results;
(Chandler & Schwarz, 2010)	Priming about nature of car;	Intention to Replace Technology; Importance of Quality in Replacement Decision Decreased;	Significant;
(Sundar, Jung, Waddell, & Kim, 2017)	(Implied) social role; robot personality;	Robot Use Intention;	Significant when controlling for Task Type and Personality;

(Xu, 2018)	Robot gestural movement;	Likeability; Motivation for Future Interaction;	Likeability -> significant; use intention -> Significant;
(Pak, Fink, Price, Bass, & Sturre, 2012)	Human like Appearance;	Expressed Trust; Exhibited Trust Behavior; Decision Accuracy; Task Time; Confidence in Answer;	Expressed Trust -> Partial (significant only for young age group); Behavioral Trust -> Significant;

While the work of de Graaf and colleagues represent the most comprehensive and ambitious model of social robot adoption that we are aware of, its limitations in terms of the conceptualization and measurement of anthropomorphism discussed above merit a deeper exploration of its hypothesized relationships as found in the extant literature.

5.1.1.2 Expanding on Attitudes, Perceptions, Adoption & Usage of Technology

Studies focused on anthropomorphism and the changing perceptions and attitudes towards artificial agents have consistently shown that human-like qualities expressed by technology can lead to elaborate positive mental models of artificial agents (Kiesler & Goetz, 2002) as well as to significant improvements over the user's impressions and evaluations of the artificial agent as a partner (Bracken, Jeffres, & Neuendorf, 2004) (Miwa & Terai, 2012). Research into the effects of anthropomorphism on the perception of technology continued with other studies showing how users could perceive the technology as possessing a personality and, through it affect the users' preferences towards the robot (Mayer & Panek, 2016) (Wu & Kraemer, 2017).

Seeing the lack of consistency in cues used to promote anthropomorphism in prior literature, Abubshait and Wiese decided to explore whether the nature of the cue used could lead to independent effects on a person's attitudes toward a robot and on their performance, and whether an interaction effect was present (Abubshait & Wiese, 2017). To explore this question, the authors conducted a two by two ANOVA with appearance functioning as a within factor, the exhibited behavior of the robot being a between subjects factor, and taking a measurement of the attitudes towards the robot before the interaction and after the interaction with the difference being used as the dependent variable of attitudes towards the technology. The study also explored the behavioral social response to the technology in the form of the socio-cognitive performance operationalized by whether the participant followed the gaze of the artificial agent. Results showed that while both the appearance and exhibited behavior of the agent let to statistically significant changes in both socio-cognitive performance and attitudes towards the robot, the effects were apparently independent of each other with the effect size on each dependent variable differing with appearance mostly affecting attitudes and exhibited behavior affecting socio-cognitive performance.

Similar results were achieved by Michael Hart (2013) on his dissertation on anthropomorphic appeals where he explored their effectiveness and the role that contextual and individual factors played on its effects over users' attitudes. Hart conducted an online panel and through a series of three experiments tested the effects of anthropomorphic appeals.

In the **first experiment**, participants were asked to fill a series of measures on loneliness and were presented with a series of three text-based print advertisements including two filler ads and one treatment condition. Afterwards, subjects were distracted for several minutes with an unrelated task and once completed were presented with the brand name of the treatment advertisement and asked to recall the related advertisements and complete measurements on its effectiveness. The results showed no significant influence of anthropomorphism on the attitude towards the brand or ad, but instead it significantly influenced the recall of related advertisements and increased the participants' purchase intention.

The **second experiment** expands on the first by exploring how users' respond to multiple anthropomorphic appeals rather than just one. This experiment followed the same procedure as the first with the exception that three different treatment advertisements were presented rather than just one. Similar results were found as in the first experiment with anthropomorphism appeals showing no significant main effects over neither the attitudes towards the brand or the attitude towards the advertisement. No-significant direct effects were found for anthropomorphic appeals on intention to purchase the product, but the effects dissipated when evaluating the attitudes effects as a mediator in the relationship and controlling for the focus predictor of anthropomorphic appeals. When controlling for the product knowledge, showed significant negative effects of anthropomorphic appeals on the attitudes toward the product when knowledge about the product was high. No other significant effects were found for anthropomorphic appeals.

The **third experiment** explored whether higher salience of the entity to be anthropomorphized may be necessary to achieve the significant attitudinal changes reported elsewhere in the literature on anthropomorphism. The study followed the same procedure as the second experiment participants were only exposed to one ad. Hart attempted to increase the salience of the ad by providing visual elements depicting a drawing or a photograph of the product. The drawn image included a humanlike mouth and eyes in the anthropomorphism appeal condition and normal features in the non-anthropomorphism condition. The photograph depicted the product being watched by paparazzi while on a red carpet in the anthropomorphic condition or a normal relevant context for the non-anthropomorphic condition.

Results from this third study found significant main effects for anthropomorphic appeals on both the attitudes towards the brand and the attitude towards the brand represented by the ad. When exploring the relationship between anthropomorphic appeals and purchase intention, anthropomorphic appeals showed non-significant direct effects on the purchase intention. Since both attitudes towards the brand and the ad showed significant effects on the purchase intention, the author tested for indirect effects of anthropomorphic appeals on purchase intention through both attitudes towards the brand and towards the ad. This test revealed significant effects resulting in the author concluding that the relationship between anthropomorphic appeals and purchase intention was fully mediated by the attitudes towards the brand and ad.

The work of Hart (Hart, 2013) provides support to the hypothesis that anthropomorphism has significant effects over the attitudes towards both the artificial agent being anthropomorphized and also other entities that it represents. More importantly, it shows that this relationship is contingent on the salience of the entity with a higher salience increasing the presence of the entity (i.e. social contact) and the likelihood of it being anthropomorphized (Hart, 2013, p. 62) reflecting our conclusions from section 4.3.1 above. Other studies by Araujo (Araujo, 2018) as well as Go and Sundar (Go & Sundar, 2019) suggest a lack of significant effects from anthropomorphism on the attitudes towards both the artificial agent or the entity represented by it could potentially be explained by Hart's findings. While Araujo (Hart, 2013) failed to find significant effects, his operationalization of the agent to be anthropomorphized was entirely dependent on text which could implied a low level of salience resulting in the non-significant results on attitudes towards the agent or the company it represented (This is further discussed under section 4.4.1.1 on the role of embodiment). On the other hand, Go and Sundar (2019) suffered with some of the same limitations leading to no significant main effects of anthropomorphic cues on the attitudes towards the agent or the website it supported despite displaying a human's photograph as part of the chatbot. Nevertheless, their study did find indirect results when considering the social presence, perceived homophily and perception of being involved in a dialogue.

While these results suggest that anthropomorphizing a technology possesses significant positive direct effects over the users attitudes towards a technology, the results on factors related to users intention discussed above remain inconsistent and thus are further discussed in section 5.3 on Impact on Intentions, Trust, and Perceived/Actual Performance.

5.1.2 Moral Agency & Accountability/Responsibility

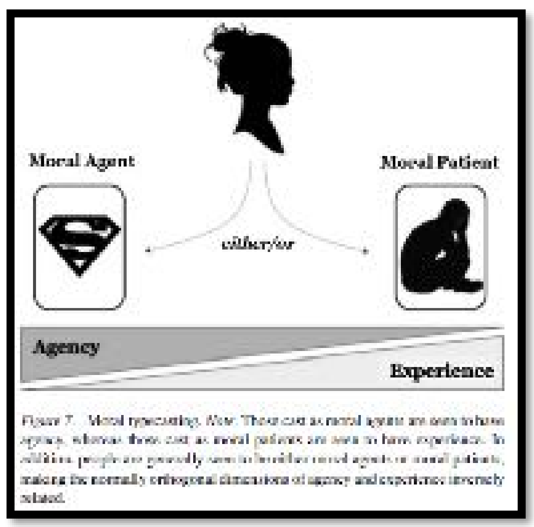
The question of whether technology can be perceived as possessing agency and responsibility has also been explored in the literature. Gray, Gray and Wegner (Gray, Gray, & Wegner, 2007) conducted an exploratory study exploring what it means to perceive a mind in others by conducting a survey in which participants rated pairwise comparisons of different agents in one of eighteen mental capacities (e.g. “capacity to feel pain”) and one of six personal judgments (e.g. “which character do you like more?”). The results of the study suggested that people tended to categorize agents differently along two main factors: the agents’ capacity to act or agency (including factors such as self-control, morality, emotion recognition, planning among others), and its capacity to feel or “Experience”(e.g. hunger, pain, pleasure, among others). The study demonstrated that individuals tend to perceive some cognitive capacities from robots and rate then as being highly capable of acting on their own (i.e. possess high agency) but were less capable of experiencing things. These results suggest that all forms of entities can be perceive as possessing mental capabilities, but these capabilities can vary based on individuals’ perception about the entity.

The study by Gray, Gray, and Wegner (Gray, Gray, & Wegner, 2007) formed the basis for a series of studies in which Gray and colleagues explored the relationship between perceptions of mind of agents and the moral attributions made on them. In particular, Gray and Wegner (2009) expanded on the previously mentioned study to argue that not only individuals perceive mind along two factors, but how an agent is perceived along those factors can determine whether an agent is perceived as an actor capable of inflicting good or evil upon others, or an agent on which said good or evil is inflicted.

To test their argument, Gray and Wegner conducted a series of seven studies with multiple phases in which participants completed surveys or completed questionnaires with priming messages in which hypothetical characters were presented or described with various levels of capacity to act on their own accord (agency) or feel (experience) and were positioned in hypothetical scenarios that were the target did something “bad” or something “good”. The authors found support for the theory of moral typecasting where agents were perceived as being either moral actors (high agency and low experience) that were less vulnerable to having good or evil done upon them, or moral patients (low agency, high experience) that were less capable of performing the good or evil upon others. While this study focused on human to human interactions it was a direct expansion of the arguments and findings by Gray, Gray, and Wegner and were argued to remain valid for all types of agents discussed there (2007, p. 506).

A following study by Gray, Young, and Waytz (2012) expanded on this research stream by arguing that the mind perception described by Gray, Gray and Wegner (Gray, Gray, & Wegner, 2007) was at the core of the results on the moral judgement towards others found by Gray and Wegner (2009). Gray, Young and Waytz (2012) explored multiple views of morality in the extant literature to propose that mind perception on a variety of agents including humans, animals, robots, and supernatural entities could lead to perceptions of moral violations that vary along the lines of whether an agent was perceived as intentional and suffering (2012, p. 103). This conceptual piece develops a series of propositions on how the moral dyad of perceived intention and suffering could compel and constrain moral judgements towards agents regardless of their nature.

Figure 12 Illustration of Moral Typecasting presented by Gray, Young, and Waytz (Gray, Young, & Waytz, 2012).



The results found by Gray and colleagues were supported in the extant literature with key theoretical studies elaborating on how components of agency in the form of perceived autonomy, intention, and responsibility can lead to the perception of artificial agents as moral agents (Sullins, 2006), and other related studies providing empirical support for the propositions within the context of human to human interaction (Moretto, Walsh, & Haggard, 2011). Within the field of human robot interaction (HRI), these results have been supported by the work of Khan and colleagues (Khan P. J., et al., 2012) which explores whether individuals would find morally accountable a robot committing a mistake that harms the individual. In the study, participants were led to interact with a "Robovie" robot for 15 minutes after which Robovie would "judge" the participants performance in a game and determine whether the participant won a $20 prize. In the study, Robovie was programmed to incorrectly determine the participant as failing the game and thus prevented them from earning the $20 prize. Participants were interviewed about how they perceived the robot.

The results showed that participants attributed cognitive and affective states to the robot as well as social attributes. Moreover, 65 percent of the participants attributed some level of moral accountability to Robovie. Statistical analysis of the responses indicated that Robovie was found significantly less accountable than a hypothetical human would, but more accountable than a vending machine thus providing additional support to the argument that anthropomorphism leads to artificial agents being perceived as moral agents.

Furthermore, Gray and Wegner (2012) have built on these arguments and shown that how an artificial agent is attributed mind can have significant effects on how it is perceived. Specifically, the authors posited that feelings of uncanniness (Mori, The Uncanny Valley, 1970) (Mori, MacDorman, & Kageki, 2012) individuals sometimes feel when confronted with human-looking artificial agents arises when humans ascribe experience (i.e. capacity to feel and sense) to them rather than agency (i.e. capacity to act). To test this hypothesis, the authors conducted three experiments.

In the **first experiment**, participants were saw a video of either humanlike robot or a mechanical robot and rated both their feelings of unease towards it, and their attributions of agency and experience. The results suggested that the perceptions of experience mediated the relationships between the appearance of the robot and the feelings of uncanniness.

The **second experiment** explored whether the unease feelings were limited to the appearance of the machine, or whether they could be disconnected from it. Participants were given a questionnaire that described a supercomputer in different ways depending on the condition. The control condition describe the supercomputer to participants as "like a normal computer, but much more powerful", while the with-experience condition described it as "[able to feel] hunger, fear and other emotions" (2012, p. 127). Participants rated their feelings of unease in each condition as well as rated the supercomputer in terms of the perceived agency and experience.

As hypothesized by the authors, the results showed a link between the ratings of experience and uncanniness but not between ratings of agency and uncanniness providing support to the hypothesis that the uncanny effects were related to attribution of experience to machines rather than to its appearance. Finally, in a **third experiment**, Gray and Wegner explored how participants perceived other humans that have lost mental capacity resulting in either a reduced agency or experience and whether the participants felt an increase in uneasiness. Participants saw descriptions of a man and his mental capacities with the control condition describing the man as “quite normal”, the reduced agency condition describing him as “unable to ‘plan or make goals,’ or ‘do things a normal person can do’”, and the reduced experience condition describing him as “unable to ‘feel pain, pleasure or fear or otherwise experience what a normal person can experience’” (2012, p. 128). Participants rated their affective reactions similarly to how they did in experiment one. The results of the study showed that a person with reduced experience led participants to feel unease similar to how they had done on prior studies for the low experience machine, while the same effect was not reported for the control condition or the reduced agency condition.

The research stream conducted by Gray and colleagues shows that anthropomorphizing artificial agents (as conceptualized in the form of perceiving mind in them) can lead to a perception that the artificial agent itself possesses both a capacity to act (agency) and a capacity to feel (experience) depending on related factors such as how it was introduced. These perceptions can lead individuals to perceive the artificial agent as a moral agent capable of doing good or bad upon others while possessing little vulnerability to good or evil being done upon it, or a moral patient with a low capacity to inflict good or evil on others but a being highly receptive to good or evil being done on it. Moreover, whether mind is attributed to artificial agents through increased agency or increased experience, also seem to affect the overall perception of an individual about it with artificial agents showing high experience but low agency possessing an increased likelihood that individuals will feel uneasy about interacting with it.

The results reported by Gray and Wegner (Gray & Wegner, 2012) call for caution in how we develop artificial agents that appear to feel in order to prevent negative interactions with users; however, other studies have shown that highly experiential artificial agents can also lead to improvements in the perception of the agent (Khan P. H., et al., 2012) (Kory-Westlund, et al., 2017) (Kory-Westlund, Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots, 2019). Khan and colleagues explored the nature of relationships formed between children and early social robots (Khan P. H., et al., 2012). In their study, children between the ages of 9 and 15 interacted with the humanoid robot “Robovie” in 15-minute sessions. The sessions ended with the researcher interrupting a game between the children and Robovie at the start of Robovie’s turn to put Robovie away into a closet while the robot protested that it was not fair, that it was afraid of the dark and that it did not want to be put away into the closet. A post facto interview showed how all children though it was alright to put a broom into the closet but only a minority though it was alright to put Robovie there. During the interview, the children described Robovie as a social entity with intelligence and feelings that was deserved fair treatment and argued it should not be harmed psychologically. While the study did not directly evaluate the attribution of mind as described by Gray and colleagues (Gray, Gray, & Wegner, 2007), the descriptions by the children match appear to position Robovie as an agent with high experience and position it as a moral patient per Gray and Wegners’ Moral Typecasting hypothesis (Gray & Wegner, 2009) (Gray, Young, & Waytz, 2012). Therefore, the study provides support for the argument that anthropomorphizing an artificial agent can lead individuals to perceived it as a moral agent and, moreover, that perceiving the artificial agent as a possessing high experience can also lead to significant positive effects over the individuals evaluations of the technology. Finally, in order to facilitate the evaluation of the perceptions of social machines, Banks (Banks, 2019) developed a and tested a Perceived Moral Agency (PMA) scale for the purpose of measuring how individuals perceive other entities as moral agents including both other humans and machines.

To develop the scale, Banks conducted an extensive review of the literature including philosophical, theoretical, and empirical perspectives on morality as well as popular and futuristic perspectives on machine morality to generate a pool of 84 candidate items for the scale. A subject matter expert was asked to review the selection for content validity, "applicability across agent types, inclusivity of perspectives on morality, and attention to moral functioning" the pool was reduced to 49 items (Banks, 2019, p. 365). The reduced pool was presented to participants through an online survey that directed them to one of five conditions varying in type of agent including an avatar, a chatbot, a physically-embodied humanoid robot, a physically embodied non-humanoid robot in the form of a voice assistant, or a human. Participants were presented with a short vide of the agent speaking a script which remained the same regardless of condition except to describe the type of agent the speaker was. Participants then completed the item pool and were asked to complete items for perceived anthropomorphism, measures of criterion validity, an interpersonal trust scale, and a social attraction scale. The results suggested a set of 10 items surrounding two factors (morality and dependency) were sufficient to measure the PMA, and showed that anthropomorphism tended to vary among different agent types though not in a scale from low to high starting with a chatbot, passing through a personal assistant, an agent, a robot and finally human as expected.

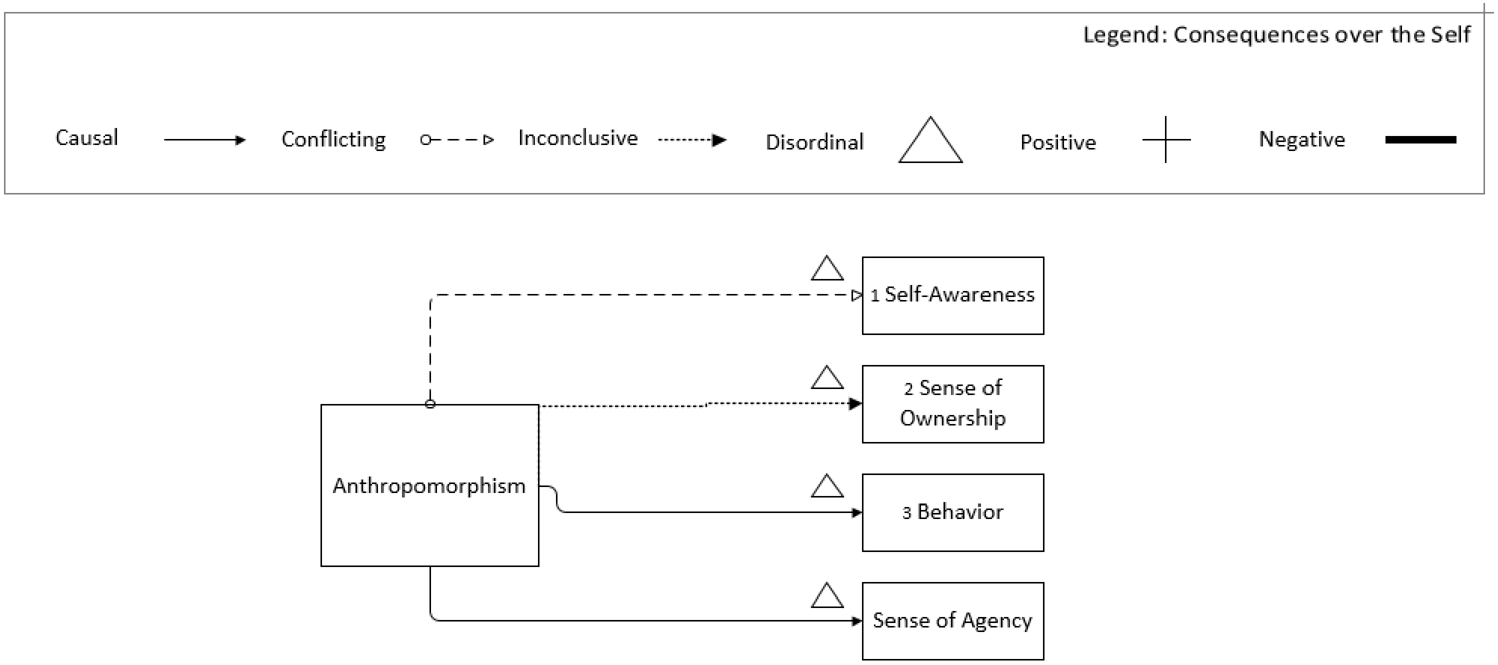
The 10 item and 2 factor scale were validated through an online survey where participants judged others' personalities. The participants assigned to one of four conditions depicting a robot (high or low morality, and high or low dependency) or a neutral human control condition. Participants saw an identical condition of a Nao robot holding a child's hand with the robot described as being called Ray and "[spending] the days helping children to be more comfortable in learning situations" (Banks, 2019, p. 366). The results of the survey suggested that the questionnaire possessed both construct validity when compared with other heuristic assessments of the agent's "good/bad status", and criterion validity when assessed for factors associated with other agent's perception and behavioral intentions (Banks, 2019, p. 367).

The extant literature seems to consistently point towards anthropomorphism significantly influencing the perception of agency and moral agency on an artificial agent (Gray, Gray, & Wegner, 2007). It also suggests, that these perceptions can significantly alter other attributes of the perceived agent (Gray & Wegner, 2012), with poorly designed agents leading to eerie feelings on the part of the users (Gray, Young, & Waytz, 2012) and well-designed agents leading to the formation of simple relationships (Khan P. H., et al., 2012) (Kory-Westlund, et al., 2017) (Kory-Westlund, Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots, 2019). These studies suggest that while anthropomorphizing an artificial agent leads to changes in how an individual would perceived it, whether the perception of the agent becomes more positive or negative seems to be moderated by other factors related to the technology such as the social role that we place it in (Kory-Westlund, 2019).

5.2 EFFECTS OVER SELF PERCEPTIONS, EVALUATIONS, & BEHAVIOR

The effects of anthropomorphism have been shown to go beyond changing the perception individuals hold about a particular artificial agent, and instead have been shown to also affect the individuals' interacting with the agents (Chambon & Haggard, 2012) (Neave, Jackson, Saxton, & Hönekopp, 2015). The reported effects have range from both positive and negative behavioral changes (Mou & Xu, 2017) (Timpano & Shaw, 2013) (Riva, Sacchi, & Brambilla, 2015) to alterations in the self-perceptions and evaluations individual hold about themselves (Bartneck, Bleeker, Bun, Fens, & Riet, 2010) (Sah & Peng, 2015). These effects have been shown to take place both automatically as well as after individuals reflect about the nature of the artificial agent, with stronger believes that the agent is humanlike being associated with individuals more frequently displaying behaviors typically associated with building interpersonal relationships with others (Schechtman & Horowitz, 2003). Therefore, it becomes important for both researchers and practitioners to understand how technology choices can affect its users' behaviors and self-perceptions to fully understand the implications of anthropomorphism.

Figure 13 Effects of Anthropomorphism over the Self



1- The effect varied between private self-awareness and public self-awareness.
2- Only some components of psychological ownership were tested, and some were significant while others were not. This included the component of computer self-efficacy which was reduced based on how the anthropomorphic device was held in Banks, Westerman, and Sharabi (2017).
3- Behavior was affected significantly but the end outcome depended on the context and the individual variability. Negative effects such as hoarding behaviors could result when a person with a high need for social cognition anthropomorphized an entity (see Timpano and Shaw 2013). Other effects on behavior included exhibited personality, self-disclosures, and the desire for control.
4- Measures varied significantly between studies and Included self-perceptions.

5.2.1 Anthropomorphism and the Changing Behaviors of Individuals

The effects of anthropomorphism over the individuals' behavior have been reported to vary significantly. Among the studies describing the positive effects of anthropomorphism was that of Mou and Xu (Mou & Xu, 2017) who explored whether individuals vary in terms of the style of communication, level of control over the engagement, and willingness to disclose information over an interaction exhibited when interacting with an artificial agent compared to how an interaction with a human friend. In their study, Mou and Xu relied on the CASA paradigm to develop hypotheses on how the initial interaction between a user and an inherently social technology could take place.

5.2.1.1 Exhibited personality traits, self-disclosures, and level of control

The authors hypothesized that since encountering an AI would be equivalent to encountering a non-judgmental listener, users would vary in the personality traits, level of control (i.e. exhibited behavior associated with taking control of the direction of the conversation) and self-disclosure tendencies that they exhibit when interacting with an artificial agent compared to when interacting with a human or when asked for self-reports (Mou & Xu, 2017, p. 434). To explore these hypotheses, Mou and Xu gathered a snowball sample of individuals (referred t as volunteers in the study) who had recently engaged with an openly available chatbot from Microsoft called "Little Ice" in the WeChat messenger application and collected recorded transcripts of their initial interaction with Little Ice as well as transcripts of their interaction with a human friend. The transcripts were then provided to two hundred and seventy-seven participants to review and evaluate the transcripts in terms of the personalities and communication attributes exhibited by the volunteers.

The results of Mou and Xu's work suggests that individuals exhibit different personality traits as well as variations in their disclosure levels. Specifically, individuals tended to be more open, agreeable, extroverted, conscientious, and self-disclosing in their interactions towards human friends. Interestingly, the level of control exhibited by participants appeared to not be significantly different between the two interaction types, though the exhibited level of control remained significantly different from self-rated levels of control in both cases. Therefore, the work of Mou and Xu suggests that while individuals may respond socially to technology, the interaction style exhibited when interacting with artificial agents can still differ from that used when interacting with other humans.

Mou and Xu's hypothesis only tested significant differences without explicit consideration for the direction of the relationships. Nevertheless, the authors had originally argued that since artificial agents were likely to be perceived as less judgmental individuals, it was reasonable to assume users would be more willing to disclose more information, while feeling more confident about the interaction and taking control of it thus increasing their exhibited controlling behavior (Mou & Xu, 2017, p. 434). The results seem to oppose this argument since the direction of self-disclosure behavior was in the opposite direction and no significant difference was found on the level of control. Nevertheless, exploratory results found by Sah and Peng (2015) offer a potential explanation.

In their study, Sah and Peng (2015) explored the role of anthropomorphic cues on social perceptions, self-awareness, and information disclosure. While not initially hypothesized, they also tested for the indirect effects of the anthropomorphic cues on the individual's disclosure of information through changes in the levels of both private and public self-awareness (i.e. self-awareness referring to the inner state in which individuals focus their attention on themselves (Duval & Wicklund, 1972)). Private self-awareness referring to an individual placing attention on the covert or hidden (e.g. beliefs, thoughts) aspects of him/herself, while public self-awareness describes an individual focus on overt or observable aspects (e.g. public self) of him/herself (Sah & Peng, 2015, p. 394) (Froming, Walker, & Lopyan, 1982).

Part of the results of the study showed that anthropomorphized artificial agents in the form of a chatbot that communicated in a humanlike way possessed significant positive indirect effects on the on the level of public self-awareness of the participant which in turn cause the participants to significantly decrease the information they would disclose. Therefore, these results provide both empirical support for the direction of the relationship initially proposed by Mou and Xu despite Mou and Xu's own results which suggested a relationship in the opposite direction, while also presenting potential mechanism to explain the discrepancy in results. Specifically, Sah and Peng shows that results similar to those of Mou and Xu can be found if the chatbot was not anthropomorphized, which could be the case for Little Ice (chatbot explored by Mou and Xu) since we don't have much information on how it worked and Mou and Xu did not measured anthropomorphism itself, or the behavior of the chatbot may have triggered changes in the level of self-awareness of the participant thus altering the direction of the relationship as shown in Sah and Peng's study. Nevertheless, since the exact nature of the results presented by Mou and Xu cannot be inferred correctly due to the lack of measurement of anthropomorphism, further studies are needed to explain the relationship.

5.2.1.2 Anthropomorphism and its Negative Consequences through Hoarding & Gambling

Other researchers have focused on the potential negative effects of anthropomorphism over individuals' behavior. Taking into consideration the generally accepted view that excessive attachment was associated with hoarding (Frost & Hartl, 1996), Timpano and Shaw (2013) conducted the first study that tested whether anthropomorphism and could lead to increased attachment to objects and therefore be associated with increased hoarding. Hoarding was described as an, that is increased persistent difficulty in discarding possessions resulting in clutter accumulating in living spaces and a corresponding increase in distress (Mataix-Cols, Fernandez de la Cruz, Nakao, & Pertusa, 2011).

To test their hypotheses, Timpano and Shaw conducted a survey asking participants for self-reports of hoarding symptoms (Frost, Steketee, & Grisham, Measurement of compusive hoarding: Saving inventory-revised, 2004) (Frost, et al., 1998), saving cognitions which refers to the attitudes and beliefs about hoarding (Steketee, O., & Kyrios, 2003), anthropomorphism measured through the IDAQ questionnaire which measures anthropomorphic tendencies (Waytz, Cacioppo, & Epley, 2010), and a questionnaire on emotional attachment to objects (Grisham, et al., 2009). The results indicated significant positive effects of anthropomorphism on hoarding behaviors even after controlling for depression and anxiety scores. Interestingly, anthropomorphic tendencies were not correlated with emotional attachment to objects. Anthropomorphic tendencies were not found to significantly affect hoarding cognitions, though the scores remained close to significance and thus reported as marginally significant.

Neave and colleagues (2015) built on top of the work of Timpano and Shaw (2013) to explore how anthropomorphism affected hoarding by developing and testing a new measure of anthropomorphism with assessments more relevant to the beliefs and behaviors related to anthropomorphism. The IDAQ questionnaire (Waytz, Cacioppo, & Epley, 2010) used by Timpano and Shaw before explicitly relied on measures constructs that rely on reflection and high-level deductive reasoning as a form of anthropomorphic tendency. Neave and colleagues present the construct of Consciousness as an example of this, and argue that measuring it as explicit questions on whether an entity possessed consciousness, the IDAQ questionnaire may not be able to tap into intuitive thoughts (Neave, Jackson, Saxton, & Hönekopp, 2015, p. 215). Similarly to Timpano and Shaw (2013), the authors differentiated between hoarding behaviors which refers to the the extent individuals hoard possessions and hoarding cognition which refers to how the individuals feel about their possessions.

To test the predictive capability of their Anthropomorphic measure and how it affected hoarding behaviors and cognitions, Neave and colleagues (2015) conducted a survey with the corresponding measurements. The results showed that both measures of anthropomorphism were significantly positively correlated with increases in hoarding behaviors and cognitions. Running a regression analysis with both measures of anthropomorphism showed that the new anthropomorphic questionnaire remained significantly positively related to the hoarding behaviors and cognitions but the significant effects of the IDAQ questionnaire became non-significant. Additionally, adding the IDAQ questionnaire to a model measuring anthropomorphism with the Neave and colleagues' instrument led to marginal increases in predictive power from R^2 of .31 to 0.34. These results support Timpano and Shaw conclusions that anthropomorphism was likely a significant predictor hoarding.

Since the earlier studies of Timpano and Shaw (2013) and Neave and colleagues (Neave, Jackson, Saxton, & Hönekopp, 2015) argued that anthropomorphism was affecting the hoarding behaviors of an individual by increasing the emotional connection individuals felt towards the objects leading to excessive attachment, Neave and colleagues ran a second study to explore the relationship between anthropomorphic tendencies, object attachment, attachment style, hoarding severity and hoarding behaviors (Neave, Tyson, McInnes, & Hamilton, 2016). Participants to the study completed questionnaires for the constructs of interests which indicated strong positive correlations between the measures of object attachment, attachment style and anthropomorphism with the measures of hoarding behaviors and cognitions. Nevertheless, when running a regression with all factors of interests and hoarding behaviors and cognitions as dependent variables, the significant effects of anthropomorphism become non-significant while the attachment style explains most of the variation.

Neave and colleagues (Neave, Tyson, McInnes, & Hamilton, 2016) argued that these results may be due to both attachment style and anthropomorphism explaining the same kinds of behaviors. Since this study as well as Neave and colleagues (Neave, Jackson, Saxton, & Hönekopp, 2015) and Timpano and Shaw (2013) relied on a survey methodology with self-reports measures, time precedence between variables was not considered. Considering that the measures of attachment style and anthropomorphism were also correlated, it seems reasonable to consider that one variable may be mediating the effect of the other on hoarding behaviors and cognition.

Other behavior changes have been reported in the literature as well. Riva and colleagues (Riva, Sacchi, & Brambilla, 2015) reported on how promoting the anthropomorphic perceptions of gambling machines significantly increased both individuals tendency to gamble, as well as the amount they were willing to gamble. On the other hand, Tam (2015) described how presenting participants with anthropomorphic representations of nature while appealing for the participant to carry out conservation behavior such as recycling, reusing things, saving water, or using energy efficient devices significantly increased their reported intention to carry out these conservation behaviors compared to doing the same appeal without the anthropomorphic characteristics. The extant literature includes multiple more studies exploring how behavior can be affected by anthropomorphic perceptions, however we will discuss this on the section reporting on changes in the interaction since they are framed from the point of view of social effects promoted by an interaction with a social agent rather than being centered on the changing behavior (Abubshait & Wiese, 2017).

5.2.2 Changing Self-Evaluations & the Sense of Self

Besides affecting individuals' behaviors, anthropomorphism has also been shown to affect individuals' self-evaluations and self-perceptions as shown by the effects of anthropomorphism on an individual's self-awareness reported by Sah and Peng and discussed above (Sah & Peng, 2015). Other significant effects explored have included feelings of embarrassment as reported by Bartneck and colleagues (Bartneck, Bleeker, Bun, Fens, & Riet, 2010) as well as changes to sense of agency and ownership during an interaction (Obhi & Hall, 2011) (Böffel & Müsseler, 2018) (Limerick, Coyle, & Moore, 2014) (Grynszpan, et al., 2019).

As we discussed above in section 4.1.2, the extant literature has shown that anthropomorphizing an entity results in an ascription of agency to it and can result in an increased tendency to perceive it as a moral agent (Gray, Gray, & Wegner, 2007) (Gray, Young, & Waytz, 2012). Following this view of technology as a potential agentic entity, Obhi and Hall conducted what, to the extent of our knowledge, constitutes the first attempt to explore how an individual's sense of agency changes as they engaged in a joint task with a computer (Obhi & Hall, 2011).

The argument that a joint action with a computer could impact the users perceived agency was developed as an extension to a prior study by the same authors (Obhi & Hall, Sense of agency and intentional binding in joint action, 2011) that proposed that when two individuals engage alongside each other in a collaborative joint action, their subjective experience of agency could be altered their reported subjective feelings of agency become independent from their experimentally demonstrated sense of agency as reported through intentional binding effects (see section 2.2.2.1 for a discussion on the intentional binding measure) transforming their perceived "I" agency into what the authors call a "we" agency (Obhi & Hall, Sense of agency and intentional binding in joint action, 2011, p. 661).

Following these results from a human to human interaction, the authors decided to test whether the same effects could be achieved when an human interacts with a computer in a joint action task (Obhi & Hall, Sense of Agency in Joint Action: Influence of Human and Computer Co-actors, 2011). To test this hypothesis, Obhi and Hall set up an experiment with two conditions. In the human to human condition, the authors asked a participant and a confederate pretending to be a participant to sit side by side with a curtain blocking them from seeing each other. Then, the participants engaged in a series of conditions testing their perceptions of agency. In the human to computer condition, the same procedures were followed with the exception that rather than relying on a confederate, the participants were told they would be interacting with a computer that possessed software that would take the role of the other participant. The results of the study showed that similarly to their previous study, participants in the human joint action reported a decreased judgement of their agency when the action was initiated by the partner, but demonstrated a significant and indistinguishable intentional binding to that reported when their initiated the action suggesting the presence of a perceived joint agency or we-agency. On the human to computer condition however, the results showed no significant intentional binding effects suggesting **that engagement with a computer in a joint task failed to lead to a joint-agency effect**. Furthermore, the authors hypothesized that the reported effect were likely the result of individuals forming a we-agency based on their comprehension of the other agent's intentions as being similar to their own which suggest that anthropomorphizing the technology could bring forth those effects seen in joint-tasks with other humans.

Despite Obhi and Hall's initial results, authors have increasingly argued that joint-agency effects are possible recent studies have argued that the **joint agency effects can be achieved when humans interact with more human like technology** such as social robots. Building on these results, Barlas (Barlas, 2019) explored how the sense of agency in a human is affected when interacting with other humans and how it compared with an interaction with humanoid robots with varying levels of autonomy. Participants in Barlas experiment were asked to perform either free key presses when they chose to do so, to perform the key press when instructed by either a human or a humanoid robot (the NAO robot by Softbank was used for this purpose). Regardless of the condition, auditory and visual stimuli would be given to the participant shortly after the key press and the intentional binding effects were estimated based on the participants perceptions of the time interval between the action and the event as discussed above in the section on intentional binding. Alternatively, participants could also hear a sound that would indicate another sound which would then be followed by a separate sound shortly thereafter and binding effects would be calculated for this case as well. The results showed that both humans and humanoid robots were capable of provoking similar binding effects on the sense of agency of the participant.

Moreover, Ciardo and colleagues (Ciardo, Tommaso, Beyer, & Wykowska, 2018) explored how individuals sense of agency in a given task may decrease **when interacting with embodied artificial agents** in a similar way as it does when interacting with other humans. In the experiment, participants were exposed to one of two conditions. In the first condition, participants were entirely capable of taking a costly loss of points to prevent a balloon from exploding, while in the second condition both the participant and a “Cozmo” robot (a type of social robot widely available in the market) were both charged with preventing the balloon from exploding representing a joint condition. In the experiment, participants needed to sacrifice points to prevent the balloon from exploding. The more time participants waited, the less points they would lose, but if the balloon exploded, they would lose a significantly larger amount of points. Additionally, if Cozmo stopped the balloon from exploding, the participant would not lose any points. The results of the experiment showed that when the participants stopped the balloon from exploding, they reported significantly lower sense of agency in the joint condition than in the individual condition regardless of the amount of points lost suggesting that a joint interaction with an artificial agent can decreased the perceived agency over an interaction by a user in a similar way that an interaction with another human can.

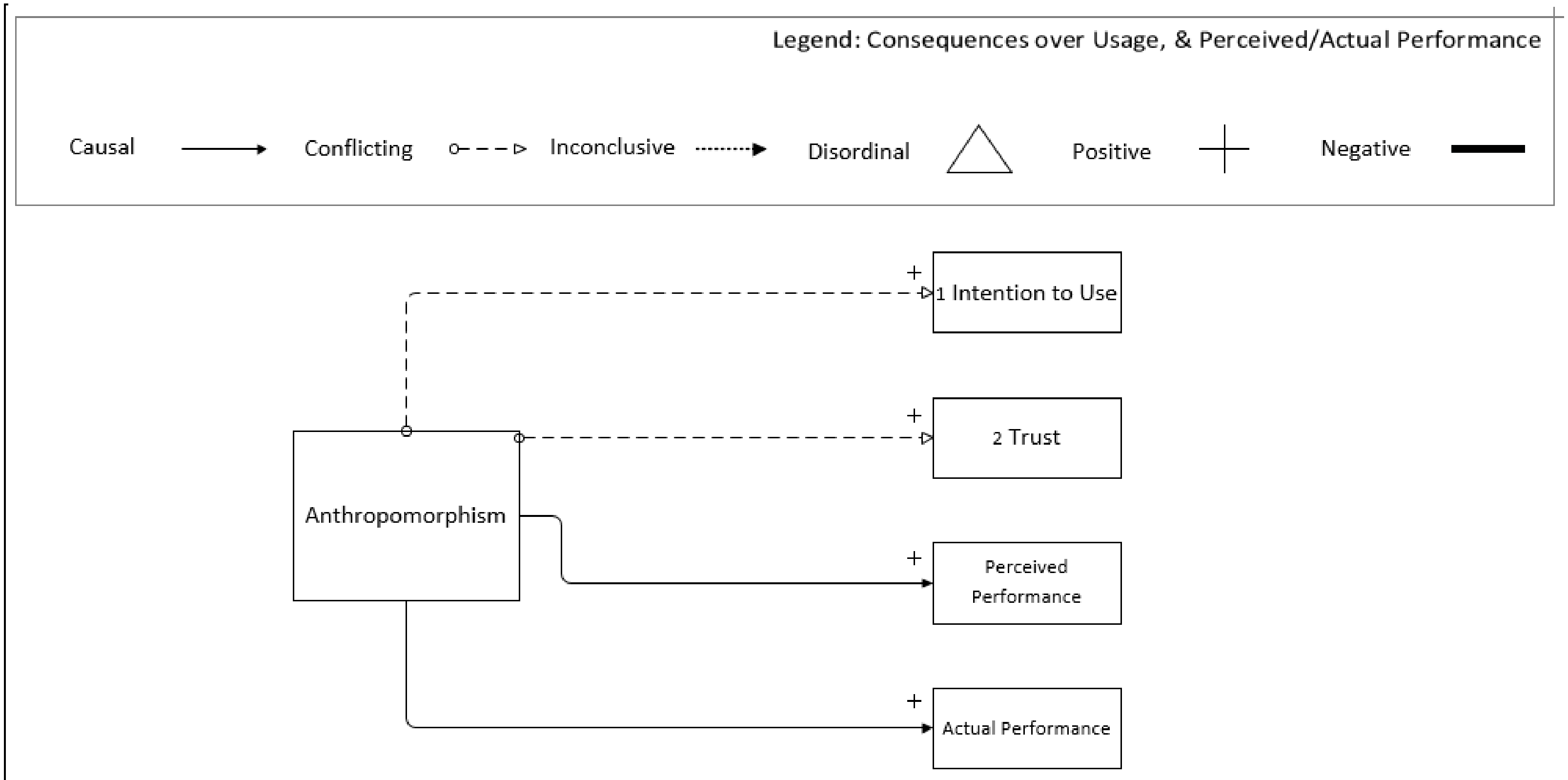
Later on, Grynzpan and colleagues decided to explore the initial relationship explored by Obhi and Hall (2011) to test whether the reported effects could be replicated through bottom-up processes rather than the top-down processes used by Obhi and Hall in the form of a priming effect where the researchers told participants the partner was a computer performing tapping actions in the joint task (Grynszpan, et al., 2019). Grynzpan and colleagues operationalized their technology as a non-human like robot that provided haptic feedback to the finger of the participant to suggest kinesthetic feedback to the participant (i.e. haptic feedback on the handle of the participant). The results of Grynzpan and colleagues resembled those of Obhi and Hall (2011) with participants in a joint task with a human reporting joint agency effects while participants in the robot condition had no such effects and displayed a significant reduction in their sense of agency.

While Obhi and Hall as well as Grynzpan failed to find joint-agency effects in interactions between humans and computers, it is important to note the type of agent they used. In Obhi and Hall operationalization, the joint task was carried out between a human and a computer that the participant was told possessed software that enabled it to carry out the tasks of initiating actions. There was no perceivable agent that through its appearance or apparent behavior could evoke an attribution of mind in the participant. Additionally, the description of the computer as possessing software that allowed it to initiate the actions that would otherwise have been carried out by a human partner offered little to no content that could encourage the anthropomorphization of the computer. Grynzpan operationalization suffered from the same issues. In their study, the participants engaged with a robot that exhibited no human like appearance and whose behavior was limited to providing haptic feedback to the participant if it began an action before the participant did. Neither case allowed for any form of mind perception which arguably explains the results as suggested by the conceptualization of mind attribution of Gray, Gray and Wegner (Gray, Gray, & Wegner, 2007) (Gray, Young, & Waytz, 2012).

Joint agency, also known as We-agency, represents a significant new construct that we still do not know much about (McEneaney, 2009) (McEneaney, 2013) (Moore & Obhi, 2012). Nevertheless, it promises to lead to significant effects in human to human interaction from both practical and theoretical perspectives (Pacherie, 2012) (Admoni & Scassellati, 2012) (Salmela & Nagatsu, 2017). While not much research exists regarding how it takes place in interactions between humans and artificial agents, the findings of Ciardo and colleagues (Ciardo, Tommaso, Beyer, & Wykowska, 2018) as well as Barlas (Barlas, 2019) strongly suggest that anthropomorphism is the core element needed to enable its effects within the context of humans cooperation with autonomous and relational technologies (Bolt, Poncelet, Schultz, & Loehr, 2016).

5.3 IMPACT ON INTENTIONS, TRUST, AND PERCEIVED/ACTUAL PERFORMANCE

Figure 14 Consequences over Intentions, Usage, and Performance.



1- The literature suggest significant positive effects of anthropomorphism but it remains unclear if the effect takes place directly, or through changes in the attitudes towards the technology. The literature also suggests that these effects will vary significantly based on individual differences. Nevertheless, conflicting results exist about these effects (e.g. de Graaf, Allouch, and Dijk, 2019 as well as Araujo 2018).

2- Refers to trust towards the artificial agent.

5.3.1 Artificial Agents Acceptance and Intention to Use and Replace

The works of de Graaf and colleagues (2019), as well as Hart (2013) discussed under section 4.1.12 on “attitudes towards technology” go beyond exploring the effects of anthropomorphism on attitude to also explore how it affects users’ intention to adopt and use technology. While de Graaf and colleague’s study hinted at the role of the social perception of technology through significant effects found on the “expected level of sociality”, it failed to find significance on factors more closely related to anthropomorphism such as animism and social presence. On the other hand, Hart’s study not only found that anthropomorphism’s effects over the attitudes towards the technology were contingent on the level of salience of the artificial agent introduced to participants, but it also found that through this relationship anthropomorphism had significant indirect effects over the intention to purchase the artificial agent. These two studies combined seem to suggest that while anthropomorphism may not directly influence user’s intention to engage with an artificial agent, its effects over the users’ attitudes support its indirect influence over the users’ intention. Other studies have further explored the relationship between the anthropomorphic perception of technology and various forms of users’ intentions.

Following prior literature on anthropomorphic characters used within the field of marketing, Goudey and Bonnin (2016) explored the role that the human-like appearance of an artificial agent would have on others’ acceptance of the agent and their intention to use it. The authors conduced online interviews with adult women with children and jobs and asked them about their willingness to use the robot at their home in a situation where the robot would interact with their children. The participants were presented with a picture of one of three possible robots as operationalizations of the artificial agents that varied in the level of human likeness of their appearance. Their results showed no significant main effects of the human likeness on the users' acceptance of the technology. However, after controlling for the users' level of prior experience using their smartphones, the effects of anthropomorphic appearance of the robots turned significant with users with high experience reporting stronger intentions to use the artificial agent, and users with low or no experience using smartphones reporting significantly lower intentions to use the agents. Taking this into consideration, Goudey and Bonnin (2016) suggest that anthropomorphism does have a significant direct effect over a users' intention to use a technology, but such effect appears to be moderated by individual factors such as the user's prior experience with technology.

While none of the studies in our literature have explicitly explored the nature of the contrasting results based on different levels of prior experience reported by Goudey and Bonnin (2016), Zlotowski, Proudfoot, Yogeeswaran and Bartneck (2015) offer a potential explanation from a purely theoretical basis. In their study of the opportunities and challenges of anthropomorphism in human-robot interaction, Zlotowski and colleagues argue that low levels of familiarity with the technology will lead to increased perceptions of unpredictability in the mind of users which will be reflected as increased negative attitudes towards the technology. Moreover, the authors argue that as individuals become familiarized with the technology, their negative attitudes will diminish accordingly.

An important limitation of the relevance of the results presented by Goudey and Bonnin is their conceptualization of anthropomorphism as a "[physical] resemblance to human beings” (Goudey & Bonnin, 2016, p. 4) (Ambroise & Valette-Florence, 2010) (Keeley, 2004). While this conceptualization differs from the conceptualization of anthropomorphism as an attribution of mental states, the operationalization used by the authors matched that used by other studies more fitting conceptualizations of anthropomorphism thus minimizing our concerns about the relevance of these findings within our context (Bartneck, Kulic, & Croft, 2009) (Bartneck, Kanda, Mubin, & Mahmud, 2009).

Other studies have achieved similar results. Eyssel and Kuchenbrandt (2012) explored the users’ intention to adopt a humanoid robot based on users’ perception of the robot as an in-group as opposed to an out-group. Participants in the study were presented with a picture of a robot on a screen and asked to fill a questionnaire they were told would help developers improve the design of the robot. The authors varied the perceived group membership of the robot by altering the reported nationality of the robot as well as its name to either resemble or differ from the nationality of the participant. Robots presented as being in-group were anthropomorphized significantly more, while participants also reported significantly higher intentions to contact the robot as operationalized in the form of increased willingness to live with the robot and to talk with it (Eyssel & Kuchenbrandt, 2012, p. 727). While the study provides no evidence of causation, the results provide some support for the existence of a relationship between the level of anthropomorphism of the robot and the users’ contact intention with it which is also implicitly supported by other researchers exploring the social perception of technology and users’ intention to use it (Sundar, Jung, Waddell, & Kim, 2017) (Wu & Kraemer, 2017) (Xu, 2018) (Go & Sundar, 2019).

Chandler and Schwarz (2010) extended these findings by studying the role of the anthropomorphic perception of a vehicle on the users' intention to replace it. The authors conducted two experiments. In the first experiment, they asked participants to complete an online study supposedly aimed at exploring "what people think about their cars" (2010, p. 140) while the level of anthropomorphism varied through variations of the framing of the study. Participants described the vehicle in their own words and rated the likelihood that they would replace it before leaving college. The results showed significant differences between the anthropomorphic and the non-anthropomorphic conditions with participants within the anthropomorphic being significantly more likely to describe the vehicle using humanlike language (i.e. interpersonal emotions such as love, or personality) while participants in the non-anthropomorphic condition described it more in terms of its quality. Additionally, participants in the object condition became less willing to replace their vehicle as their description of the vehicle became more positive, however the same relationship was not significant for the anthropomorphic condition. Moreover, participants in the anthropomorphic condition reported significantly lower willingness to replace their vehicles than those in the object condition.

In their **second experiment**, Chandler and Schwarz (2010) aimed to explore whether features valued in interpersonal relationships would affect participants replacement intentions when they anthropomorphize the vehicle. The experiment followed a two by three factorial design with the color label (i.e. warm or cold) and a priming message (anthropomorphic, object, or no-prime control) as conditions. The warm or cold condition was operationalized by asking participants to select the color of their own car from a list of nine common car colors described by either a warm name like "summer blue" or a cold name such as “blizzard blue” (Chandler & Schwarz, 2010, p. 141), while the priming manipulation used was the same as in the first study. Similarly, to experiment one, participants in the anthropomorphic condition reported lower replacement intentions and displayed no relationship between product quality and their replacement intention. Moreover, participants in the warm color reported lower replacement intentions than those in the cold condition, but only if they were also part of the anthropomorphic condition rather than the object condition.

The two studies together show an interesting pattern. Participants in the object condition altered their replacement intention based on their perception of the quality of the vehicle but not based on how warm it was, while participants in the anthropomorphic condition were not affected by the quality of the vehicle and would rather see their replacement intentions change based on how warm they perceive the vehicle to be. This strongly suggest a significant change in the nature of the interaction, with object-like relationships between humans and machines being affected by traditional quality-related factors and anthropomorphic relationships between them being affected by interpersonal factors typical of human-to-human relationships. Furthermore, the authors point out that the study has the additional benefit of showing that anthropomorphism can be induced without the need to add anthropomorphic features (i.e. humanlike appearance or behavior) to the entity to be anthropomorphize (Chandler & Schwarz, 2010, p. 143).

5.3.2 Credibility, Performance and Satisfaction with the Interaction

Multiple researchers have explored the relationship between anthropomorphism and the trust placed on an artificial agent. Results for the most part suggest strong significant positive effects of anthropomorphism on credibility and trust (Gong, 2008), though some non-significant or inconsistent results have also been reported (Pak, Fink, Price, Bass, & Sturre, 2012) (Kim & Sundar, 2012).

An early study by Gong (2008) explored the question of the relationship between anthropomorphism and trustworthiness by exploring how variations in the level of human likeness of the appearance of an artificial agent affected the trust individuals had on a recommendation the agent made for how the participant could solve a dilemma. Specifically, Gong asked participants to read a scenario on a computer detailing a dilemma in which the participant had to choose between a risky but rewarding alternative, or a safer option that would bring a less significant reward. After this, participants were presented with a face with varying levels of anthropomorphism which recommended a choice. The results suggested that both the trust participants felt for the recommended choice was significantly positively affected by the level of anthropomorphism of the agent's face, with a higher level of anthropomorphism leading to higher trust in the choice. Additional studies have been carried since which provide additional support to the findings of Gong (2008). For instance, Pak and colleagues (Pak, Fink, Price, Bass, & Sturre, 2012) explored the trust participants felt towards a chatbot with varying degrees of anthropomorphism and showed that when anthropomorphizing a chatbot users become significantly more likely to display behaviors corresponding to trusting the chatbot; a tendency that remained even when participants expressed to perceive little to no difference in trust towards the agent when asked. Salem and colleagues (Salem, Lakatos, Amirabdollahian, & Dautenhahn, 2015) took the relationship a step further in an experiment and tested whether a robot making a mistake that impeded participants from receiving a monetary reward would significantly affect the trust felt towards the robot. The results of Salem and colleagues showed that even though participants reported a decrease in the reliability of the robot, their exhibited behavior remained consistent with possessing high trust towards the artificial agents.

Nevertheless, not all studies exploring anthropomorphism and trust showed significant positive effects. Kim and Sunder explored the effects of the presence or absence of an agent and its level of interactivity on the perceived social presence of the agent, anthropomorphism and the perceived credibility of the agent's displayed information (Kim & Sundar, 2012). In their study, participants interacted with an agent on a computer that varied between different levels of interactivity depending on the condition the participants were involved in. The results suggested that varying the level of interactivity led to both significantly higher levels of anthropomorphism and credibility. While correlated, the effects of anthropomorphism on the credibility of the agent was not measured and, instead, the authors explored the effects of social presence on the credibility finding no effects in that relationship. The lack of significant effects found for social presence on information credibility point towards a lack of effect of the social perception of technology on credibility. Nevertheless, despite the use of social presence as a proxy for anthropomorphism in prior literature, social presence and anthropomorphism are different constructs and therefore the relationship between anthropomorphism and credibility should have been explored. After all, the level of interactivity could have both direct and indirect effects on credibility through the anthropomorphic perception.

Despite their limitations, these studies suggest that there is a significant positive relationship between anthropomorphism and the level of trust or credibility humans have on a particular artificial agent which limit the impact of it failures on our perceptions of the technology (Salem, Lakatos, Amirabdollahian, & Dautenhahn, 2015), and changing the proportion of times humans agree with artificial agents or agree to look at alternatives (what was referred to as "Behavioral Trust" by Pak and colleagues) (Pak, Fink, Price, Bass, & Sturre, 2012).

5.3.2.1 Anthropomorphism, performance, and satisfaction with Interactions

Both actual and perceived performance have been key factors explored in the extant literature since the original work of Nass and colleagues. The earliest experiment that we identified showing evidence of changing performance was that of Fogg and Nass (1997) who conducted a laboratory experiment to determine the extent that humans would be susceptible to flattery effects from an artificial agent and whether the extent of influence would be similar to that of flattery coming from other humans. While the study did not measure anthropomorphism, it was one of the original stream of research into the CASA paradigm that posited individuals would perceived computers as social actors and therefore it implies that its conclusions are relevant for our analysis. Participants in the study engaged with a computer in a guessing game, after which the computer provided feedback to the participants. The feedback could be sincere representing the actual performance of the participant, insincere in which case the participant was told the feedback they would receive would be entirely independent of their performance, or it could be generic.

The results showed that praise from a computer, whether it was sincere or not, would lead to participants perceiving the interaction as being more enjoyable, their performance as being better than those who received a generic feedback. This suggest that anthropomorphized agents such as the computer used in Fogg and Nass study, can improve the perceived performance of an individual though it does not clarify if the anthropomorphization of the agent is enough for such effects to take place, or whether they take place indirectly through other factors such as the flattery used in the study as an independent variable.

Contradictory effects were reported by Lee (Lee E.-J. , 2010) when relying on flattery effects as a representation of social responses to computers to explore how the human likeness of the technology could impact individuals' evaluations of a computer. The authors posited that not only participants would evaluate their performance more positively when the computer provided then with flattering feedback, but the effect would be significantly higher when the computer showed a human like character to represent itself rather than pure text. The results indicated that flattery effects took place, though they were moderated by the level of rationality of the individual. In a second experiment to test whether the cognitive load would affect the effects, the study revealed that individuals who interacted with the agent with a human like appearance were suspicious of the computer's claims and significantly increased the likelihood they would dismiss them. These negative effects however disappeared as the cognitive load increased.

Wiese and her students (Abubshait & Wiese, 2017) (Hertz & Wiese, 2017) (Hertz & Wiese, 2018) explored this phenomenon in a more direct way than the preceding studies in their stream of research. Rather than relying on flattery as a proxy for the anthropomorphic perception of technology, Wiese and colleagues relied on well-documented physiological responses that humans exhibit when interacting with other humans such as gaze following (i.e. socio-cognitive behavior). In the first experiment in the series, Abubshait and Wiese (2017) demonstrated how inducing mind perception by increasing the human likeness of the appearance of an agent, or by increasing the reliability of the behavior of the agent leads to significant yet independent increases in socio-cognitive performance (gaze following) and in the attitudes towards the agent.

Parallel to this study, Hertz and Wiese (2017) explored whether still images of increasing human likeness could lead to social facilitation effects. The results suggested that despite other research showing social facilitation effects taking part in human's interactions with artificial agents, still images were not enough of a stimulus to encourage such effects on participants. To expand on this study, Hertz and Wiese (2018) moved on to explore whether other social effects such as social conformity could take place when interacting with more engaging artificial agents. The results of the study showed that when participants engaged with a group of computers, robots, or other humans to complete a social and analytical task social conformity would take place. Participants exhibited similar levels of conformity for analytical tasks in all types of agents, while conformity in social tasks increased as the agent became more human like. This suggest that social conformity effects were taking place for all types of tasks, but the effect was moderated by the match between task type and the human likeness of the of agent.

The studies by Wiese and colleagues demonstrate that anthropomorphic technology is capable of promoting social effects over individuals that can in turn lead to changes in performance providing support to the results of other studies including measures of performance and discussed in separate sections of this dissertation (Pak, Fink, Price, Bass, & Sturre, 2012) (Gong, 2008) (Hall & Henningsen, 2008) (Fasola & Mataric, 2012). While there is a paucity of research focused on the implementation of anthropomorphic agents to improve performance within the IS field, some researchers have begun to build on this topic. In the intersection of human-robot interaction and education, Kory-Westlund, Cynthia Breazeal and colleagues have conducted a series of studies showing how anthropomorphic agents can be used in classrooms to improve children performance and satisfaction in their classes (Kory-Westlund, et al., 2017) (Kory-Westlund, 2019).

In one of the key studies in the series (Kory-Westlund, et al., 2017), Kory-Westlund posited that the results of prior research into the effectiveness of social robots in education was dependent on the children's capability to relate to the robots as "interactive, social beings" (Kory-Westlund, et al., 2017, p. 2), a view supported by prior studies (Saerbeck, Schut, Bartneck, & Janse, 2010). Taking this view into consideration, Kory-Westlund and colleagues decided to explore whether increasing the expressiveness of a robot could significantly affect the learning experience of children within the context of a classroom as is well regarded to be the case when a human reads to children with an active voice rather than a monotone voice (Cremin, Flewitt, Mardell, & Swann, 2016).

For the study, the authors invited preschool children that were 5 years old on average to engage in a reading task with the robot. The robot would then narrate the story using gestures (which remained constant regardless of condition) and either an active dialogic voice (expressive robot) or a flat voice. While the children reported to like and learn the same with both robots, there were significant differences in both conditions. Children engaged with the active robot appeared to be more concentrated and engaged based on their facial expressions, when repeating the story told by the robot were significantly more likely to emulate its behavior, and took longer times to tell the stories.

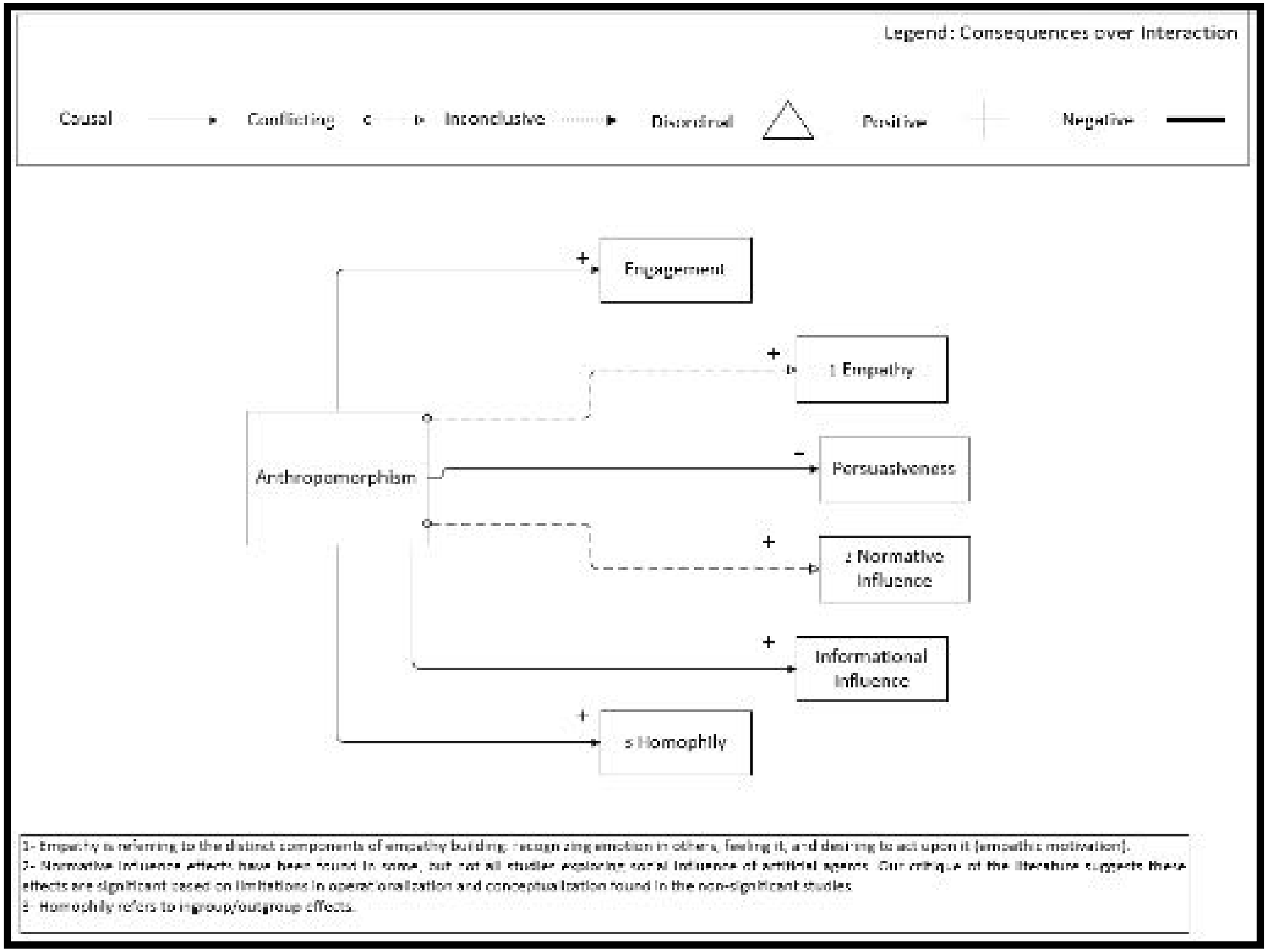
At the same time, the children engaged with the expressive robot were more likely to correctly identify the vocabulary in the expressive robot condition than the flat-voice robot condition suggesting improvements in their overall performance. While focused on children in a classroom environment, the results of Kory-Westlund's study suggest that anthropomorphic robots can build on social effects to induce improvements in performance in humans that interact with them, whether they are aware of it or not making anthropomorphic a significant element of human's relationship with and use of technology in productivity tasks.

5.4 ANTHROPOMORPHISM AND ITS EFFECTS OVER THE INTERACTION

One key area where the social perception of technology alters seems to be the perception of the interaction and the social effects it arouses in individuals. Early studies showed how anthropomorphizing artificial agents make them more persuasive leading to higher likelihoods of individuals conforming to their suggestions (Fogg & Nass, 1997) (Ogawa, Bartneck, & Sakamoto, 2009). Nevertheless, the effects seem to go beyond persuasion as some authors have reported multiple social effects such as social pressures (Xu & Lombard, 2017), normative and informational social influence (Vollmer, Read, Trippas, & Belpaeme, 2018), group polarization effects (i.e. homophily) (Eyssel & Kuchenbrandt, 2012), as well as social facilitation and social loafing effects (Park & Catrambone, 2007) (Hall & Henningsen, 2008).

Moreover, interactions with artificial agents have been reported to show different components of empathy development as well as the formation of relationships with other agents. These findings suggest that while individuals remain aware of the nature of these agents, the social effects persist leading to interactions that resemble human to human interactions to a great extent.

Figure 15 Consequences over the Interaction



5.4.1 Social Effects, Influence, and Pressures

Interactions with anthropomorphic agents have been shown to lead to individuals being influenced from a vast array of social effects. Early studies by Nass and colleagues showed how perceiving a computer as a social agent led to both increases in its persuasiveness (Fogg & Nass, 1997) (Fogg B. J., 2002) and homophily effects with the corresponding dissimilar evaluation of agents perceived to be in-group, against agents perceived to be part of the outgroup (Eyssel & Kuchenbrandt, 2012) (Go & Sundar, 2019).

Table 14 Type of social influence from anthropomorphism reported in the literature.

Type of Social Influence	Sample Related Article
Persuasiveness	(Fogg & Nass, 1997) (Fogg B. J., 2002) (Ogawa, Bartneck, & Sakamoto, 2009) (Lee E.-J. , 2010) (Patel, 2015)
Conformity	(Xu & Lombard, 2017) (Hertz & Wiese, 2018) (Gong, 2008)
Normative Social Influence	(Vollmer, Read, Trippas, & Belpaeme, 2018)
Informational Social Influence	(Vollmer, Read, Trippas, & Belpaeme, 2018)
Homophily: group polarization	(Xu & Lombard, 2017) (Eyssel & Kuchenbrandt, 2012) (Go & Sundar, 2019)

	(Gong, 2008) (Häring, Kuchenbrandt, & André, 2014)
Social Facilitation	(Park & Catrambone, 2007) (Hall & Henningsen, 2008) (Riether, Hegel, Wrede, & Horstmann, 2012)

Expanding on these studies, Vollmer, Read, Trippas, and Belpaeme (2018) explored whether social robots were able to exert peer pressure effects on individuals in the form of normative and informational social conformity. Informational conformity refers to the participants tendency to conform to others' responses as they rely on them as a source of information to information their own answers in a uncertain scenario. On the other hand, normative conformity refers to the tendency individuals have to conform to others' answers because of social pressures when the correct responses are clear.

To explore their research question, the authors asked children and adults to participate in a variation of an Asch paradigm methodology which places real participants in a group of confederates of the researchers that the participant believes are other real participants and see whether they conform to the groups tendency to respond in a way the participant clearly believes is incorrect (Asch, 1956). Vollmer and colleagues personalized their implementation of the Asch paradigm by including multiple social robots to compose the majority group rather than rely on confederates, which would in turn give them the capability to test whether those robots could stir up conformity effects. The study was carried out in two experiments.

In the first experiment, adults participated in the Asch paradigm experiment with social robots as the other agents rather than confederates of the researchers. The results showed no significant difference in the accuracy of the answers of the participants between the control condition and the experimental condition suggesting that normative effects were not achieved on the adults.

The second experiment aimed to explore whether children would be susceptible to the social effects of the robots. The authors argued that since children were more susceptible to social effects, testing the paradigm on them would reveal whether humans were not influenced at all by social robots, or adults simply resisted the conformity effects. The results of this second experiment saw children's accuracy in their answers drop when pressured by social robots in the experimental condition compared to their performance on the control condition suggesting that they were being affected by the normative conformity effects of the group of robots. Between the two experiments, Vollmer and colleagues concluded that while artificial agents can exert normative effects on individuals, these effects can be overridden as shown in the experiment with adults.

The results of Vollmer and colleagues work has been supported in the extant literature with Hertz and Wiese (2018) showing that social robots exert informational conformity on adults regardless of the appearance of the robot, while normative conformity would take place as a function of the degree of human likeness of the agent with higher levels of human likeness leading to stronger normative conformity effects. Additionally, while Hertz and Wiese (Hertz & Wiese, 2017) indicated that mere images of agents of varying degrees of human likeness were not enough to promote social facilitation effects, other studies have shown that the presence of robots (Riether, Hegel, Wrede, & Horstmann, 2012) and virtual avatars (Park & Catrambone, 2007) of higher degrees of engagement than a picture are sufficient for those effect to manifest (Woods, Dautenhahn, & Kaouri, 2005).

5.4.2 Empathizing with Artificial Agents

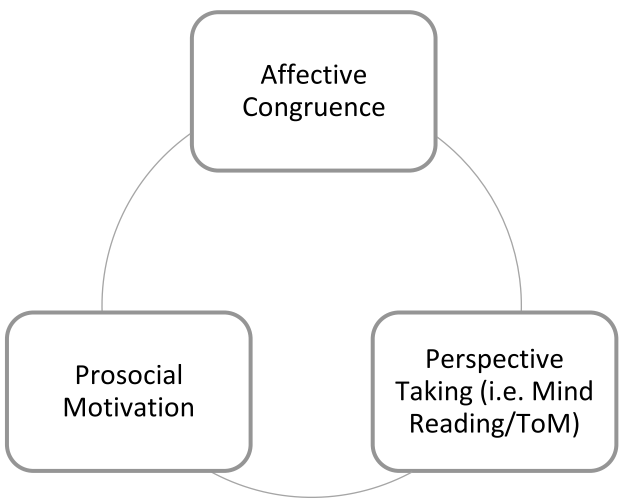
Social interactions with anthropomorphic agents have also been shown to be capable of promoting the development of empathy towards artificial agents. Research within this area has explore topics surrounding whether individuals can identify and attribute emotions to those agents (Lee, Baek, & Ju, 2018), relate to the perceived emotions, and promote prosocial behavior in the individual (Tahiroglu & Taylor, 2018).

One of the early studies on this topic was conducted by Riek, Rabinowitch, and Chakrabarti (2009) explored how the level of human likeness in appearance of a robot influences the empathy individuals' feel towards it. Participants viewed a film featuring one of five robots with as it was abused by humans who shouted, pushed and ordered it to do embarrassing things. Afterwards, participants rated the robot in terms of how sorry they felt for it and whether they would choose to save it. The results showed that individuals felt more empathy towards robots as its human likeness increased.

While Riek and colleagues (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009) provided a basis to support the relationship between anthropomorphism and empathy towards artificial agents, Zaki and Ochsner (Zaki & Ochsner, 2012) argue that when dealing with empathy, it becomes necessary to distinguish between it's the multiple processes that together come to produce the empathic state (Watt, 2005). These include

mind reading or perspective taking in reference to a person's ability to reason and make inferences about the mental states of others, **affect matching or experience sharing** which refers to a person's tendency to resonate with and 'feel' the emotions of others, and **empathic motivation also known as prosocial concern** in reference to a person's motivation to help others as a result of ring to the having reasoned about what others experience or resonating with their emotions (Zaki & Ochsner, 2012, p. 676).

Figure 16 Recreation of Figure 1 of "Three major facets of empathy" by Zaki and Ochsner (2012) page 676.



Based on this view, it seems reasonable to argue that the results presented by Riek and colleagues (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009) refer to both, a form of affect matching, and a proxy for prosocial behavior (Lieberman M. D., 2013, p.

152) since the experiment measured whether individuals felt sorry for the robot and whether they would hypothetically help it if they could respectively.

Interestingly, since anthropomorphism is defined as an attribution of cognitive and affective states to a non-human entity (Epley, Waytz, & Cacioppo, 2007), and the mechanisms through which it is studied rely heavily on the research into theory of mind (Abubshait & Wiese, 2017), it seems reasonable to consider that anthropomorphizing a technology by definition is closely related to taking the perspective of an "other" entity encouraging an individual to start the process of empathizing with the technology as an artificial agent (Airenti, 2015) (Airenti, The Development of Anthropomorphism in Interaction: Intersubjectivity, Imagination, and Theory of Mind, 2018). Additionally, Lee, Baek and Ju (2018) as well as McDonell and colleagues (McDonell, Jorg, Mchugh, Newell, & O'Sullivan, 2009) provide further examples of how different individuals can perceive emotions from these technologies with ease through anthropomorphic designs or variations in body shape respectively.

Furthermore, Obaid, Kuchenbrandt and Bartneck (Obaid, Kuchenbrandt, & Bartneck, 2014) propose how relying on yawn contagion can be used as a measured of the empathy felt towards artificial agents in the form of "sharing someone's emotional reactions" (Obaid, Kuchenbrandt, & Bartneck, 2014, p. 260), which clearly represents a form of **affect matching** based on the definition above by Zaki and Ochsner (2012). Obaid and colleagues based this proposition on prior literature showcasing the relationship between empathy between humans and the likelihood of a Yawn spreading among them as it relates to social bonding and emotional closeness (Norsia & Palagi, 2011). While the authors did not provide evidence for their proposition, the same idea was later further developed and tested by Lehmann and Broz with significant results showing in their preliminary data (Lehmann & Broz, 2018).

More recently, Tahiroglu and Taylor (2018) explored the relationship between social understanding, anthropomorphism and prosocial attitudes hypothesizing that anthropomorphic tendencies in the form of the IDAQ measurement (Waytz, Cacioppo, & Epley, 2010) would be significantly and positively correlated with prosocial behaviors and empathy. The authors conducted a survey where they asked participants to answer questionnaires for each construct of interest. Results indicated no correlation between the IDAQ measurements and the self-reported prosocial attitudes. While at first appearing to contract the past literature, it becomes important to assess what the authors measured.

First, the IDAQ questionnaire measures anthropomorphic tendencies rather than anthropomorphism itself. That is, it measures the individual differences in tendency to anthropomorphize an agent all else being equal, and it does so only from a from a reasoning point of view where anthropomorphism can happen both consciousness (i.e. through reasoning) or non-consciously. Additionally, the prosocial attitudes represent individual tendencies to engage in prosocial behavior all else equal (Caprara, Steca, Zelli, & Capanna, 2005). Once more, the measurement used does not represent an actual instance of an empathic state leading to motivation to help, but rather it reflects on individual's differences in tendency to be motivated to help all else equal. Therefore, the study measured whether a correlation existed between individual differences in likelihood to anthropomorphize (i.e. perceive cognitive and affective states in non-humans), and individual differences in likelihood to help in dire situations (i.e. prosocial motivation). While the arguments described before support the idea of a correlation existing between anthropomorphizing an entity and possessing prosocial motivation towards it, this is an entirely different problem than whether a correlation exist in tendencies for anthropomorphism and prosocial attitudes.

There appears to be a paucity of research into the relationship between prosocial behavior and anthropomorphism from our point of view. This problem appears to be exacerbated by a lack of consideration of the context of an interaction when studying empathic processes as shown by Tahiroglu and Taylor (2018) and further argued by Clark and colleagues (Clark, Boothby, Clark-Polner, & Reis, 2015). Clark and colleagues argue that since the relational context of an interaction guides the antecedents, consequences and frequency of prosocial behavior, a lack of consideration for the context of an interaction would lead researchers to miss one of its central components.

Other studies that have explored the role of prosocial behavior include Larsen and colleagues (Larsen, Lee, & Ganea, 2018) work on story telling with anthropomorphic characters, and both Darling and colleagues (Darling, Nandy, & Breazeal, 2015) and Barneck and colleagues (Bartneck, Verbunt, Mubin, & Al Mahmud, 2007) work on empathy towards robots and willingness to harm them.

Larsen and colleagues explored whether presenting children with stories of anthropomorphic agents in the form of human like animal characters would lead to an increase in altruistic behavior. The results showed that rather than the character being human like in appearance, it was the realism of the stories what significantly affected the likelihood of altruistic behavior increasing. Since the concept of anthropomorphism is focused on the attribution of cognitive and affective states rather than the appearance of the entity, we believe this study provides some support for the link between anthropomorphism and prosocial behavior rather than evidence against it.

The works of Bartneck and colleagues (Bartneck, Verbunt, Mubin, & Al Mahmud, 2007) as well as Darling and colleagues (Darling, Nandy, & Breazeal, 2015) present us with instances of actual prosocial behavior taking place when interacting with robots. While neither study explicitly tested for anthropomorphism, Bartneck and colleagues explored whether individuals' willingness to destroy a robot would change as they perceive the robot as possessing increasing levels of intelligence (i.e. an example of cognitive states). Darling and colleagues on the other hand explored whether individuals' willingness to harm a robot would change as they bonded with it through storytelling and increasingly projected life-like attributes on it (i.e. increased affective states). These studies show that individuals would decrease their willingness to harm the robot as they bonded with it and attributed intelligence and affective traits to it thus suggesting that increasing the anthropomorphization of the robots led to higher prosocial behaviors.

Table 15 Role of anthropomorphism in evoking empathy from an artificial agent.

Empathic Process	**Representative Work**
Perspective Taking (Mind Reading)	(Lee, Baek, & Ju, 2018) (McDonell, Jorg, Mchugh, Newell, & O'Sullivan, 2009) (Kwak, Kim, Kim, Shin, & Cho, 2013)

	(Böffel & Müsseler, 2018)
Affect Matching	(Obaid, Kuchenbrandt, & Bartneck, 2014) (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009) (Lehmann & Broz, 2018)
Prosocial Motivation	(Tahiroglu & Taylor, 2018) (Larsen, Lee, & Ganea, 2018) (Darling, Nandy, & Breazeal, 2015) (Bartneck, Verbunt, Mubin, & Al Mahmud, 2007) (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009) (Traeger, Sebo, Jung, Scassellati, & Christakis, 2020)

5.4.3 Building Relationships with Artificial Agents

As suggested by the previous section, anthropomorphizing an agent appears to lead to the formation of bonds between humans and the artificial agents which can lead to significant changes in the interaction (Darling, Nandy, & Breazeal, 2015) (Bartneck, Verbunt, Mubin, & Al Mahmud, 2007). Multiple other studies in the extant literature have shown explicit or implicit evidence of these bonding effects and the changing nature of the interaction between the agents involved such as the attribution of social roles and responsibilities to artificial agents (Kory-Westlund, et al., 2017) (Kory-Westlund, Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots, 2019).

Multiple studies have investigated the process through which interpersonal relationships with artificial agents are developed. Lemaignan and colleagues (Lemaignan, Fink, Dillenbourg, & Braboszcz, 2014) developed a conceptual study in which they argued that anthropomorphism would developed through three phases starting with an initial interaction characterized by non-conscious initial perception of the other entity. After some observation, an individual would go into a second phase where behavioral and cognitive models of the entity are developed. Finally, after a model is created, an individual will enter a third and final stage where they engage in a purposeful context-relevant interaction with the entity and reshapes the behavioral and mental models of the entity. Evidence for the development of an initial mental model and its role in forming a relationships with the entity has been presented by Pitsch and Koch (2010).

Pitsch and Koch (2010) investigated recordings from a previous study in which infants from 3 to 8 years of age played with a robot and conducted an Ethnomethodological Conversation Analysis (EM/CA) to explore how they perceived and formed mental models of the robots as well as how they stablished coordinated sequences of actions where the children fed the robot Pleo in a manner resembling the purposeful interactions discussed by Lemaignan and colleagues (Lemaignan, Fink, Dillenbourg, & Braboszcz, 2014). The results of the study show a process through which children developed mental models of the robot through a series of interactions progressively altering their mental models from an object, to an animate object, to a animate object capable of multiple engagement and back to an object with multiple functions.

Fussell, Kesler, Setlock and Yew expanded the literature of how relationships are formed by demonstrating that on-going interactions with an artificial agent can enhanced the anthropomorphic mental model that participants hold of that agent solidifying their relationships, a finding supported by research on the use of paralinguistic cues and back-channeling cues to strengthen the relationships with the artificial agents (Lee, Lee, & Sah, 2019) (Friedman, Kahn, & Hagman, 2003). A stream of research on this area has been undertaken by Kory-Westlund and Cynthia Breazeal of the MIT Media Lab based on research on how social robots can be deployed in classrooms in order to help young students (Kory-Westlund & Breazeal, 2019) (Kory-Westlund, et al., 2017) (Kory-Westlund, Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots, 2019).

Kory and colleagues (Kory-Westlund, et al., 2017) became interested in whether social robots could help children expand their vocabulary through active and dialogic book reading exercises. Specifically, the authors decided to explore whether varying the level of expressivity of a robot as it read a book and conversed with the children would affect the effectiveness of the active reading session. The experiment possessed two conditions: one with an expressive robot that spoke with variations in intonation and emotion, and a flat-voice condition in which the robot spoke with a monotone voice reminiscence of a text-to-speech engine with low variations in intonation. Regardless of the condition, the robot narrated the book's story with active reading techniques and using key target vocabulary words that children were meant to learn. Afterwards, children were tested on the new vocabulary and asked to retell the story. The results show that despite children reporting enjoying and learning similarly in both scenarios, those exposed to the expressive robot were more focused, remember more words, and were significantly more likely to imitated the robot when retelling their stories while spending more time telling them. These results suggest that increasing the expressiveness of the robot improve the overall quality of the interaction.

Expanding on the previous study, Kory-Westlund and Breazeal (2019) explored how speech entrainment, that is the tendency to mimic the behavior of others in an interaction, when interacting with children as well as the presentation of a backstory for the robot affects the relationship between the robot and the children. To explore these relationships, the authors conducted an experiment with a two by two between subjects design with varying levels of entrainment (entrainment present vs no entrainment) and varying levels of backstory (introduced a backstory or excluded the backstory). Similarly to the previous study (Kory-Westlund, et al., 2017), the robot told children a story using some vocabulary that was new to the children and then asked them to retell the story. Children exposed to the entrainment showed significantly more positive emotions and fewer negative ones, while children exposed to the backstory were significantly more likely to accept the robot possessed poor hearing abilities indicating the formation of a stronger relationship. Moreover, children exposed to both the entrainment and backstory conditions were more likely to use some of the new words introduced by the robot and use some of the same phrases the robot had used before. Based on these results, it seems clear that both speech entrainment and giving the robot a backstory can significantly improve the quality of the interaction and lead to higher rapport and learning.

These studies suggest that relationship building behaviors exhibited by technology are effective in improving the interaction between humans and artificial agents in a similar manner as they do in interactions between humans. While individual differences exist, the extant literature shows that forming relationships with these agents is possible and can enable key social effects such as the development of rapport and social influence, and the ascription of roles to artificial agents (Kory-Westlund, Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots, 2019) (Kim, Cho, Ahn, & Sung, 2019) (Kory-Westlund, Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots, 2019).

Throughout this dissertation we have conducted a critical analysis of the results of the extant research into anthropomorphism and the social perception of technology and used it to form a model based of the factors influencing the anthropomorphic attribution and its consequences. Since not all studies agree in their results , operationalization of the construct and theoretical definition (Powers & Kiesler, 2006) (Kim & Sundar, 2012), we consider it pertinent to reexamine these views on anthropomorphism through the lenses of the critical analysis conducted above.

6.1 VIEWS ON ANTHROPOMORPHISM

6.1.1 Anthropomorphism as a form of irrational thinking in the young

Multiple researchers have explored the nature of anthropomorphism throughout the years. Possibly the oldest and most influential conceptualization of anthropomorphism comes from the work of Piaget as he explored the differences in reasoning style seen between children and adults (The Child's Conception of the World, 1929). Through this work, Piaget came into instances of animism and anthropomorphism from multiple children who described objects' behaviors in human like terms. While he often referred these instances as animism or the tendency to perceive an entity as being alive and intentional, Piaget's records indicate multiple instances referring to cognitive and affective state attributions that represent anthropomorphism rather than animism. In one such description, a child explains that the sun "goes away" during bad weather "because it doesn't want to be rained on" (Piaget, 1929, p. 187) thus providing an entity, the sun, with an affective state and consequently representing anthropomorphism. Following these descriptions, Piaget concluded that animism and anthropomorphism were forms of irrational thinking that children expressed but were ultimately eliminated once they reached adulthood.

Despite the importance of Piaget's work towards the development of the theory of cognitive development (Piaget, The origins of intelligence in children, 1936), his conceptualization appears to be contested by the extant literature.

Firstly, while an individual's age has been shown to lead to significantly differences responses to anthropomorphic technology suggesting it plays a role in whether anthropomorphism takes place or not (Vollmer, Read, Trippas, & Belpaeme, 2018), the literature shows multiple studies in which individuals anthropomorphize a technology regardless of their particular age (Pak, Fink, Price, Bass, & Sturre, 2012).

Secondly, argument that it represented irrational form of thinking came forth from his view that the children were developing and holding incorrect beliefs about the entities argued. In his work, Piaget explicitly asked children of multiple ages about their beliefs with questions such as "can the sum feel anything? […] why not?" (Piaget, 1929, p. 186) which he came to view as the children's incorrect beliefs. However, whether these responses represent actual beliefs is under debate. In reviewing Piaget's views on anthropomorphism, Airenti (2018) notes that asking children questions in this form when they had never considered these views, leads them to look for a potential solution to the question which they end up expressing as if it was a belief. Moreover, recent research strongly suggest that anthropomorphism can take place both through rational and conscious though (i.e. top-down processing) or in a non-conscious form (bottom-up processing) further diminishing Piaget's conceptualization (Urquiza-Haas & Kotrschal, 2015).

Proposition 1: Age will affect an individual's likelihood to anthropomorphize an entity only to the extent that it can influence other related factors (indirect effects only).

Proposition 2: Anthropomorphism is not limited to conscious, rational though and instead can emerge from non-conscious processes.

6.1.2 Anthropomorphism as a form of perception

A different conceptualization of anthropomorphism was provided by Guthrie who argued that anthropomorphism represented a form of perception of an entity (Guthrie S. , 1995). For Guthrie, anthropomorphism is a rational process through which individuals respond to uncertainties due to perceptual ambiguities, applying human like mental models to them because of our familiarity with and ease of access of these models. While Guthrie's view of anthropomorphism may find some support as shown in studies relying on the comparable construct of elicited agent knowledge from Epley, Waytz, and Cacioppo's three factor theory of anthropomorphism (Epley, Waytz, & Cacioppo, 2007), multiple studies show that anthropomorphism goes far beyond an initial response to an unknown, and can instead developed into full interpersonal relationships (Kory-Westlund, 2019). Moreover, recognizing human appearances or behaviors in a non-human entity is not enough to attribute cognitive or affective states such as intentions to the entity as demonstrated by researchers' failure to elicit anthropomorphism in studies relying on static images alone as discussed in sections 4.4.2 and 4.4.3 (Sah & Peng, 2015) (Go & Sundar, 2019) (Pak, Fink, Price, Bass, & Sturre, 2012).

Proposition 3: Mere perception of humanlike characteristics is not enough to elicit Anthropomorphism attributions.

6.1.3 Anthropomorphism as an automatic process

The next theory developed to explain the social perception of technology is the CASA paradigm by Nass and colleagues (Nass, Steuer, & Tauber, 1994) (Nass & Moon, 2000). From the point of view of the authors, individuals would homogenously perceive computers and other media solutions as social actors and interact with them accordingly. Nass and colleagues initially rejected anthropomorphism as a potential explanation of the social perception of technology since they consider it to represent a sincere belief that the computer possessed human traits and characteristics and "should be understood in human terms or should be treated as a person" (Nass & Moon, 2000, p. 82). The authors argued instead for the concept of "Ethopoeia" which they described as "a direct response to an entity as human while knowing that the entity does not warrant human treatment or attribution" (Nass & Moon, 2000, p. 94). In essence, Nass and colleagues argued that the social perception of technology was a non-conscious process that caused individuals to attribute human like qualities to the computer despite their better knowledge, which is more in line with what we are discussing as anthropomorphism than their original conceptualization.

Nass view can be understood as similar yet opposite to Piaget’s view. Whereas both described anthropomorphism as an incorrect attribution, Piaget view it as a form of conscious irrational though, while Nass and colleagues saw it as an automatic non-conscious response. Because of this, Nass argumentation appears to suffer from the opposite flaw to Piaget with multiple studies showing anthropomorphism taking place through inductive reason as suggested by Epley and colleagues three factor theory of anthropomorphism (Epley, Waytz, & Cacioppo, 2007) and other studies relying on it. Additionally, Nass view that anthropomorphism, or to be more precise, the social perception of technology, is an homogeneous process has been challenge multiple times with research showing vast ways in which individuals possess differences in their tendencies to anthropomorphize technology (Marakas, Johnson, & Palmer, 2000) (Culley & Madhavan, 2013) (Wang W. , 2017).

Proposition 4: Anthropomorphism is not limited to non-conscious, automatic responses and instead can emerge from conscious inductive processes.

6.1.4 Anthropomorphic Inductions and Anthropomorphic Interactions

Two of the most recent perspectives on anthropomorphism come from Urquiza-Haas and Krotschal (Urquiza-Haas & Kotrschal, 2015) and from Airenti (Airenti, 2018) both of which recognize the multifaceted nature of anthropomorphism.

Urquiza-Haas and Kortschal argued that when anthropomorphizing an entity, individuals rely on the same cognitive mechanisms used when they interact with other humans as suggested by social neuroscience research (Caramazza & Shelton, 1998) (Martin & Weisberg, 2003). Based on this perspective, the authors argued that anthropomorphism could emerge from both bottom-up or top-down mental processes. In their view, these bottom-up processes would be characterized by non-conscious and automatic responses to non-human agents resulting from automatic neurological mechanisms of motor matching, agency detection and social cognition that indicate animacy, agency, and intentionality. On the other hand, top-down processes would be characterized by those reflective processes such as induction and causal reasoning that lead individuals to ascribe non-human entities with human like qualities (Urquiza-Haas & Kotrschal, 2015, p. 170).

Airenti (2018) agrees with Urquiza-Haas and Kotrschal's (2015) conceptualization, however, she considers that it is important to explicitly distinguish between anthropomorphic beliefs and an anthropomorphic interaction. Airenti argues that anthropomorphism is a basic human attitude that emerges when humans engage with a non-human entity in a modality typically reserved for human interlocutors such as when an individual attempts to influence another to gain their cooperation. By doing so, she argues that a person establishes a relation with the non-human agent leading to attributions of intentionality and other social perceptions characteristic of anthropomorphism (2018, p. 8). From this point of view, she argues that an individual's beliefs become immaterial to the emergence of an anthropomorphic interaction except to the extent that these beliefs can motivate the individual to initiate such an interaction in the first place.

Airenti's built her rejection of the view of anthropomorphism as a set of beliefs based on the observations that if we consider anthropomorphism as a belief it becomes unfeasible to explain why non-human entities are anthropomorphized even when an individual is aware it does not possess a mental life (Kim & Sundar, 2012), why an entity can be anthropomorphized in one interaction only to be treated as an object in the next one, why there is no consistency in the entities that are anthropomorphized (Kim & Sundar, 2012) (Araujo, 2018), and why individual's tendency to anthropomorphized has been shown to vary based on affective states of the individual rather than what a person knows about the entity (Letheren, Kuhn, Lings, & Pope, 2016) (Airenti, 2018, p. 10). In Airenti's view, these limitations of anthropomorphism as a belief could be explained if we consider it a form of interaction with non-conscious components that is only affected by an individual's belief to the extent these beliefs can impact other relevant factors. In such an scenario, an individual's awareness of the lack of inner life of an entity wouldn't affect whether it is anthropomorphized, the entity would be anthropomorphized only in those interactions it is placed in the role of an interactant, an entity could be anthropomorphized irrespective of its characteristics, and we would expect individuals' to vary in their tendency to anthropomorphized based on affective factors other than their beliefs about the entity.

Airenti's argument remain compelling and demonstrate that anthropomorphism cannot be based entirely on beliefs about an agent. Nevertheless, these arguments provide insufficient evidence to demonstrate that anthropomorphism is entirely rooted in the non-conscious mechanisms surrounding the mode of interaction with the agent. Considering anthropomorphism as having distinct potential origins from both top-down and bottom-up processes, as argued by Urquiza-Haas and Kotrschal's (2015), means that we can explain the four arguments against anthropomorphism presented by Airenti through the lens of bottom-up processes (i.e. automatic non-conscious processes) while still allowing beliefs and mental models about the non-human entity to encourage anthropomorphism. Following this view, we would have to consider that anthropomorphic attributions reached from bottom-up and top-down mental processes necessarily possess different characteristics and implications or otherwise we wouldn't observe the arguments made by Airenti. The extant literature provides support for this expanded view. For example, the studies on individual differences (see section 4.2.3 on this document) demonstrate that the role of beliefs and mental model in increasing humans' tendencies to anthropomorphize a technology (Marakas, Johnson, & Palmer, 2000) and, while not being necessary for an anthropomorphic attribution to take place, the characteristics of a technology have been shown to be capable of significantly increasing the tendency to anthropomorphize it as discussed in section 4.4 of this document (Lee, Lee, & Sah, 2019) (Lee E.-J. , 2010) (Gong, 2008).

It is also important to recognize that while these arguments suggest anthropomorphism can emerge from both conscious and non-conscious processes, Airenti's conceptualization doesn't reject the potential influence of mental models and beliefs and instead argues the influence of these factors would be limited to indirect effects to the extent that they can motivate an individual to engage in a communicative interaction with the non-human entity. Therefore, the key difference between Airenti's (2018) and Urquiza-Haas and Kotrschal's (2015) conceptualization lays in whether the effects of a person's beliefs are indirect or direct respectively.

As we have discussed before in section 4.2.3 on the role of beliefs and mental models, multiple researchers have explored the relationship between individual's beliefs and their tendency to anthropomorphize and shown significant positive effects (Marakas, Johnson, & Palmer, 2000) (Schechtman & Horowitz, 2003) with beliefs about the intelligence, socialness, locus of control, and controls over rights and freedoms of the technology being the most significant (Johnson, Marakas, & Palmer, 2008). Nevertheless, the possibility remains that these effects are observed not because the beliefs directly lead to anthropomorphism, but instead because they encourage individuals to engage in a communicative interaction with the technology. Therefore, we propose that:

Proposition 5: Anthropomorphism achieved through bottom-up non-conscious mechanisms (e.g. rationalization or induction) and anthropomorphism achieve through conscious top-down mechanisms (e.g. belief systems or mental models) can possess a) different characteristics and b) different effects.

And we also consider it necessary to further expand our understanding of the nature of the effects of beliefs about the technology on our perception of the technology as a social agent.

RQ1: Why do beliefs and mental models about an artificial agent affect humans' perception of the agent as a social being?

6.1.5 Anthropomorphic Motivators & Mind Perception

Other notable theories include Epley and colleagues three factor theory of anthropomorphism (Epley, Waytz, & Cacioppo, 2007), and Gray, Gray, and Wegner's theory of mind perception (Gray, Gray, & Wegner, 2007). Epley and colleagues' view focuses on the psychological determinants of anthropomorphism arguing that an individuals' desire to understand an entity's behavior combines with their desire to establish social connections with others to promote the anthropomorphization of the entity specially in circumstances where human like referent knowledge is readily available. These arguments appear to receive vast support from the extant literature as discussed in the individual differences section above (see section 4.2.2).

Proposition 6a: An individual's desire to understand the behavior of an entity increases the likelihood of perceiving it as a social agent.

Proposition 6b: An individual's desire to establish social connections with others increases the likelihood of perceiving an artificial agent as a social agent.

The mind attribution theory of Gray, Gray, and Wegner (2007) argues that people perceive different characteristics of mind in different types of agents along the lines of increased agency or apparent capacity to act on its own volition, and increased experience or capacity to feel. As we have discussed under the sections on perceived moral agency and accountability (see section 4.1.2) this theory has received vast support from empirical research strengthening the argument that the key factors that lead humans to the attribution of mind are the perception that an entity is either capable of acting or feeling or both (Gray & Wegner, 2009) (Gray, Young, & Waytz, 2012).

Proposition 7a: the social perception of technology results from the perception that an entity can act on its own volition.

Proposition 7b: the social perception of technology results from the perception that an entity possesses a subjective experience.

The extant empirical literature seems to support some of the key elements of each outstanding theory of anthropomorphism and the social perception of technology, giving us in the process a baseline through which we can further define what it means to anthropomorphize an entity. So far, this brief critique of the existing theories suggests a view of anthropomorphism as:

- A phenomenon resulting from an interaction with an entity which emerges from both automatic and rational psychological mechanisms due to the perception of agency or subjective experience in an entity, and which is promoted by an individual's desire to connect and explain the behavior of others.

Additionally, taking into account the similarity reported by Urquiza-Haas and Kotrschal (Urquiza-Haas & Kotrschal, 2015) between the mental mechanisms used by humans to perceive mind in others (i.e. mindreading) and those used to anthropomorphize technology it seems reasonable to consider anthropomorphism to be a special case of mindreading in which the target is an object or other non-human entity rather than an actual human. Following this view, some significant implications arise.

Firstly, the view of anthropomorphism as a special case of mind reading used in interactions with non-living entities does explain the major weaknesses of each of the previously presented theories of anthropomorphism, while also providing us with an framework from which to continue exploring the phenomenon empirically. Specifically, it gives us a theoretical basis to explore the mechanisms that lead to mind-reading and empathy and how they relate to anthropomorphism. We will expand on this in the next section.

Secondly, this perspective of anthropomorphism represents a unique form of interaction. A form of interaction in which an entity breaks the boundary between what is perceived to be alive and conscious and what is perceived not to be. Prior to our current technological advances, the only instances in which humans encountered this type of interaction was through pretend play, religion and occasional descriptions of objects or natural phenomena (Guthrie S. E., 1993) (Airenti, 2015).

The current availability of technological artifacts such as voice assistants and chatbots are transforming anthropomorphic interactions into a widespread phenomenon relevant to the everyday life of organizations. Moreover, as advances in AI and social robotics continue, it is expected that the autonomy of technology as well as its capacity to express and respond to emotions will improve significantly potentially leading to significantly more anthropomorphic interactions as the boundaries between objects and subjects continue to blur (Gray & Wegner, 2012).

Over the next two sections we will expand on what our critique of the literature on anthropomorphism means for how we understand human computer interaction and explore its potential implications in the development of Behavioral AI, and Relational AI.

6.2 The Nature of Anthropomorphism

Our analysis of the literature supports the view that anthropomorphism represents a special case of mindreading as argued by Urquiza-Haas and Kotrschal (2015). This support has been shown from the perspective of both behavioral and neuroscience research focused on exploring the mechanisms underlying the anthropomorphic attribution and other antecedents.

Behavioral research has documented cases of both conscious and non-conscious anthropomorphic attributions taking place (Cullen, Kanai, Bahrami, & Rees, 2014) (Epley, Waytz, Akalis, & Cacioppo, 2008), as well as significant increases in tendency to anthropomorphize when either agency or social cues suggestive of experience are presented to participants (Schroeder & Epley, 2016) (Lee, Lee, & Sah, 2019).

On a neurological basis, mechanisms associated with theory of mind (i.e. attribution of cognitive and affective states in other humans) have also been shown to be activated when anthropomorphizing an entity, and factors suggestive of agency (such as the observation of biological looking movement) have been associated with encourage automatic attributions of cognitive and affective states to non-human entities through similar perceptual mechanisms as to those activated when interacting with other humans (Hoenen, Lübke, & Pause, 2016) (Spunt, Ellsworth, & Adolphs, 2017).

In addition to the research mentioned above, studies on the consequences of anthropomorphism can also help us understand what it means to anthropomorphize an entity including how and why humans do it. For example, while previous theories could explain some effects such as changes in how individuals perceive the technology (see section 5.1 for a discussion on this topic), these theories appear to be insufficient to explain other reported effects such as changes in an individual's sense of self and agency when cooperating with an artificial agent (Ciardo, Tommaso, Beyer, & Wykowska, 2018) (Grynszpan, et al., 2019), the capability of anthropomorphized technology to influence users through social pressures and conformity effects (Abubshait & Wiese, 2017) (Vollmer, Read, Trippas, & Belpaeme, 2018), or even the development of bonds with and empathy towards artificial agents (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009) (Tahiroglu & Taylor, 2018).

The significance of these effects becomes more evident when we compare our current understanding of the role of technology in an interaction to the results of the studies exploring the social influence of anthropomorphic entities.

6.3 CHANGING IDENTITIES AND THE SENSE OF SELF THROUGH AGENTS

Within the field of Information Systems, technology has often been considered a neutral entity capable of aiding users in carrying out a user's actions effectively, with its influence depending on how it is used as it alternates between constraining and facilitating humans actions (Orlikowski, 1992, p. 410) (Hirschheim, 1986) (Marakas, Johnson, & Palmer, 2000). Recently, researchers have become interested in how different technologies can alter an individual’s sense of self and own identity. Based on a combination of Identity theory and Social Identity Theory, researchers have argued that these changes can lead to changes in key factors that are widely studied in the field such as the individuals’ beliefs, intentions and behaviors, and their overall performance.

Two prominent views on this topic are those of Carter and Grover’s IT Identity (2015), as well as that of You and Robert robot identification and emotional attachment (2018). In the next pages, we will briefly introduce their views, and present an alternative way in which anthropomorphizing a technology can also result in significant changes in an individuals’ sense of self and identity albeit through different mechanisms.

Table 16 Effect of modality on the type of influence technology exerted.

Modality	Type of Influence	Nature of Influence
A	Technology as Neutral Tool	Technology influences an individual’s behavior to the extent that it enables or constrains a user’s actions (Orlikowski, 1992)
B	Technology as Extension of Self	Technology influences individual by becoming part of their own identity (Carter & Grover, 2015)
C	Technology as a reminder of Team Membership	Technology evokes homophily effects on an individual as it acts as a referenced of a team the person is involved with (You & Robert Jr., 2018)

D	Technology as an Agent	Technology evokes social influence effects itself, enabling to generate both team membership effects and shared agency effects

6.3.1 Technology as an extension of the self

In their seminal article, Carter and Grover recently proposed the concept of IT Identity as an important construct influencing how individuals' self-perceptions change as they use technology. The authors argued that as an individuals' reliance on a particular technology increases, they integrate the capabilities it enables into their own set of perceived resources leading to the development of an extended sense of self that, in turn, results in significant changes in behavior (Carter & Grover, 2015, p. 932).

Carter and Grover based their conceptualization on a combination of both identity theories (McCall & Simmons, 1978) (Stryker, 1980) (Burke & Reitzes, 1991) and theories of material identity (Dittmar, 2011) and argued that it is "reflected in an individual's feelings of relatedness, emotional energy and dependence when thinking of themselves in relation to a particular IT" (Carter & Grover, 2015, p. 945).

6.3.2 Technology as a reminder of group membership

The conceptualization of IT Identity provided by Carter and Grover was further tested and expanded by You and Robert in their study on how identification and emotional attachment with robots can improve team's performance (You & Robert Jr., 2018). Within the context of a team working with an embodied robot, You and Robert explored how the team's emotional attachment to its own robots affects the teams' performance and viability, and whether the robot and team identification can increase emotional attachment to the robots. Where Carter and Grover saw a technology's capabilities as potentially being integrated in the self-concept of an individual, You and Robert proposed that a technological artifact could also influence the identity of the individual through sense-making (Weick, 1995) (Huettermann, Doering, & Boerner, 2016). Through sense-making, individuals establish connection with other team members and starts seeing themselves as members of the team developing emotional preferences for others that are perceived to also be part of the team as oppose to outsiders (i.e. homophily or in-group and out-group effects).

You and Robert (2018) argued that the connection with "in-groups" rather than "outgroups" creates an emotional bond that can extent to objects that remind the individual of their membership in the team. Therefore, the authors posited that an embodied robot specifically, or a technological artifact in general, can lead individuals to perceive in-group effects to the extent that they remind the individuals of their membership in the team (You & Robert Jr., 2018, p. 384).

In their study, You and Robert tested both forms of identification (i.e. technology as an extension of self, and technology as a reminder of the group membership) demonstrating that it lead to significant effects over the emotional attachment felt towards an EPA robot both independently as well as jointly, which in turn led to improvements in the teams' performance and viability.

6.3.3 Technology as a Perceived Agent

While the work of Carter and Grover and You and Robert provide us with two ways in which Information Technology usage can influence an individuals' sense of self and identity, anthropomorphism provide us with yet another approach (Carter & Grover, 2015) (You & Robert Jr., 2018). The extant literature suggests that by anthropomorphizing a technology, individuals ascribe mind to it, and through this mechanism they give it the capability of evoking team membership effects (i.e. homophily) on the individual in turn leading to the establishment of bonds between the person and the technology (Norsia & Palagi, 2011) (Darling, Nandy, & Breazeal, 2015), the recognition of emotions and feelings on it (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009), and it can finally lead to the desire to assist the technology through prosocial behavior (Bartneck, Verbunt, Mubin, & Al Mahmud, 2007) (Traeger, Sebo, Jung, Scassellati, & Christakis, 2020).

In this way, anthropomorphism enables the creation of real relationships between the individual and the robot, leading to social identity effects emanating from the technology as the individual bonds and identifies with the technology on its own right rather than reminisce about teams they belong to (You & Robert Jr., 2018). These anthropomorphism-enabled relationships have also been shown to lead to other team effects such as the formation of joint-agency in tasks as discussed in section 5.2.2 (Barlas, 2019) (Ciardo, Tommaso, Beyer, & Wykowska, 2018) (Grynszpan, et al., 2019).

All three of these approaches function by influencing the formation of an individual's identity, however significant differences exist between them. Carter and Grover's conceptualization points towards the technology capabilities being incorporated by its users (Carter & Grover, 2015) rather than the technology pointing to any form of social influence as is the case for You and Robert's argument (You & Robert Jr., 2018) and for anthropomorphism, both of which depend on the technology evoking social effects on the individual's identity based on social identity theory. Moreover, the key difference between You and Robert's argument and anthropomorphism lays in the source of the social influence. While You and Robert's view the technology as a reminder for individuals of a group membership similar to how a flag or uniform may remind a person of their membership in a larger group, the anthropomorphic view sees the technology as an agent capable of evoking those social effects that result in the formation of teams by itself.

This emergence of social effects from the technology itself can be observed in the literature where cases of team membership (i.e. homophily) effects are perceived despite the technology not being associated with any team the participant in the study may recognize (Vollmer, Read, Trippas, & Belpaeme, 2018) (Kory-Westlund, 2019). This is further exemplified when examining the nature of the experiments conducted so far. Multiple experiments demonstrated the capability of anthropomorphized technology to exert social influence over users. Vollmer and colleagues (Vollmer, Read, Trippas, & Belpaeme, 2018) showed how exposing a child to a group of robot, and asking them to answer a simple question while the robots answered erroneously (i.e. Ash paradigm) increased their tendency to conform to the answers of the robot. Xu and Lombard (Xu & Lombard, Persuasive computing: Feeling peer pressure from multiple computer agents, 2017) on the other hand demonstrated how sharing a color with computer agents led to group identification effects. While the work of You and Robert may appear to be similar, it is important to note that in their study participants had prior experience as a group and their interactions with the robot merely remind them of their group membership through material identity effects. This is not a possibility in neither Vollmer's nor Xu and Lombard's work, after all participants had no prior experience with the artificial agents or a group that could be reflected upon the robots the participant interacted with.

In this sense, the social pressures felt by participants in the anthropomorphism studies had to originate from somewhere other than a prior group affiliation of participants such as form the artificial agent itself. Moreover, studies on bonding and relationship building with artificial agents have strengthen this view by demonstrating that as a robot exhibits more behavior oriented to building relationships, participants emotional bonding with the agent increases as does their performance (Kory-Westlund, et al., 2017) (Kory-Westlund & Breazeal, 2019).

Proposition 8: Anthropomorphizing technology leads to the perception of social pressures emanating from the anthropomorphized technology.

Combining our arguments with the current literature suggest that technology can:

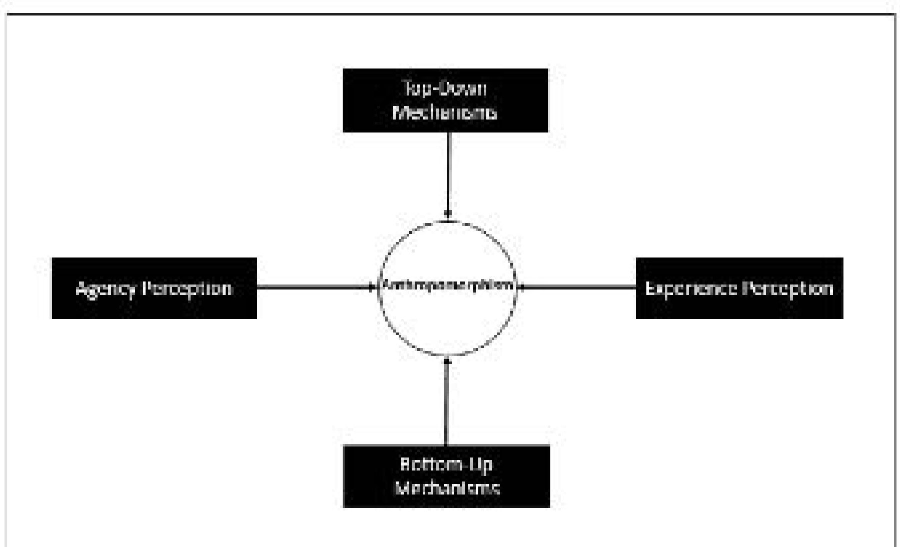
- Be viewed as a neutral object, in which case it influences interactions by either constraining or facilitating individuals' actions as the technology is used (Orlikowski, 1992).
- Be perceived as an extension of the self in which case individuals perceive the technology's capabilities as being their own changing their behavior (IT becomes incorporated into the self) (Carter & Grover, 2015).
- Be a projection of a social group the individual is affiliated to resulting in the groups social effects being exerted through the technology (IT becomes a projection of the teams' influence on the self) (You & Robert Jr., 2018).
- Be perceived as an independent agent in which case the technology exerts its own social influence (IT as an independent agent).

Nevertheless, the extant literature suggests that these social effects can vary significantly. Specifically, the effects observed appear to be closely dependent on the characteristics of the artificial agent indicative of its inner life in the form of a capacity to act and feel (Gray, Gray, & Wegner, 2007), and on the underlying mechanisms through which the agent was first anthropomorphized (Urquiza-Haas & Kotrschal, 2015). In the following section we will discuss these factors in more detail.

6.3.4 Guiding the Social Effects of Anthropomorphic Agents

Our analysis of the extant literature suggests that how we interact with an artificial agent is largely dependent on how we anthropomorphized it in the first place. Research in social neuroscience and social psychology indicates that how an agent is anthropomorphized largely depends on the combination of the factors related to attribution of mind, namely perceived capacity to act and perceived capacity to experience (Gray, Gray, & Wegner, 2007), as well as whether the anthropomorphization of the agent had a non-conscious origin or was the result of rational consideration (Urquiza-Haas & Kotrschal, 2015). These considerations lead us to propose a four factors model of anthropomorphism that guides how it will affect the users' future interactions with the technology.

Figure 17 Factors affecting the way individuals interact with an anthropomorphized agent.



6.3.5 Mind Attribution & Anthropomorphism: Relational and Behavioral AI

The first consideration that guides how we interact with artificial agents is how we attribute a mind to it. The stream of research of Gray and Wegner proposes that the attribution of mind to other beings goes along two dimensions: the entity's apparent agency and its apparent capacity to feel or experience (Gray, Gray, & Wegner, 2007). The stream of research of Gray and Wegner has shown that humans rely on these dimensions to evaluate other agents attributing them with different characteristics and leading significant changes in how they are evaluated in terms of perceived responsibility based on how capable of either experience or agency they perceive the entity to be (Gray & Wegner, 2009).

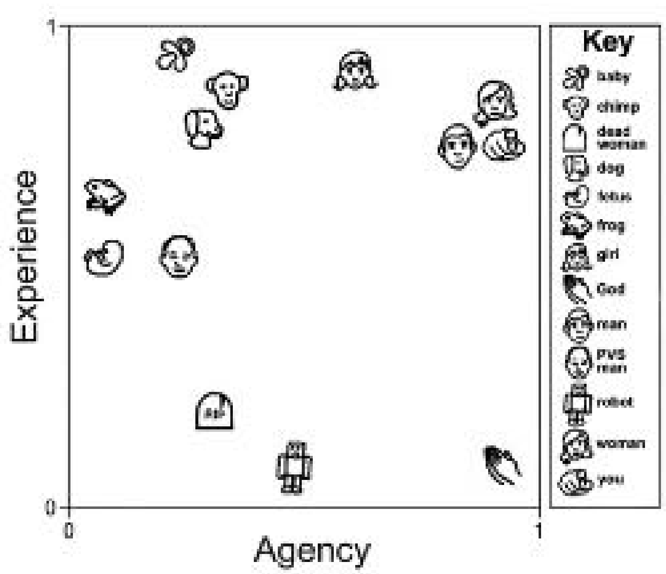
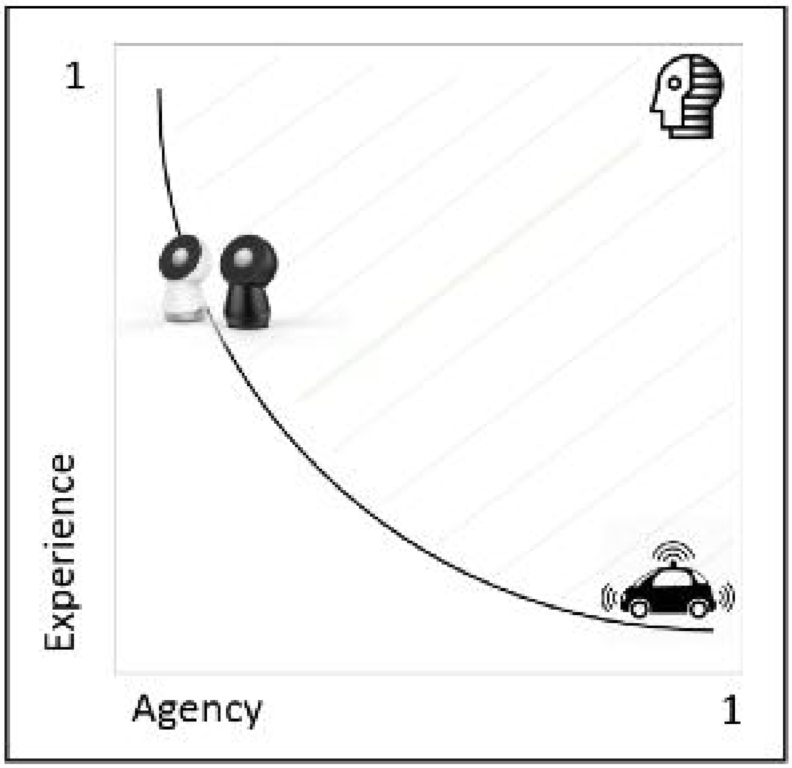


Figure 18 The perceived agency and experience attributed to different types of agents in Gray, Gray, and Wegner's (2007).

Within the realm of information technology, a similar pattern has been described with the stream of research of Kory-Westlund and Cynthia Breazeal (Kory-Westlund, et al., 2017), as well as the work of Levillain and Zibetti (Levillain & Zibetti, 2017) providing insights into how changes in the level of apparent experience and agency respectively, affect how users interact with artificial agents.

Figure 19 A two-factor model of artificial agent's mind attribution based on Gray, Gray, and Wegner's (2007) work.



An autonomous robot representing a highly agentic technology, a Jibo robot represents a highly experiential technology, and an hypothethical Strong AI represents the intersection of a highly agentic and experiential technology equivalent to a human being.

6.3.5.1 Perceiving Mental Agency: Behavioral Objects

In their research, Levillain and Zibetti (Levillain & Zibetti, 2017) introduced the notion of behavioral objects, objects whose behavior became expressive on its own right without being influenced by exogenous factors such as the object's appearance. Levillain and Zibetti identified three elements typically relied on to distinguish between a simple movement, and an apparent behavior regardless of intentionality or agency. These include:

- The existence of a transformation (i.e. a change of state) resulting from the behavior that leads to a change in the world (Levillain & Zibetti, 2017, p. 10).

- The behavior of an entity is associated with a functional organization that hold together to form an entity which is associated with the behavior (Levillain & Zibetti, 2017, p. 11).

- The behavior reflects a relationship between the entity and its environment with either spontaneous or externally-initiated activities causing them (Levillain & Zibetti, 2017, p. 11).

Combining these factors, Levillain and Zibetti argue behavioral objects appear to generate transformations themselves rather than because of external factors and whose transformation appear to have meaning within the context of the environment. As such, they defined behavioral objects as objects that appear to produce cues indicative of internal states and a disposition to interact with the environment (Levillain & Zibetti, 2017, p. 11).

Levillain and Zibetti proposed a framework explaining how and why the interpretation given to the behavior of these objects can lead to attributions of mental states as its perceived complexity increases. Specifically, they argued that:

- A behavioral object is likely to be perceived as animated if its behavior appears to be consistent and capable of spontaneous changes in direction or activation of motion. This is supported by studies discussed in section.
- It will be assessed as possessing agency if its behavior appears to react contingent to changes in the environment and capable of adjusting its trajectory to achieve or reach apparent functional goals.
- Finally, it will be perceived as possessing mental agency if is behavior reacts consistently to other agent's goals, including the display of apparent attempts to engage in an interaction with the other agents.

Levillain and Zibetti's argues that the apparent capacity to coordinate its behaviors with other entities at higher levels of complexity is viewed by individuals as a potential indicator of an ability to infer mental states in others, and while the individual may know that the object doesn't possess such inner life, the effects can be strong enough to endure (Levillain & Zibetti, 2017, p. 15). The extant literature seems to support this view with other studies showing how simple movement can be interpreted as being animated or human-like (Chaminade, Hodgins, & Kawato, 2007), contingent behavior being associated with increases in agency perception (von der Pütten, Krämera, Gratch, & Kang, 2010, p. 1643) (Kang & Watt, 2013), and behavior that that's into consideration other agents being associated with cognitive state attributions (Wang, Lignos, Vatsal, & Scassellati, 2006) (Schroeder & Epley, 2016) (Xu, 2018) as discussed under the artificial agents' behavior sections 4.4.8 and 4.4.9.

These increases have been associated with consequences that make it important to consider. While initially the research of Gray and Wegner (Gray & Wegner, 2009) (Gray, Young, & Waytz, 2012) pointed towards changes in the perceived responsibility of an agent for the outcomes of its behaviors as its apparent agency increased, the extant literature on anthropomorphism also points towards significant effects when using highly agentic technologies to carry out tasks (Obhi & Hall, 2011). Specifically, the literature suggests that when individuals perform joint-tasks with highly agentic technology, a sense of joint-agency (i.e. shared-agency) develops where regardless of the actual role in producing a result, an individual consciously registers agency for the outcome of an activity despite non-consciously indicating a different level of agency (Obhi & Hall, Sense of agency and intentional binding in joint action, 2011).

Pacherie describes this phenomenon as a perceived boundary loss where self-awareness blurs and an increase in the sense we-ness or joint agency develops (Pacherie, 2012). Contrary to the self-extension reported by Carter and Grover (Carter & Grover, 2015), these joint-agency effects appear to be dependent on perceiving the technology as a collaborator with its own intention, and the joint task as a responsibility of both the individual and the technology (McEneaney, 2013, p. 803) (Limerick, Coyle, & Moore, 2014, p. 7) as discussed in section 4.2.2 on "Changing Self-Evaluations & the Sense of Self".

6.3.5.2 Perceiving Experience: Relational AI

On the other side of the model, multiple studies have shown how increasing the apparent capacity to feel of an entity can lead to the development of relationships with it allowing individuals to perceive the emotions of the entity (Lee, Baek, & Ju, 2018) (Böffel & Müsseler, 2018), feel it in themselves (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009) (Lehmann & Broz, 2018), and even feel motivated to assist (Larsen, Lee, & Ganea, 2018) (Darling, Nandy, & Breazeal, 2015). The stream of research of Kory-Westlund and her advisor Cynthia Breazeal represent one of the most comprehensive views of this topic.

In her research, Kory-Westlund became interested in how social robots could be used to help children's learning, and hypothesized that the children's in-class engagement and learning can be significantly enhanced through the use of relational AI by building long-term interactions. Relational AI was defined as those autonomous technologies that aim to build and maintain socio-emotional relationships with users over the long term through the use of a human-centered, collaborative and reciprocal focus (Kory-Westlund, 2019, pp. 58-59).

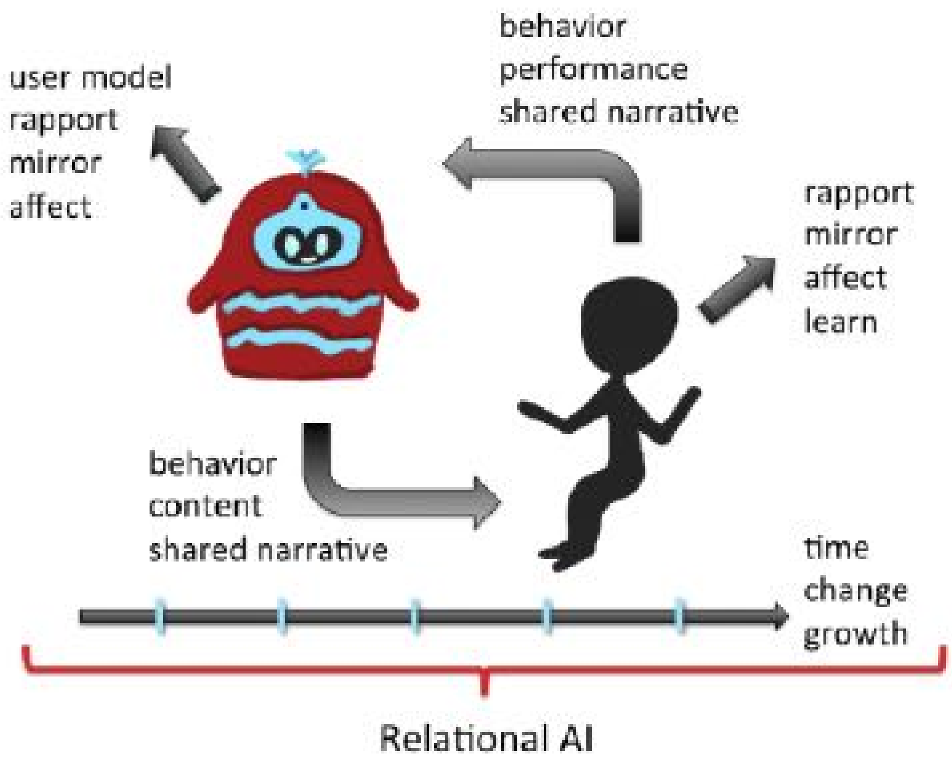


Figure 20 Kory-Westlund's diagram on the components of Relational AI as presented in her dissertation work (Kory-Westlund, 2019).

Kory-Westlund defined six characteristics of Relational AI which she used as a basis to promote relationships between children and social robots (Kory-Westlund, 2019, p. 60):

- The AI needed to be capable of handling **repeated encounters** with the user and as well as capable of acknowledging **shared experiences** between the user and the AI.

- The AI must also be capable of **changing over time** because of the interaction with the user and this change must be exhibited in a way that users will perceive as meaningful and contingent.

- It must model human relationships by being **responsive to the users' behavior**. The author argues this is key to form rapport and showcase entrainment (i.e. mirroring behavior) and social reciprocity.

- The AI must also **respond to the emotional states** of the user and act in a friend-like manner to promote attachment and build friendship, empathy, and affection.

- Finally, the AI must be **capable of reciprocity** exhibiting information disclosures, offering help, converse, and performed joint activities with the user.

What Kory-Westlund's conceptualization of Relational AI provides to the discussion on anthropomorphism is a series of guidelines as to how the technology can be developed to express higher levels of experience. The effects and importance of this is further shown in her research stream. Her work shows important considerations of the implications of relational behavior, engagement, and rapport building as tools to cultivate a relationship that was then shown to lead to significant improvements in engagement and performance (Kory-Westlund, et al., 2017) (Kory-Westlund & Breazeal, Exploring the Effects of a Social Robot's Speech Entrainment and Backstory on Young Children's Emotion, Rapport, Relationship, and Learning, 2019) (Kory-Westlund, Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots, 2019). These effects appear to form the basis through which the social effects of anthropomorphic technologies, such as social pressures and conformity effects, emerge as the increasing bonding and empathy towards the artificial agent leads users to engage in prosocial behavior with it (Kwak, Kim, Kim, Shin, & Cho, 2013) (Darling, Nandy, & Breazeal, 2015).

Based on these views, while the effects of increase agency lead users to attribute higher responsibility to the artificial agent and also enable them to share their own perceived agency with it, the effects of increasing the perceived experience of the artificial agent enables the formation of relationships and empathy towards the entity as well as the emergence of social effects from it. The final consideration as to how individual will interact with an artificial agent seems to surround the way they initially anthropomorphized it.

6.3.5.3 Conscious and non-Conscious Sources of Anthropomorphism

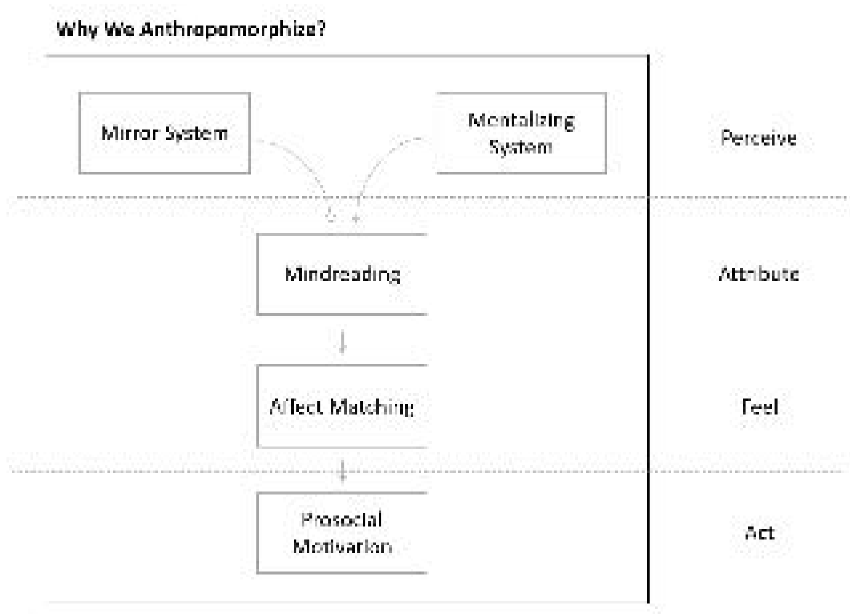
As described by Urquiza-Haas and Kotrschal (Urquiza-Haas & Kotrschal, 2015), the process of anthropomorphizing an artificial agent seems to rely on the same neurological and cognitive mechanisms associated with the recognition of mind in other humans including processes of agency detection, mind attribution and empathy development, as well as conscious processes of causal and inductive reasoning.

Lieberman and Spunt have conducted a series of studies exploring how these non-conscious processes take place and argued that multiple mental processes work in conjunction to explain different aspects of the question. In this stream of research, the mirror neuron system of the brain works in together with the mentalizing system to identify how and why other individuals' actions are taking place respectively, and together they mark the first step in the process of developing feelings towards other agents starting the process towards achieving an empathic state (Lieberman M. , 2007) (Spunt, Falk, & Lieberman, 2010).

According to Spunt and Lieberman, the mirror system of the brain (see section 2.3.2 for a review of the literature of this topic) (Gallese & Goldman, 1998) (Gazzola, Rizzolatti, Wicker, & Keysers, 2007) is activated almost instantly at the beginning of an interaction and functions to provide humans with a basic understanding of ***how*** an action took place, while the mentalizing systems becomes highly active once an individual attempts to answer the question of ***why*** the entity acted the way it did (Spunt, Falk, & Lieberman, 2010)

(Geiger, et al., 2019). These two systems are described as forming the basis to how humans perceive agents, and can either act separately or in conjunction to encourage the activation of mindreading processes where the entity is attributed with cognitive and affective states (Lieberman M. , 2007) which are equivalent to the process of anthropomorphization though within the realm of human to human interaction. This process of mindreading forms the initial step necessary in the formation of empathy towards other agents as it allow us to understand what others are feelings, but it still must be expanded by processes of affect matching and prosocial motivation, corresponding to feeling what the others are feeling and desiring to act accordingly, to reach a full empathic state (Wicker, et al., 2003) (Spunt & Lieberman, 2012).

Figure 21 Model describing the mechanisms guiding why we Anthropomorphize.



Relationships between different neural systems supporting the attribution of cognitive and affective states to others as well as the development of an empathic state.

This work within the field of social neuroscience supports the argument by Urquiza-Haas and Kotrschal (Urquiza-Haas & Kotrschal, 2015) that automatic neural processes enable individuals to perceive an artificial agent as humanlike, attribute them with cognitive and affective states, relate and feel to these affective states, and finally react with a desire to help, or avoid these agents (Morelli, Rameson, & Lieberman, 2014) (Batson, 2014). Urquiza-Haas and Kotrschal argue these processes are further expanded by conscious and reflective processes of inductive reasoning where an individual transfers prior knowledge about a subject or object on to a new one (Heit E. , 2000) and causal reasoning where the individual uses acquired knowledge about the world to explain behavior when dealing with nonhumans (Horowitz & Bekoff, 2007).

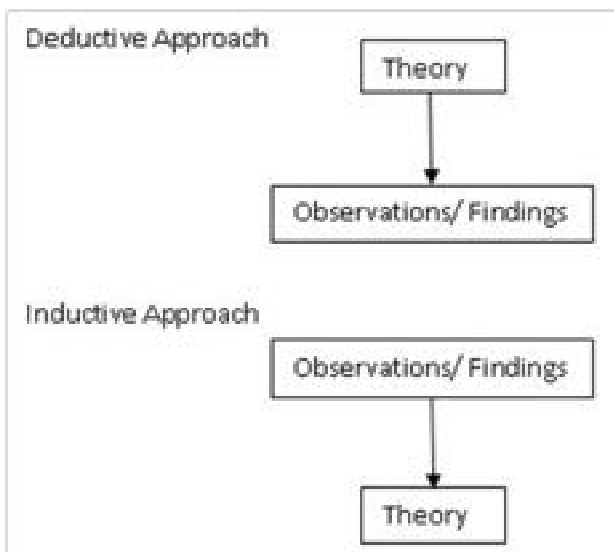


Figure 22 Illustration of Deductive/causal reasoning and Inductive reasoning by Bryman *(Bryman, 2012)*.

An agent can be anthropomorphized through either approach which can result in both variations in the effects over the individual interacting with the agent and with contradictions between the conscious and non-conscious evaluations that need to be resolved (Vollmer, Read, Trippas, & Belpaeme, 2018).

The implicit bottom-up processes bring about an initial evaluation of the agent guided by an individual's mental representations and biases about the agent, which encourage its continued evaluation as a social being and potential development of empathy and bonding with the agent through the attribution of affective states to it (Riek L. D., Rabinowitch, Chakrabarti, & Robinson, 2009). On the other hand, the reflective processes involve a more conscious evaluation of the agent which may results in the attribution of simple cognitive and affective states to the agent that further affect the on-going interaction (Urquiza-Haas & Kotrschal, 2015, pp. 170-171).

Important difference between these processes becomes evident when we consider the match or mismatch between these evaluations. Whereas human to human interaction will typically result in a perceptual match between conscious and non-conscious evaluations of the other individuals with the possible exception of the objectification and dehumanization of others (Haslam, 2006) (Zlotwski, Sumioka, Bartneck, Nishio, & Ishiguro, 2017), the social perception of artificial agents is likely to result in discrepancies in how individuals perceive it (de Borst & de Gelder, 2015). These discrepancies in the social perception of the agent can result in cognitive dissonance effects that an individual must them solve, potentially explaining conflicting results found on the extant literature as discussed in section 5.1.1 on Attitudes Toward Artificial Agents.

If no contradiction exist between the conscious and non-conscious perception of an agent, it seem reasonable to consider the agent will be treated in a similar way as a human treats another human, at least in terms of the agent being perceived as a social being.

Proposition 9: If the conscious and non-conscious perception of the entity match, the entity should be treated as a) an object, or b) a full subject depending on the nature of the perception.

However, differences between conscious and non-conscious evaluations are likely to result in significant differences in how individuals perceive the artificial agent depending on their cognitive load (Urquiza-Haas & Kotrschal, 2015, p. 172) and whether they are explicitly asked to evaluate the agent as an anthropomorphic entity as discussed in section 4.2.3 on Beliefs and Mental Models about technology. Urquiza-Haas and Kotrschal (Urquiza-Haas & Kotrschal, 2015) posit that if there is a high cognitive load such as the individual being involved in an intensive task, the conscious evaluations would be suppressed, and the non-conscious perception would flourish.

Proposition 9c: If experiencing a high cognitive load, an individual's conscious evaluations would be suppressed, and the non-conscious evaluation would be exhibited.

On the other hand, if the individual is tasked to explicitly evaluate an artificial agent while the cognitive dissonance remains unsolved, the non-conscious processes would have little influence over the evaluation, and the conscious understanding of the agent would be exposed.

Proposition 9d: If an individual experiencing cognitive dissonance is asked to evaluate an anthropomorphic entity, the individual would excessively rely on the conscious perception of the agent to describe it.

6.3.6 Putting It All Together

Despite the vast number of variables influencing the anthropomorphic attributions, the way individuals interact with an artificial agent appears to be highly dependent on how it was first anthropomorphized. The model above suggest that four categories play a significant role in this perception but it remains important to recognize that they represent ranges rather than discrete categories and as such most anthropomorphic attributions will likely fit somewhere within that range. Moreover, as individuals' interactions with the anthropomorphic agent continue, their perception of the agent is likely to continue to evolve making it difficult to predict exactly how they will engage. Nevertheless, the framework presented above can inform our understanding of how cognitive load and awareness of the nature of a technology can affect the interaction, and, more importantly, how teams of users and artificial agents can develop a relationship among them, and change their behavior when engaging in joint tasks.

Abubshait, A., & Wiese, E. (2017). You look human, but act like a machine: agent appearance and behavior modulate different aspects of human-robot interaction. *Frontiers in Psychology, 8,* 1393.

Admoni, H., & Scassellati, B. (2012). A Multi-Category Theory of Intention. *In Proceedings of the Annual Meeting of the Cognitive Science Society, 34*(34).

Adolphs, R. (2009). The Social Brain: Neural Basis of Social Knowledge. *Annual Review of Psychology, 60*, 693-716.

Aggarwal, P., & McGill, A. L. (2012). When brands seem human, do humans act like brands? Automatic behavioral priming effects of brand anthropomorphism. *Journal of Consumer Research, 39*(2), 307-323.

Airenti, G. (2015). The Cognitive Bases of Anthropomorphism: From Relatedness to Empathy. *International Journal of Social Robotics, 7*(1), 117-127.

Airenti, G. (2018). *The Development of Anthropomorphism in Interaction: Intersubjectivity, Imagination, and Theory of Mind* (Vol. 9). Frontiers in Psychology.

Ajzen, I. (1985). *From Intentions to Actions: A Theory of Planned Behavior.* Berling, Heidelberg: Springer.

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Allport, G. (1968). The Historical Background of Social Psychology. In G. E. Lindzey, & E. E. Aronson, *The Handbook of Social Psychology* (p. 5). New York: McGraw Hill.

Ambroise, L., & Valette-Florence, P. (2010). The brand personality metaphor and inter-product stability of a specific barometer. *Recherche et Applications en Marketing, 25*(2), 3-28.

Ansuini, C., Cavallo, A., Bertone, C., & Becchio, C. (2015). Intentions in the brain: the unveiling of Mister Hyde. *The Neuroscientist, 21*(2), 126-135.

Antonietti, A. (2011). Introspecting a conscious decision or the consciousness of a decision? *Consciousness and Cognition, 20*(4), 1916-1917.

Araujo, T. (2018). Living up to the chatbot hype: The influence of anthropomorphic cues and communicative agency framing on conversational agent and company perceptions. *Computers in Human Behavior*, 183-189.

Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological monographs: General and Applied*, 1.

Austernmann, A., Yamada, S., Funakoshi, K., & Nakano, M. (2010). How do Users Interact wiht a Pet-Robot and a Humanoid. *Conference on human factors in computing systems*, (pp. 3727-3732). Atlanta.

Bachman, R., & Schutt, R. K. (2013). *The practice of research in criminology and criminal justice.* Sage.

Bae, J., & Kim, M. (2011). Selective visual attention occurred in change detection derived by animacy of robot's apperance. *Proceedings of the 2011 international conference on collaboration technologies and systems,* (pp. 190-193).

Bagozzi, R. P., Lee, K.-H., & Van Loo, M. F. (2001). Decisions to donate bone marrow: The role of attitudes and subjective norms across cultures. *Psychology and Health, 16*(1), 29-56.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control.* New York: W.H. Freeman.

Bandura, A. (1999). Social Cognitive Theory: An Agentic Perspective. *Asian Journal of Social Psychology, 2*(1), 21-41.

Bandura, A. (2017). *Agency*. Retrieved from professoralbertbandura.com: http://professoralbertbandura.com/albert-bandura-agency.html

Bandura, A. (2018). Toward a Psychology of Human Agency: Pathways and Reflections. *Perspectives on Psychological Science, 13*(2), 130-136.

Banks, J. (2019). A Perceived Moral Agency Scale: Development and Validation of a Metric for Humans and Social Machines. *Computers in Human Behavior, 90*, 363-371.

Banks, J., & Bowman, N. D. (2016). Avatars are (sometimes) people too: Linguistic Indicators of Parasocial and Social Ties in Player-Avatar Relationships. *New Media & Society, 18*(7), 1257-1276.

Banks, J., Westerman, D. K., & Sharabi, L. L. (2017). A mere holding effect: Haptic influences on impression formation. *Computers in Human Behavior, 76,* 303-311.

Barlas, Z. (2019). When robots tell you what to do: Sense of Agency in Human- and robot-guided actions. *Consciousness and Cognition*.

Barley, S. (1988). The Social Construction of a Machine: Ritual, Superstition, Magical Thinking and other Pragmatic Responses to Running a CT Scanner. In M. Lock, &

D. Gordon, *Knowledge and Practice in Medicine: Social, Cultural, and Historical Approaches* (pp. 497-539). Hingham, MA: Reidel.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind.* MIT press/Bradford Books.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "Theory of Mind"? *Cognition*, 37-46.

Bartneck, C. (2008). Who like androids more: Japanese or US Americans. *RO-MAN 2008- The 17th IEEE International Symposium on Robot and Human Interactive Communication*, 553-557.

Bartneck, C., Bleeker, T., Bun, J., Fens, P., & Riet, L. (2010). The influence of robot anthropomorphism on the feelings of embarrassment when interacting with robots. *PALADYN Journal of Behavioral Robotics, 1*(2), 109-115. doi:10.2478/s13230-010-0011-3

Bartneck, C., Kanda, T., Mubin, O., & Mahmud, A. A. (2009). Does the design of a robot influence its animacy and perceived intelligence? *International Journal of Social Robotics, 1*(2), 195-204.

Bartneck, C., Kulic, D., & Croft, E. (2009). Measurement instrument for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots. *International Journal of Social Robotics, 1*(1), 71-81.

Bartneck, C., Reichenbach, J., & Breemen, A. V. (2004). In Your Face, Robot! The Influence of a Character's Embodiment on How Users Perceive Its Emotional Expressions.

Bartneck, C., Verbunt, M., Mubin, O., & Al Mahmud, A. (2007). To kill a mockingbird robot. *Proceedings of the 2nd ACM/IEEE International Conference on Human-Robot Interaction* (pp. 81-87). Washington, DC: IEEE.

Bartz, J. A., Tchalova, K., & Fenerci, C. (2008). Reminders of Social Connection Can Attenuate Anthropomorphism: A Replication and Extension of Epley, Akalis, Waytz, and Cacioppo (2008). *Psychological Science, 27*(12), 1644-1650.

Batson, C. D. (2014). *The altruism question: Toward a social-psychological answer.* Psychology Press.

Bayne, T., & Pacherie, E. (2007). Narrators and comparators: the architecture of agentive self-awareness. *Synthese*, 475-491.

Benfield, J. A., Szlemko, W. J., & Bell, P. A. (2007). Driver Personality Relate to Reported Aggresive Driving Tendencies. *Personality and Individual Differences, 42*(2), 247-258.

Berberian, B., Sarrazin, J.-C., Blaye, P. L., & Haggard, P. (2012). Automation Technology and Sense of Control: A Window on Human Agency. *PLoS One, 7*(3).

Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators & virtual environments*, *12*(5), 456-480.

Blakemore, S.-J., Wolpert, D. M., & Frith, C. D. (1998). Central cancellation of self-produced tickle sensation. *Nature Neuroscience*, 635-640.

Bodford, J. E., Kwan, V. S., & Sobota, D. S. (2017). Fatal Attractions: Attachment to Smartphones Predicts Anthropomorphic Beliefs and Dangerous Behaviors. *Cyberpsychology, Behavior, and Social Networking, 20*(5), 320-326.

Böffel, C., & Müsseler, J. (2018). Perceived ownership of avatars influences visual perspective taking. *Frontiers in Psychology, 9*, 743.

Bolt, N. K., Poncelet, E. M., Schultz, B. G., & Loehr, J. D. (2016). Mutual Coordination Strengthens the Sense of Joint Agency in Cooperative Joint Action. *Consciousness and Cognition, 46*, 173-187.

Bracken, C. C., Jeffres, L. W., & Neuendorf, K. A. (2004). Criticism or praise? The impact of verbal versus text-only computer feedback on social presence, intrinsic motivation, and recall. *Cyberpsychology & Behavior*, *7*(3), 349-357.

Brass, M., Schmitt, R. M., Spengler, S., & Gergely, G. (2007). Investigating Action Understanding: Inferential Processes versus Action Simulation. *Current Biology, 17*(24), 2117-2121. doi:https://doi.org/10.1016/j.cub.2007.11.057

Breazeal, C. (1998). Early Experiments using Motivations to Regulate Human-Robot Interaction. *AAAI Fall Symposium on Emotional and Intelligent: The tangled knot of cognition, Technical Report FS-98-03*, 31-36.

Breed, M. D., & Moore, J. (2012). Chapter 6 - Cognition. In M. D. Breed, & J. Moore, *Animal Behavior* (pp. 151-182). Elsevier.

Broadbent, E. (2017). Interactions With Robots: The Truths We Reveal About Ourselves. *Annual Review of Psychology, 68*, 627-652.

Broadbent, E., Kumar, V., Li, X., 3rd, J. S., Stafford, R. Q., MacDonald, B. A., & Wegner, D. M. (2013). Robots with Display Screens: A Robot with a More Humanlike Face Display Is Perceived To Have More Mind and a Better Personality. *PloS one, 8*(8).

Bryman, A. (2012). *Social Research Methods, 4th Edition.* Oxford University Press.

Buehner, M. J. (2012). Understanding the Past, Predicting the Future: Causation, Not Intentional Action, Is the Root of Temporal Binding. *Psychological Science, 23*(12), 1490-1497.

Buehner, M. J. (2012). Understanding the Past, Predicting the Future: Causation, Not Intentional Action, Is the Root of Temporal Binding. *Psychological Science, 23*(12), 1490-1497.

Bulhak, A. C. (1996). *On the Simluation of Postmodernism and Mental Debility using Recursive Transition Networks.* Monash University Department of Computer Science.

Burgoon, J. K., Bonito, J. A., Bengtsson, B., Cederberg, C., Lundeberg, M., & Allspach, L. (2000). Interactivity in Human-Computer Interaction: A study of credibility, understanding, and influence. *Computers in Human Behavior, 16*(6), 553-574.

Burin, D., Battaglini, A., Pia, L., Falvo, G., Palombella, M., & Salatino, A. (2017, November). Comparing intensities and modalities within the sensor attenuation paradigm: Preliminary evidence. *Journal of Advance Research, 8*(6), 649-653.

Burke, P. J., & Reitzes, D. C. (1991). An Identity Theory Approach to Commitment. *Social Psychology Quarterly, 54*(3), 239-251.

Byron, R., & Nass, C. (1996). *The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places.* New York: Cambridge University Press.

Caprara, G. V., Steca, P., Zelli, A., & Capanna, C. (2005). A new scale for measuring adults' prosocialness. *European Journal of Psychological Assessment, 21*(2), 77-89.

Caramazza, A., & Mahon, B. Z. (2003). The Organization of Conceptual Knowledge: the Evidence from Category-Specific Semantic Deficits. *Trends in Cognitive Sciences*, 354-361.

Caramazza, A., & Shelton, J. R. (1998). Domain-Specific Knowledge in the Brain: The Animate-Inanimate Distinction. *Journal of Cognitive Neuroscience*, 1-34.

Carlin, J., Calder, A. J., Kriegeskorte, N., Nili, H., & Rowe, J. B. (2011). A head view-invariant representation of gaze direction in anterior superior temporal sulcus. *Current Biology, 21*(21), 1817-1821.

Carruthers, P., & Smith, P. K. (1996). *Theories of theories of mind.* Cambridge; New York: Cambridge University Press.

Carter, M., & Grover, V. (2015). Me, my self, and I(T): Conceptualizing information technology identity and its implications. *MIS Quarterly, 39*(4), 931-958.

Castelli, F., Happe, F., Frith, U., & Frith, C. (2000). Movement and mind: A functional imaging study of perception and interpretation of complex intentional movement patterns. *NeuroImage, 12*(3), 314-325.

Cha, Y.-J., Baek, S., Lee, H., Lee, B., Shin, J.-e., & Jang, D. (2020). Compensating for the loss of human distinctiveness: The use of social creativity under Human-Machine comparisons. *Computers in Human Behavior, 103*, 80-90.

Chambon, V., & Haggard, P. (2012). Sense of control depends on fluency of action selection, not motor performance. *Cognition, 125*, 441-451.

Chaminade, T., Hodgins, J., & Kawato, M. (2007). Anthropomorphism influences perception of computer-animated characters' actions. *Social Cognitive and Affective Neuroscience, 2*(3), 206-216.

Chaminade, T., Zecca, M., Blakemore, S.-J., Takanishi, A., Frith, C. D., Micera, S., . . . Lauwereyns, J. (2010). Brain Response to a Humanoid Robot in Areas Implicated in the Perception sof Human Emotional Gestures. *PloS One, 5*(7).

Chandler, J., & Schwarz, N. (2010). Use does not wear ragged the fabric of friendship: Thinking of objects as alive makes people less willing to replace them. *Journal of Consumer Psychology, 20*(2), 138-145.

Chao, L. L., Haxby, J. V., & Martin, A. (1999). Attribute-based Neural Substrates in Temporal Cortex for Perceiving and Knowing about Objects. *Nature Neuroscience*, 913-919.

Charmaz, K. (2014). *Constructing Grounded Theory.* Sage.

Chattaraman, V., Kwon, W.-S., Gilbert, J. E., & Ross, K. (2019). Should AI-based, conversational digital assistants employ social- or task-oriented interaction style? A task-competency and reciprocity perspective for older adults. *Computers in Human Behavior, 90*, 315-330. Retrieved from https://doi.org/10.1016/j.chb.2018.08.048

Chin, M. G., Sims, V. K., Clark, B., & Lopez, G. R. (2004, September). Measuring Individual Differences in Anthropomorphism Toward Machines and Animals. *Proceedings of the Human Factors and Ergonomics Society, 48*(11), 1252-1255.

Cho, E., Molina, M. D., & Wang, J. (2019). The Effects of Modality, Device, and Task Differences on Perceived Human Likeness of Voice-Activated Virtual Assistants. *Cyberpsychology, Behavior, and Social Networking, 22*(8), 515-520.

Choi, J., & Kim, M. (2009). The usage and evaluation of anthropomorphic form in robot design. *Undisciplined! Design research society conference 2008* (pp. 16-19). Sheffield: Sheffield Hallam University.

Ciardo, F., Tommaso, D. D., Beyer, F., & Wykowska, A. (2018). Reduced Sense of Agency in Human-Robot Interaction. *International Conference on Social Robotics* (pp. 441-450). Cham: Springer.

Clark, M. S., Boothby, E., Clark-Polner, E., & Reis, H. (2015). Understanding Prosocial Behavior Requires Understanding Relational Context. *Oxford Handbook of Prosocial Behavior*, 329.

Clodic, A., Alami, R., & Chatila, R. (2014, August). Key Elements for Joint Human-Robot Action. *RoboPhilosophy*, 23-33.

Costa, P. T., & McCrae, R. R. (1988). Personality in Adulthood: a six-year longitudinal study of self-reports and spouse ratings on the NEO Personality Inventory. *Journal of Personality and Social Psychology, 54*(3), 853.

Cremin, T., Flewitt, R., Mardell, B., & Swann, J. (2016). *Storytelling in Early Childhood: Enriching language, literacy and classroom culture.* Taylor & Francis.

Creswell, J. W., & Brown, M. L. (1992). How chairpersons enhance faculty research: A grounded theory study. *The Review of Higher Education*, *16*(1), 41-62.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches.* Thousand Oaks, CA: SAGE Publications, Inc.

Cullen, H., Kanai, R., Bahrami, B., & Rees, G. (2014). Individual differences in anthropomorphic attributions and human brain structure. *Social Cognitive and Affective Neuroscience*, 1276-1280.

Culley, K. E., & Madhavan, P. (2013). A note of caution regarding anthropomorphism in HCI agents. *Computers in Human Behavior, 29*(3), 577/579.

Cunningham, W. A., & Zelazo, P. D. (2007). Attitudes and evaluations: A social cognitive neuroscience perspective. *Trends in Cognitive Sciences, 11*(3), 97-104.

Darling, K., Nandy, P., & Breazeal, C. (2015). Empathic concern and the effect of stories in human-robot interaction. *Proceedings of teh 24th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN).* Kobe, Japan: IEEE.

Davies, M., & Stone, T. (1995). *Folk Psychology: The theory of mind debate.* Wiley-Blackwell.

Davies, M., & Stone, T. (1998). Folk Psychology & Mental Simulation. *Royal Institute of Philosophy Supplements*, 53-82.

de Borst, A. W., & de Gelder, B. (2015). Is it the real deal? Perception of Virtual Characters versus Humans: an Affective Cognitive Neuroscience Perspective. *Frontiers in Psychology, 6,* 576.

de Graaf, M. M., Allouch, S. B., & Dijk, J. A. (2019). Why would I use this in my home? A model of domestic social robot acceptance. *Human-Computer Interaction, 34*(2), 115-173.

de Visser, E. J., Monfort, S. S., Goodyear, K., Lu, L., O'Hara, M., Lee, M. R., . . . Krueger, F. (2017). A Little Anthropomorphism Goes a Long Way: Effects of Oxytocin on Trust, Compliance, and Team Performance With Automated Agents. *Human Factors, 59*(1), 116-133.

Deng, E., Mutlu, B., & Matarić, M. J. (2019). Embodiment in Socially Interactive Robots. *arXiv preprint*. doi:arXiv:1912.00312

Diehl, J., Schmitt, L., Villano, M., & Crowel, C. (2012). The clinical use of robots for individuals with Autism Spectrum Disorders: a critical review. *Research in Autism Spectrum Disorders, 6*(1), 249-262.

Dittmar, H. (2011). Material and consumer identities. In S. J. Schwartz, K. Luyckx, & V. L. Vignoles, *Handbook of identity theory and research* (pp. 745-769). New York, NY: Springer.

Dow, J. M. (2018). On the Awareness of Joint Agency: A Pessimistic Account of the Feelings of Acting Together. *Journal of Social Philosophy*, *49*(1), 161-182.

Duffy, B. R. (2003). Anthropomorphism and the Social Robot. *Robotics and Autonomous Systems*, 177-190.

Durayappah-Harrison, A. (2011, August 22). *The Spoiler Paradox*. Retrieved from Psychology Today: https://www.psychologytoday.com/us/blog/thriving101/201108/the-spoiler-paradox

Duval, S., & Wicklund, R. A. (1972). *A theory of objective self awareness.* Oxford, England: Academic Press.

Eagly, A. H., & Chaiken, S. (1993). *The Psychology of Attitudes.* Harcourt Brace Jovanovich College Publishers.

Eisenberger, N. (2012). The neural bases of social pain: Evidence for shared representations with physical pain. *Psychosomatic medicine, 74*(2), 126.

Elo, S., & Kyngas, H. (2008). The Qualitative Content Analysis Process. *Journal of Advance Nursing, 62*(1), 107-115.

Epley, N., Akalis, S., Waytz, A., & Cacioppo, J. T. (2008). Creating Social Connection Through Inferential Reproduction: Loneliness and Perceived Agency in Gadgets, Gods, and Greyhounds. *Psychological Science, 19*(2), 114-120.

Epley, N., Waytz, A., & Cacioppo, J. T. (2007). On Seeing Human: A Three-Factor Theory of Anthropomorphism. *Psychological Review, 114*(4), 864-886.

Epley, N., Waytz, A., Akalis, S., & Cacioppo, J. T. (2008). When we need a human: Motivational determinants of anthropomorphism. *Social Cognition, 26*(2), 143-155.

Epstein, S. (1994). An integration of the cognitive and the psychodynamic unconscious. *American Psychologist*, *49*, 709-724.

Epstein, S., & Pacini, R. (1999). Some basic issues regarding dual-process theories from the perspective of cognitive-experiential self-theory. *Dual-process theories in social psychology*, 462-482.

Evans-Thirlwell, E. (2016, July 13). *From All Ghillied Up to No Russian, the making of Call of Duty's most famous levels*. Retrieved from pcgamer: https://www.pcgamer.com/from-all-ghillied-up-to-no-russian-the-making-of-call-of-dutys-most-famous-levels/2/

Eyssel, F., & Kuchenbrandt, D. (2012). Social Categorization of Social Robots: Anthropomoprhism as a Function of Robot Group Membership. *British Journal of Social Psychology, 51*(4), 724-731.

Eyssel, F., Hegel, F., Horstmann, G., & Wagner, C. (2010). Anthropomorphic inferences from emotional nonverbal cues: A case study. *Proceedings - IEEE International Workshop on Robot and Human Interactive Communication*, 646-651.

Eyssel, F., Kuchenbrandt, D., & Bobinger, S. (2011, March). Effects of anticipated human-robot interaction and predictability of robot behavior on perceptions of anthropomorphism. *Proceedings of the 6th international conference on Human-Robot Interaction*, 61-68.

Eyssel, F., Kuchenbrandt, D., Bobinger, S., De Ruiter, L., & Hegel, F. (2012). "If you sound like me, you must be more human": on the interplay of robot and user features on human-robot acceptance and anthropomorphism. *HRI '12: Proceedings of the 7th annual ACM/IEEE international conference on human-robot interaction*, (pp. 125-126).

Eyssel, F., Kuchenbrandt, D., Hegel, F., & de Ruiter, L. (2012). Activating elicite agent knowledge: How robot and user features shape the perception of social robots. *IEEE RO-MAN: The 21st IEEE International Symposium on Robot and Human Interactive Communication*, 851-857.

Eyssel, F., Schiffhauer, B., Dalla Libera, F., Yoshikawa, Y., Zlotowski, J., Wullenkord, R., & Ishiguro, H. (2016). Mind Attribution: From Simple Shapes to Social Agents. *25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN).* New York, USA: Columbia University.

Fasola, J., & Mataric, M. J. (2012). Using Socially Assistive Human-Robot Interaction to Motivate Physical Exercise for Older Adults. *Proceedings of the IEEE, 100*(8), 2512-2526.

Fink, J. (2012). Anthropomorphism and Human Likeness in the Design of Robots and Human-Robot Interaction. *International Conference on Socail Robotics*, 199-208.

Fisher, A. V., & Sloutsky, V. M. (2005). When Induction Meets Memory: Evidence for Gradual Transition from Similarity-based to Category-based Induction. *Child Development, 76*(3), 583-597.

Florian, E., Wollmer, M., Poitschke, T., Schuller, B., Blaschke, C., Farber, B., & Nguyen-Thien, N. (2010). Emotion on the Road -- Necesity, Acceptance, and Feasibility of Affective Computing in Car. *Advances in Human-Computer Interaction, 10*.

Fogg, B. J. (2002, December 2). Persuasive technology: using computers to change what we think and do. *Ubiquity*(5), pp. 89-120. doi:https://doi.org/10.1145/764008.763957

Fogg, B. J., & Nass, C. (1997). Silicon sycophants: the effects of computers that flatter. *International Journal of Human-Computer Studies, 46*, 551-561.

Fong, T., Nourbakhsh, I., & Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and autonomous systems, 42*, 143-166.

Frankish, K. (2009). Systems and levels: Dual-system theories and the personal-subpersonal distinction. In J. Evans, & K. Frankish, *In two minds: Dual Processes and Beyond* (pp. 89-107). Oxford: Oxford University Press.

Friedman, B., Kahn, P. H., & Hagman, J. (2003). Hardware companions? What online AIBO discussion forums reveal about the human-robotic relationship. *SIGCHI conference on Human factors in computing systems*, (pp. 273-280).

Frith, C. (2005, December). The self in action: Lessons from delusions of control. *Consciousness and Cognition, 14*(4), 752-770.

Frith, C. D. (2007). The social brain? *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 671-678.

Frith, C. D., & Frith, U. (1999). Interacting Minds - A Biological Basis. *Science*, 1692-1695.

Froming, W. J., Walker, G. R., & Lopyan, K. J. (1982). Public and private self-awareness: When personal attitudes conflict with societal expectations. *Journal of Experimental Social Psychology, 18*(5), 476-487.

Frost, R. O., & Hartl, T. L. (1996). A cognitive-behavioral model of compulsive hoarding. *Behavior research and therapy, 34*(4), 341-450.

Frost, R. O., Kim, H. J., Morris, C., Bloss, C., Murray-Close, M., & Steketee, G. (1998). Hoarding, compusilve buying and reasons for saving. *Behaviour Research and Therapy, 36*(7-8), 657-664.

Frost, R. O., Steketee, G., & Grisham, J. R. (2004). Measurement of compusive hoarding: Saving inventory-revised. *Behaviour Research and Therapy, 42*(10), 1163-1182.

Fussell, S. R., Kesler, S., Setlock, L. D., & Yew, V. (2008). How People Anthropomorphize Robots. *3rd ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 145-152.

Gabriella, A. (2015). The Cognitive Bases of Anthropomorphism: From Relatedness to Empathy. *International Journal of Social Robotics, 7*(1), 117-127.

Gage, N., & Baars, B. (2018). *Fundamentals of Cognitive Neuroscience.* Academic Press.

Gallagher, S. (2007). The Natural Philosophy of Agency. *Philosophy Compass, 2*(2), 347-357.

Gallese, V., & Goldman, A. (1998). Mirror neurons and the simulation theory of mind-reading. *Trends in Cognitive Sciences, 2*(12), 493-501.

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Brain, 119*(2), 593-609.

Galloti, M., & Frith, C. D. (2013). Social Cognition in the We-Mode. *Trends in Cognitive Sciences, 17*(4), 160-165.

Gaudiello, I., Lefort, S., & Zibetti, E. (2015). The ontological and functional status of robots: How firm our representations are? *Computers in Human Behavior, 50*, 259-273.

Gazzola, V., Rizzolatti, G., Wicker, B., & Keysers, C. (2007). The anthropomorphic brain: the mirror neuron system responds to human and robotic actions. *NeuroImage, 35*(4), 1674-1684.

Geiger, A., Bente, G., Lammers, S., Tepest, R., Roth, D., Bzdok, D., & Vogeley, K. (2019). Distinct functional roles of the mirror neuron system and the mentalizing system. *NeuroImage, 202*, 116102.

Go, E., & Sundar, S. (2019). Humanizing chatbots: The effects of visual, identity and conversational vues on humanness perceptions. *Computers in Human Behavior, 97*, 304-316.

Gobbini, M. I., Gentili, C., Ricciardi, E., & Bellucci, C. (2011). Distinct Neural Systems Involved in Agency and Animacy Detection. *Journal of Cognitive Neuroscience, 23*(8), 1911-1920.

Goetz, J., Kiesler, S., & Powers, A. (2003). Matching robot appearance and behavior to tasks to improve human-robot cooperation. *The 12th IEEE International Workship on Robot and Human Interactive Communication, 2003. Proceedings. ROMAN 2003*, 55-60.

Goldman, A. I. (1989). Interpretation Psychologized. *Mind & Language, 4*(3), 161-185.

Goldman, J. G. (2013, March 8). *Animating Anthropomorphism: Giving Minds To Geometric Shapes*. Retrieved from Scientific American: https://blogs.scientificamerican.com/thoughtful-animal/animating-anthropomorphism-giving-minds-to-geometric-shapes-video/

Gong, L. (2008). How social is social responses to computers? The function of the degree of anthropomorphism in computer representations. *Computers in Human Behavior, 24*(4), 1494-1509.

Gopnik, A., & Wellman, H. M. (2012). Reconstructing constructivism: Causal models, Bayesian learning mechanisms and the theory theory. *Psychological Bulletin*, 1085-1108.

Goudey, A., & Bonnin, G. (2016). Must Smart Objects Look Human? Study of the Impact of Anthropomorphism on the Acceptance of Companion Robots. *Recherte et Applications en Marketing (English Edition), 31*(2), 2-20.

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research - Concepts, procedures, & measures to achieve trustworthiness. *Nurse Education Today, 24*, 105-112.

Gray, H., Gray, K., & Wegner, D. (2007). Dimensions of Mind Perception. *Science, 315*.

Gray, K., & Wegner, D. (2012). Feeling Robots and Human Zombies: Mind Perception and the Uncanny Valley. *Cognition, 125*, 125-130.

Gray, K., & Wegner, D. M. (2009). Moral Typecasting: Divergent Perceptions of Moral Agents and Moral Patients. *Journal of Personality and Social Psychology, 96*(3), 505.

Gray, K., Young, L., & Waytz, A. (2012). Mind Perception is the Essence of Morality. *Psychological Inquiry, 23*(2), 101-124.

Grisham, J. R., Frost, R. O., Steketee, G., Kim, H. J., Tarkoff, A., & Hood, S. (2009). Formation of attachment to possessions in compusive hoarding. *Journal of Anxiety Disorders*, 357-361.

Grüneberg, P., Kadone, H., Kuramoto, N., Ueno, T., Hada, Y., Yamazaki, M., . . . Suzuki, K. (2018, March 12). Robot-assisted voluntary initiation reduces control-related difficulties of initiating joint movement: A phenomenal questionnaire study on shaping and compensation of forward gait. *PloS one*, *13*(3).

Grynszpan, O., Sahaï, A., Hamidi, N., Pacherie, E., Berberian, B., Roche, L., & Saint-Bauzel, L. (2019). The sense of agency in human-human vs human-robot joint action. *Consciousness and Cognition, 75*.

Guba, E. G., & Lincoln, Y. S. (1994). *Competing paradigms in qualitative research.* Thousand Oaks, CA: Jossey-Bass.

Gunkel, D. J. (2012). Communication and Artificial Intelligence: Opportunities and Challenges for the 21st Century. *Communication +1, 1*(1).

Guthrie, S. (1995). *Faces in the Clouds.* Oxford, United Kingdom: Oxford University Press.

Guthrie, S. E. (1993). *Faces in the Clouds: A New Theory of Religion.* Oxford Univerity Press on Demand.

Hackel, L. M., Looser, C. E., & Van Bavel, J. J. (2014). Group membership alters the threshold for mind perception: the role of social identity, collective identification, and intergroup threat. *Journal of Experimental Social Psychology, 52*, 15-23.

Haggard, P. (2005, June). Conscious intention and motor cognition. *Trends in Cognitive Science, 9*(6), 290-295.

Haggard, P., Clark, S., & Kalogeras, J. (2002). Voluntary action and conscious awareness. *Nature Neuroscience, 5*(4), 382.

Hall, B., & Henningsen, D. D. (2008, September 17). Social Facilitation and Human-Computer Interaction. *Computers in Human Behavior, 24*(6), 2965-2971.

Hancock, P., Billings, D., Schaefer, K., Chen, J., de Visser, E. J., & Parasuraman, R. (2011). A Meta-Analysis of Factors Affecting Trust in Human-Robot Interaction. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 517-527.

Häring, M., Kuchenbrandt, D., & André, E. (2014). Would you like to play with me? How robots' Group Membership and Task Features Influence Human-Robot Interaction. *9th ACM/IEEE International Conference on Human-Robot Interaction.*

Hart, P. M. (2013). *Anthropomorphism Appeals: Influencing Consumer Attitudes and Memory Through Humanlike Presentation.* Memphis: University of Memphis.

Harter, S. (1978). Effectance motivation reconsidered. Toward a Developmental Model. *Human Development, 21*(1), 34-64.

Hasan, M., & Yu, H. (2017). Innovative Developments in HCI and Future Trends. *International Journal of Automation and Computing*, 10-20.

Haslam, N. (2006). Dehumanization: An Integrative Review. *Personality and Social Psychology Review, 10*(3), 252-264.

Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* Guilford plublications.

Hegel, F., Gieselmann, S., Peters, A., Holthaus, P., & Wrede, B. (2011). Towards a typology of meaningful signals and cues in social robotics. *Proceedings of the IEEE international workshop on robot and human interactive communication*, (pp. 72-78).

Hegel, F., Krach, S., Kircher, T., Wrede, B., & Sagerer, G. (2008). Understanding social robots: a user study on anthropomorphism. *Proceedings of the 17th IEEE international symposium on robot and human interactive communication*, (pp. 574-579).

Heider, F., & Simmel, M. (1944). An experimental study of apparent behavior. *The American Journal of Psychology, 57*(2), 243-259.

Heit, E. (2000). Properties of inductive reasoning. *Psychonomic Bulletin & Review, 7*(4), 569-592.

Heit, E. (2000). Properties of Inductive Reasoning. *Psychonomic Bulletin & Review, 7*(4), 569-592.

Hertz, N., & Wiese, E. (2017, September). Social facilitation with non-human agents: possible or not? *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 61*(1), 222-225.

Hertz, N., & Wiese, E. (2018). Under Pressure: Examining Social Conformity with Computer and Robot Groups. *Human Factors*, 1207-1218.

Hickok, G. (2009). Eight Problems for the Mirror Neuron Theory of Action Understanding in Monkeys and Humans. *Journal of Cognitive Neuroscience, 21*(7), 1229-1243.

Higgins, T. (1996). Knowledge Activation: Accessibility, Applicability, and Salience. In T. Higgins, & E. Kruglanski, *Social Psychology: Handbook of Basic Principles* (pp. 133-168). New York, NY: Guilford Press.

Hinds, P. J., Roberts, T. L., & Jones, H. (2004, June 1). Whose job is it anyway? A study of human-robot interaction in a collaborative task. *Human-Computer Interaction, 19*(1-2), 151-181.

Hirschheim, R. A. (1986). The effect of a priori views on the social implications of computing: the case of office automation. *ACM Computing Surveys (CSUR), 18*(2), 165-195.

Hoenen, M., Lübke, K. T., & Pause, B. M. (2016). Non-anthropomorphic robots as social entities on a neurophysiological level. *Computers in Human Behavior, 57*, 182-186.

Horowitz, A. C., & Bekoff, M. (2007). Naturalizing anthropomorphism: behavioral prompts to our humanizing of animals. *Anthrozoos, 20*(1), 23-35.

Hortensius, R., Hekele, F., & Cross, E. (2017). The Perception of Emotion in Artificial Agents.

Huettermann, H., Doering, S., & Boerner, S. (2016). Understanding the Development of Team Identification: A Qualitative Study in UN Peacebuilding Teams. *Journal of Business and Psychology, 32*(2), 217-234.

Hughes, G. (2018). The role of the temporoparietal junction in implicit and explicit sense of agency. *Neuropsychologia, 113*, 1-5.

Hyde, J., Carter, E. J., Kiesler, S., & Hodgins, J. (2016). Evaluating Animated Characters: Facial Motion Magnitude Influences Personality Perceptions. *ACM Transactions on Applied Perception (TAP), 13*(2), 8.

Isabel, G., Tarr, M. J., Anderson, A. W., Skudlarski, P., & Gore, J. C. (1999). Activation of the middle fusiform'face area'increases with expertise in recognizing novel objects. *Nature Neuroscience, 2*(6), 568-573.

Isoda, M. (2016). Understanding Intentional Actions from Observers' Viewpoints: A Social Neuroscience Perspective. *Neuroscience Research, 1*(12), 1-9.

Jack, A. I., J., A. J., Begany, K. L., Leckie, R. L., Barry, K. P., Ciccia, A. H., & Snyder, A. Z. (2013, February). fMRI reveals reciprocal inhibition between social and physical cognitive domains. *NeuroImage, 66*, 385-401.

Johnson, R. D., Marakas, G. M., & Palmer, J. W. (2006, May). Differential Social Attributions Toward Computing Technology: An Empirical Investigation. *International Journal of Human-Computer Studies, 64*(5), 446-460.

Johnson, R. D., Marakas, G. M., & Palmer, J. W. (2008). Beliefs about the social roles and capabilities of computing technology: development of the computing technology continuum of perspective. *Behaviour & Information Technology, 27*(2), 169-181.

Judge, T. A., & Kammeyer-Mueller, J. D. (2011). Implications of Core Self-Evaluations for a Changing Organizational Context. *Human Resource Management Review, 21*(4), 331-341.

Judge, T. A., Erez, A., & Bono, J. E. (1998). The power of being positive: The relation between positive self-concept and job performance. *Human Performance, 11*(2-3), 167-187.

Judge, T. A., Erez, A., Bono, J., & Thoresen, C. (2002). Are measures of self-esteem, neuroticism, locus of control, and generalized self-efficacy indicators of a common core construct? *Journal of Personality and Social Psychology, 83*, 693-710.

Judge, T. A., Locke, E. A., Durham, C. C., & Kluger, A. N. (1998). Dispositional Effects on Job and Life Satisfaction: The Role of Core Ealuations. *Journal of Applied Psychology, 83*(1), 17.

Judge, T. A., Locke, E., & Durham, C. (1997). The dispositional causes of job satisfaction: A core evaluations approach. *Research in Organizational Behavior, 19*, 151-188.

Jung, E.-S., Dong, S.-Y., & Lee, S.-Y. (2019). Neural Correlates of Variations in Human Trust in Human-like Machines During Non-reciprocal Interactions. *Scientific Reports, 9*(1), 1-10.

Kaiser, M. D., Shiffrar, M., & Pelphrey, K. A. (2012). Socially tuned: Brain responses differentiating human and animal motion. *Social Neuroscience, 7*(3), 301-310.

Kanda, T., Miyashita, T., Osada, T., Haikawa., Y., & Ishiguro, H. (2005). Analysis of Humanoid Appearances in Human-Robot Interaction. *2005 IEEE/RSJ International Conference on Intelligent Robots and Systems* (pp. 62-69). Edmonton: IROS.

Kang, S.-H., & Watt, J. H. (2013). The impact of avatar realism and anonymity on effective communication. *Computers in Human Behavior, 29*, 1169-1181.

Kanwisher, N. (2010, June). Functional specificity in the human brain: A window into the functional architecture of the mind. *Proceedings of the National Academy of Sciences, 107*(25), 11163-11170.

Kassim, S. M. (1982). Heider and Simmel Revisited: Causal Attribution and the Animated Film Technique. *Social Psychology, 3*, 145-169.

Kawai, N. (2008). Crossmodal spatial attention shift produced by centrally presented gaze cues. *Japanese Psychological Research*.

Kawai, N. (2011). Attentional shift by eye gaze requires joint attention: eye gaze cues are unique to shift attention. *Japanese Psychological Research, 53*, 292-301.

Keeley, B. L. (2004). Anthropomorphism, primatomorphism, mammalomorphism: Understanding cross-species comparisons. *Biology and Philosophy, 19*(4), 521-540.

Kennedy, D. P., & Adolphs, R. (2012). The Social Brain in Psychiatric and Neurological Disorders. *Trends in Cognitive Sciences, 16*(11), 559-572.

Keysers, C., & Gazzola, V. (2007). Integrating simulation and theory of mind: from self to social cognition. *Trends in Cognitive Sciences, 11*(5), 194-196.

Keysers, C., & Perrett, D. I. (2004). Demysifying social cognition: a Hebbian perspective. *TRENDS in Cognitive Science, 11*(4), 501-507.

Khan, P. H., Kanda, T., Ishiguro, H., Feier, N. G., Severson, R. L., Gill, B. T., . . . Shen, S. (2012). "Robovie, You'll Have to Go into the Closet Now": Children's Social and Moral Relationships With a Humanoid Robot. *Developmental Psychology, 48*(2), 303-314.

Khan, P. J., Kanda, T., Ishiguro, H., Gill, B., Ruckert, J., & al., e. (2012). Do People Hold a Humanoid Robot Morally Accountable for the Harm it causes? *Proceedings ACM/IEEE International Conference of Human-Robot Interaction 7th* (pp. 33-40). Boston, MA: New York: ACM.

Khan, P., Ishiguro, H., Friedman, B., & Kanda, T. (2006). What is a human? Toward Psychological Benchmarks in the Field of Human-Robot Interaction. *The 15th IEEE International Symposium on Robot and Human Interactive Communication*, (pp. 364-371).

Kiesler, S., & Goetz, J. (2002). Mental Models and Cooperation with Robotic Assistants. *Conference on Human Factors in Computing Systems*.

Kiesler, S., & Hinds, P. (2004). Introduction to This Special Issue on Human-Robot Interaction. *Human-Computer Interaction, 19*, 1-8.

Kiesler, S., Powers, A., Fussell, S. R., & Torrey, C. (2008). Anthropomorphic interactions with a robot and robot-like agent. *Social Cognition, 26*(2), 169-181.

Kilner, J. M., & Lemon, R. N. (2013). What We Know Currently about Mirror Neurons. *Current Biology, 23*(23), 1057-1062. doi:https://doi.org/10.1016/j.cub.2013.10.051

Kim, A., Cho, M., Ahn, J., & Sung, Y. (2019). Effects of Gender and Relationship Type on the Response to Artificial Intelligence. *Cyberpsychology, Behavior, and Social Networking, 22*(4), 249-253.

Kim, J., Kwon, E. S., & Kim, B. (2018). Personality structure of brands on social networking sites and its effects on brand affect and trust: evidence of brand anthropomorphization. *Asian Journal of Communication, 28*(1), 93-113.

Kim, Y., & Sundar, S. (2012). Anthropomorphism of Computers: Is It Mindful or Mindless? *Computers in Human Behavior*, 241-250.

King, W. J., & Ohya, J. (1996, April). The Representation of Agents: Anthropomorphism, Agency, and Intelligence. *In Conference Companion on Human Factors in Computing Systems*, 289-290.

Kirby, R., Forlizzi, J., & Simmons, R. (2010). Affective Social Robots. *Robotics and Autonomous Systems*, *58*(3), 322-332.

Kirchner, W. B. (2017, July 6). *TPN vs. DMN – Neural Mechanisms and Mindfulness*. Retrieved October 2018, from www.exploringthebusinessbrain.com: https://exploringthebusinessbrain.com/tpn-vs-dmn-neural-mechanisms-mindfulness/

Koch, C. (2016, March 19). *How the Computer Beat the Go Master*. Retrieved from scientific american: https://www.scientificamerican.com/article/how-the-computer-beat-the-go-master/

Kory-Westlund, J. M. (2019). *Relational AI: Creating long-term interpersonal interaction, rapport, and relationships with social robots.* Boston, Massachusetts: Massachusetts Institute of Technology. Retrieved from http://oastats.mit.edu/handle/1721.1/123627

Kory-Westlund, J. M., & Breazeal, C. (2019). Exploring the Effects of a Social Robot's Speech Entrainment and Backstory on Young Children's Emotion, Rapport, Relationship, and Learning. *Frontiers in Robotics and AI, 6*(54).

Kory-Westlund, J. M., Jeong, S., Park, H. W., Ronfard, S., Adhikari, A., Harris, P. L., . . . Breazeal, C. L. (2017). Flat vs. Expressive Storytelling: Young Children's Learning and Retention of a Social Robot's Narrative. *Frontiers in Human Neuroscience, 11*, 295.

Krcmar, M., & Eden, A. (2019). Rational versus intuitive processing: The impact of cognitive load and moral salience on in-game aggression and feelings of guilt. *Journal of Media Psychology: Theories, Methods, and Applications, 31*(1), 2-11.

Kuchenbrandt, D., Eyssel, F., Bobinger, S., & Neufeld, M. (2013). When a robot's group membership matters. *International Journal of Social Robotics, 5*(3), 409-417.

Kühn, S., Brick, T. R., Müller, B. C., & Gallinat, J. (2014). Is this car looking at you? How Anthropomorphism predicts fusiform face area activation when seeing cars. *Plos One*, *9*(12).

Kumar, S. (2015). *Service Robotics Market Size, Growth To 2020.* Grand View Research, Inc.

Kupferberg, A., Glasauer, S., & Burkart, J. M. (2013). Do robots have goals? How agent cues influence action understanding in non-human primates. *Behavioral Brain Research*, 47-54.

Kwak, S. S., Kim, Y., Kim, E., Shin, C., & Cho, K. (2013). What makes people empathize with an emotional robot?: The impact of agency and physical embodiment on human empathy for a robot. *2013 IEEE RO-MAN*, 180-185.

Kwan, V. S., Gosling, S. D., & John, O. P. (2008). Anthropomorphism as a Special Case of Social Perception: A Cross-Species Social Relations Moel Analysis of Humans and Dogs. *Social Cognition, 26*(2), 129-142.

Lagattuta, K. H., Kramer, H. J., Kennedy, K., Hjortsvang, K., Goldfarb, D., & Tashjian, S. (2014). Chapter Six - Beyond Sally's Missing Marble: Further Development in Children's Understanding of Mind and Emotion in Middle Childhood. In J. Benson, *Advances in Child Development and Behavior* (Vol. 46). Elsevier.

Lang, H., Klepsch, M., Nothdurft, F., Seufert, T., & Minker, W. (2013). Are computers still social actors? *In CHI'13 extended abstracts on human factors in computing systems,* 859-864.

Lange, F. P., Spronk, M., Willems, R. M., Toni, I., & Bekkering, H. (2008). Complementary Systems for Understanding Action Intentions. *Current Biology, 18*(6), 454-457.

LaRose, R., & Easting, M. S. (2004). A social cognitive theory of Internet uses and gratifications: Toward a new model of media attendance. *Journal of broadcasting & electronic media, 48*(3), 358-477.

Larsen, N. E., Lee, K., & Ganea, P. A. (2018). Do storybooks with anthropomorphized animal characters promote prosocial behaviors in young children? *Developmental Science, 21*(3), e12590.

Lee, E.-J. (2010). The more humanlike, the better? How speech type and users' cognitive style affect social responses to computers. *Computers in Human Behavior*, 665-672.

Lee, E.-J. (2010). What triggers social responses to flattering computers? Experimental tests of anthropomorphism and mindlessness explanations. *Communication Research, 37*(2), 191-214.

Lee, J. M., Baek, J., & Ju, D. Y. (2018, October 2). Anthropomorphic Design: Emotional Perception for Deformable Object. *Frontiers in Psychology, 9*, 1829.

Lee, J.-G., Kim, K. J., Lee, S., & Shin, D.-H. (2015). Can Autonomous Vehicles Be Safe and Trustworthy? Effects of Appearance and Autonomy of Unmanned Driving Systems. *International Journal of Human-Computer Interaction*, 682-691.

Lee, K. M., Jung, Y., Kim, J., & Kim, S. R. (2006, October). Are physically embodied social agents better than disembodied social agents?: The effects of physical embodiment, tactile interaction, and people's loneliness in human-robot interaction. *International Journal of Human-Computer Studies, 64*(10), 962-973.

Lee, N., Shin, H., & Sundar, S. (2011). Utilitarian vs. Hedonic Robots: Role of Parasocial Tendency and Anthropomorphism in Shaping User Attitudes. *In Proceedings of the 6th International Conference on Human-Robot Interaction*, (pp. 183-184).

Lee, S., Lee, N., & Sah, Y. J. (2019, Dec 7). Perceiving a Mind in a Chatbot: Effect of Mind Perception and Social Cues on Co-presence, Closeness and Intention to Use. *International Journal of Human-Computer Interaction,* 1-11.

Lee, S.-L., Lau, I., Kiesler, S., & Chiu, C.-Y. (2005). Human Mental Models of Humanoid Robots. *Proceedings of the 2005 IEEE International Conference on Robotics and Automation* (pp. 2767-2772). ICRA.

Lehmann, H., & Broz, F. (2018). Contagious Yawning in Human-Robot Interaction. *HRI '18: Companion of the 2018 ACM/IEEE International Conference on Human-Robot Interaction*, (pp. 173-174). doi:https://doi.org/10.1145/3173386.3177063

Lemaignan, S., Fink, J., Dillenbourg, P., & Braboszcz, C. (2014). The cognitive correlates of anthropomorphism. *2014 Human-Robot Interaction Conference, Workshop "HRI: a bridge between Robotics and Neuro- science".*

Leslie, A. M. (2001). Theory of Mind. *International Encyclopedia of the Social & Behavioral Sciences,* 15652-15656.

Letheren, K., Kuhn, K.-A. L., Lings, I., & Pope, N. K. (2016). Individual Difference Factors Related to Anthropomorphic Tendency. *European Journal of Marketing*.

Levillain, F., & Zibetti, E. (2017). Behavioral Objects: The Rise of the Evocative Machines. *Journal of Human-Robot Interaction, 6*(1), 4-24.

Levin, D. T., Killingsworth, S. S., Saylor, M. M., Gordon, S. M., & Kawamura, K. (2013). Tests of concepts about different kinds of minds: Predictions about the behavior of computers, robots, and people. *Human-Computer Interaction, 28*(2), 161-191.

Li, H., Hsueh, Y., Wang, F., Bai, X., Liu, T., & Zhou, L. (2017). Do Young Chinese Children Gain Anthropomorphism After Exposure to Personified Touch-Screen and Board Games? *Frontiers in Psychology (Developmental Psychology), 8*, 55.

Li, W., Mai, X., & Liu, C. (2014). The default mode network and social understanding of others: What do brain connectivity studies tell us. *Frontiers in Human Neuroscience, 8,* 74.

Lieberman, M. (2007). Social Cognitive Neuroscience: a Review of Core Processes. *Annual Review of Psychology, 58*, 259-289.

Lieberman, M. D. (2013). *Social: Why our brains are wired to connect.* Oxford: Crown.

Limerick, H., Coyle, D., & Moore, J. W. (2014). The experience of agency in human-computer interactions: a review. *Frontiers in Human Neuroscience, 8*, 643.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Beverly Hills, CA: Sage Publications.

Looser, C. E., & Wheatley, T. (2010). The tipping point of animacy. How, when and where we perceive life in a face. *Psychological Science, 21*(12), 1854-1862.

Luczak, H., Roetting, M., & Schmidt, L. (2003). Let's talk: anthropomorphization as means to cope with stress of interacting with technical devices. *Ergonomics, 46*(13-14), 1361-1374.

Macerollo, A., Chen, J.-C., Pareés, I., Kassavetis, P., Kilner, J. M., & Edwards, M. J. (2015). Sensory Attenuation Assessed by Sensory Evoked Potentials in Functional Movement Disorders. *PloS one, 10*(6).

Mackinnon, M. (2017, June 17). *Neuroscience of Mindfulness: Default Mode Network, Meditation, & Mindfulness.* Retrieved from www.mindfulnessmd: https://www.mindfulnessmd.com/2014/07/08/neuroscience-of-mindfulness-default-mode-network-meditation-mindfulness/

Mahon, B. Z., Anzellotti, S., Schwarzbach, J., Zampini, M., & Caramazza, A. (2009). Category-Specific Organization in the Human Brain Does Not Require Visual Experience. *Neuron, 63*(3), 397-405.

Mandell, A. R., Smith, M. A., Martini, M. C., Shaw, T. H., & Wiese, E. (2015). Does the presence of social agents improve cognitive performance on a vigilance task? *International Conference on Social Robotics* (pp. 421-430). Springer, Cham.

Manstead, A. S., & Parker, D. (1995). Evaluating and extending the theory of planned behaviour. *European Review of Social Psychology, 6*(1), 69-95.

Mara, M., & Appel, M. (2015, March 1). Effects of lateral head tilt on user perceptions of humanoid and android robots. *Computers in Human Behavior, 44*, 326-334.

Marakas, G. M., Yi, M. Y., & Johnson, R. D. (1998). The Multilevel and Multifaceted Character of Computer Self-Efficacy: Toward Clarification of the Construct and an Integrative Framework for Research. *Information Systems Research, 9*(2), 126-163. doi:https://doi.org/10.1287/isre.9.2.126

Marakas, G., Johnson, R., & Clay, P. F. (2007). The evolving nature of the computer self-efficacy construct: An empirical investigation of measurement construction, validity, reliability and stability over time. *Journal of the Association for Information Systems, 8*(1), 2.

Marakas, G., Johnson, R., & Palmer, J. (2000). A Theoretical Model of Differential Social Attributions Toward Computing Technology: When the Metaphor Becomes the Model. *International Journal of Human-Computer Studies, 52*(4), 719-750.

Mars, R. B., Neubert, F.-X., Noonan, M. P., Sallet, J., Toni, I., & Rushworth, M. F. (2012). On the relationship between the "default mode network" and the "social brain". *Frontiers in Human Neuroscience, 6*.

Martin, A. (2007). The Representation of Object Concepts in the Brain. *Annual Review of Psychology, 58*, 25-45.

Martin, A., & Weisberg, J. (2003). Neural foundations for social and mechanical concepts. *Cognitive Neuropsychology, 20*(3-6), 575-587.

Martini, M. C., Gonzalez, C. A., & Wiese, E. (2016). Seeing minds in others-Can agents with robotic appearance have human-like preferences? *PloS one*.

Mataix-Cols, D., Fernandez de la Cruz, L., Nakao, T., & Pertusa, A. (2011). Testing the validity and acceptability of the diagnostic criteria for Hoarding Disorder: a DSM-5 survey. *Psychological Medicine, 41*(12), 2475-2484.

Matsuyama, Y., Bhardwaj, A., Zhao, R., Romeo, O., Akoju, S., & Cassell, J. (2016). Socially-aware Animated Intelligent Personal Assistant Agent. *Proceedings of the 17th Annual Meeting of the Special Interest Group on Discourse and Dialogue*, (pp. 224-227).

Mayer, P., & Panek, P. (2016). Should assistive robots have a "personality"?: Potential of simplified robot personalities. *Zeitschrift fur Gerontologie und Geriatrie, 49*(4), 298-302.

McCall, G. J., & Simmons, J. L. (1978). *Identities and Interactions.* New York, NY: Free Press.

McCloud, S. (1993). *Understanding comics* -- *The invisible art.* New York: Stanford, CA.

McDonell, R., Jorg, S., Mchugh, J., Newell, F. N., & O'Sullivan, C. (2009). Investigating the Role of Body Shape on the Perception of Emotion. *ACM Transactions on Applied Perception (TAP), 6*(3), 1-11.

McEneaney, J. E. (2009). Agency Attribution in Human-Computer Interaction. *International Conference on Engineering Psychology and Cognitive Ergonomics*.

McEneaney, J. E. (2009). Agency Attribution in Human-Computer Interaction. *International Conference on Engineering Psychology and Cognitive Ergonomics*, 81-90.

McEneaney, J. E. (2013). Agency Effects in Human-Computer Interaction. *International Journal of Human-Computer Interaction, 29*(12), 798-813.

Menon, V. (2011). Large-scale brain networks and psychopathology: a unifying triple network model. *Trends in Cognitive Sciences*, 483-506.

Milgram, S. (1974). *Obedience to Autority: An Experimental View.* Harpercollins.

Miwa, K., & Terai, H. (2012). Impact of two types of partner, perceived or actual, in human-human and human-agent interaction. *Computers in Human Behavior, 28*(4), 1286-1297.

Moon, Y. (2000). Intimate Exchanges: Using Computers to Elicit Self-Disclosure from Consumers. *Journal of Consumer Research, 26*(4), 323-339.

Moon, Y., & Nass, C. (1996). How "Real" are Computer Personalities? Psychological Responses to Personality Types in Human-Computer Interaction. *Communication Research, 23*(6), 651-674.

Moon, Y., & Nass, C. (1998). Are Computers Scapegoats? Attributions of Responsability in Human-Computer Interaction. *International Journal of Human-Computer Interaction*, *49*(1), 79-94.

Moore, J. W. (2016). What Is the Sense of Agency and Why Does it Matter? *Frontiers in Psychology, 7*(1272).

Moore, J. W., & Obhi, S. S. (2012). Intentional Binding and the Sense of Agency: a Review. *Consciousness and Cognition, 21*(1), 546-561.

Moore, J., & Fletcher, P. (2012). Sense of agency in health and disease: a review of cue integration approaches. *Consciousness and Cognition*, 59-68.

Morelli, S. A., Rameson, L. T., & Lieberman, M. D. (2014). The neural components of empathy: predicting daily prosocial behavior. *Social Cognitive and Affective Neuroscience*, 39-47.

Moretto, G., Walsh, E., & Haggard, P. (2011). Experience of agency and sense of responsibility. *Consciousness and Cognition, 20*(4), 1847-1854.

Moretto, G., Walsh, E., & Haggard, P. (2011). Experience of Agency and Sense of Responsibility. *Consciousness and Cognition, 20*(4), 1847-1854.

Morewedge, C. K. (2009). Negativity bias in attribution of external agency. *Journal of Experimental Psychology: General, 138*(4), 535-545.

Mori, M. (1970). The Uncanny Valley. *Energy*, *7*(4), 33-35.

Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [from the field]. *IEEE Robotics & Automation Magazine*, 98-100.

Morkes, J., Kernal, H. K., & Nass, C. (2000). Effects of Humor in Task-Oriented Human-Computer Interaction and Computer-Mediated Communication: A Direct Test of SRCT Theory. *Human-Computer Interaction, 14*(4), 395-435.

Morris, M. W., & Peng, K. (1994). Culture and cause: American and chinese attributions for social and physical events. *Journal of Personality and Social Psychology, 67*(6), 949-971.

Mou, Y., & Xu, K. (2017). The media inequality: Comparing the initial human-human and human-AI social Interactions. *Computers in Human Behavior*, 432-440.

Mouloua, M., & Hancock, P. A. (2019). *Human Performance in Automated and Autonomous Systems: Current Theory and Methods.* CRC Press.

Mouloua, M., & Hancock, P. A. (2019). *Human Performance in Automated and Autonomous Systems: Emerging Issues and Practical Perspectives.* CRC Press.

Mubin, O., Stevens, C., Shahid, S., Mahmud, A., & Dong, J. (2013). A review of the applicability of robots in education. *Technology for Education and Learning, 1*, 209-215.

Mutlu, B., Yamaoka, F., Kanda, T., Ishiguro, H., & Hagita, N. (2009). Non-verbal leakage in robots: Communication of intentions through seemingly unintentional behavior. *Proceedings of the 4th ACM/IEEE international conference on human robot interaction, HRI '09* (pp. 69-76). ACM, New York.

Nass, C., & Brave, S. (2005). *Wired for speech: How voice activates and advances the human-computer relationship.* Cambridge: MA: MIT press.

Nass, C., & Gong, L. (1999). Maximized modality or constrained consistency? *Proceedings of the AVSP 99 Conference.* Santa Cruz, CA: New York: Association of Computer Machinery.

Nass, C., & Mason, L. (1990). On the Study of Technology and Task: A Variable-Based Approach. In J. Fulk, & C. Steinfield, *Organizations and Communication Technology* (pp. 46-67). Newbury Park, CA: Sage.

Nass, C., & Moon, Y. (2000). Machines and Mindlessness: Social Responses to Computers. *Journal of Social Issues, 56*(1), 81-103.

Nass, C., & Sundar, S. (1994). Are Programmers Psychologically Relevant to Human-Computer Interaction? *Annual Meeting of the International Communication Association.* San Francisco, CA.

Nass, C., Fogg, B., & Moon, Y. (1996). Can Computers Be Teammates? *International Journal of Human-Computer Studies,* 669-678.

Nass, C., Isbister, K., & Lee, E.-J. (2000). Truth is Beauty: Researching Conversational Agents. In J. Cassell, J. Sullivan, S. Prevost, & E. F. Churchill, *Embodied Conversational Agents* (pp. 374-402). Cambridge, MA: MIT Press.

Nass, C., Moon, Y., & Carney, P. (1999). Are Respondents Polite to Computers? Social Desirability and Direct Responses to Computers. *Journal of Applied Social Psychology, 29*(5), 1093-1110.

Nass, C., Moon, Y., & Green, N. (1997). Are Computers Gender-Neutral? Gender Stereotypic Responses to Computers. *Journal of Applied Social Psychology, 27*(10), 864-876.

Nass, C., Moon, Y., Fogg, B., Reeves, B., & Dryer, C. (1995). Can Computer Personalities Be Human Personalities? *International Journal of Human-Computer Studies, 43*, 223-239.

Nass, C., Steuer, J., & Tauber, E. R. (1994). Computers are Social Actors. *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 72-78). ACM.

Nass, C., Steuer, J., Henriksen, L., & Dryer, D. C. (1994, March). Machines and Social Attributions: Performance Assessments of Computers Subsequent to "Self-" or "Other-" Evaluations. *International Journal of Human-Computer Studies, 40*(3), 543-559.

Nass, C., Steuer, J., Tauber, E., & Reeder, H. (1993). Anthropomorphism, Agency, & Ethopoeia: Computers as Social Actors. *INTERACT'93 and CHI'93 conference companion on Human factors in computing systems*, 111-112.

Neave, N., Jackson, R., Saxton, T., & Hönekopp, J. (2015). The influence of anthropomorphic tendencies on human hoarding behaviours. *Personality and Individual Differences, 72*, 214-219.

Neave, N., Tyson, H., McInnes, L., & Hamilton, C. (2016). The Role of Attachment Style and Anthropomorphism in Predicting Hoarding Behaviours in a non-clinical Sample. *Personality and Individual Differences, 99*, 33-37.

Nettle, D., & Liddle, B. (2008). Agreeableness is related to social-cognitive, but not social-perceptual, theory of mind. *European Journal of Personality, 22*(4), 323-335.

Noordzij, M. L., Newman-Norlund, S. E., Ruiter, J. P., Hagoort, P., Levinson, S. C., & Toni, I. (2009). Brain mechanisms underlying human communication. *Frontiers in Human Neuroscience, 3*(14).

Norberg, M. M., Crone, C., Kwok, C., & Grisham, J. R. (2018). Anxious Attachment and Excessive Acquisition: The Mediating Roles of Anthropomorphism and Distress Intolerance. *Journal of Behavioral Addictions, 7*(1), 171-180.

Norman, D. (1992). *Turn Signals are the Facial Expressions of Automobiles.* Reading, MA: Addison-Wesley.

Norman, D. (2014). *Turn Signals are the Facial Expressions of Automobiles.*

Norsia, I., & Palagi, E. (2011). Yawn contagion and empathy in homo sapiens. *PLoS ONE, 6*(12), e28472.

Nowak, K. L., & Biocca, F. (2003). The effect of the agency and anthropomorphism on users' sese of telepresence, copresence, and social presence in virtual environments. *Presence: Teleoperators & Virtual Environments*, *12*(5), 481-494.

Nowak, K. L., & Rauh, C. (2008). Choose your “buddy icon” carefully: The influence of avatar androgyny, anthropomorphism and credibility in online interactions. *Computers in Human Behavior, 24*(4), 1473-1493.

Obaid, M., Kuchenbrandt, D., & Bartneck, C. (2014). Empathy and Yawn Contagion: Can we (Humans) Catch Yawns from Robots? *Proceedings of the ACM / IEEE International Conference on Human-Robot Interaction*, (pp. 260-261). Bielfeld. doi:10.1145/2559636.2563702

Obhi, S. S., & Hall, P. (2011). Sense of agency and intentional binding in joint action. *Experimental brain research, 211*(3-4), 655-662.

Obhi, S. S., & Hall, P. (2011). Sense of Agency in Joint Action: Influence of Human and Computer Co-actors. *Experimental Brain Research, 211*(3-4), 663-670.

Obhi, S., & Sebanz, N. (2011, June). Moving together: toward understanding the mechanisms of joint action. *Experimental Brain Research*, 329-336. doi:10.1007/s00221-011-2721-0

Ogawa, K., Bartneck, C., & Sakamoto, D. (2009). Can An Android Persuade You? *RO-MAN - The 18th IEEE International Symposium on Robot and Human Interactive Communication*, 516-521.

Orlikowski, W. J. (1992). The Duality of Technology: Rethinking the Concept of Technology in Organizations. *Organization Science, 3*(3), 398-427.

Pacherie, E. (2012). The Phenomenology of Joint Action: Self-Agency vs. Joint-Agency. In A. Seeman, *Joint Attention: New Developments.* Cambridge MA: MIT Press.

Page, L. C., & Gehlbach, H. (2017). How an Artificially Intelligent Virtual Assistant Helps Students Navigate the Road to College. *AERA Open, 3*(4).

Pak, R., Fink, N., Price, M., Bass, B., & Sturre, L. (2012). Decision Support Aids with Anthropomorphic Characteristics Influence Trust and Performance in Younger and Older Adults. *Ergonomics, 55*(9), 1059-1072.

Park, S., & Catrambone, R. (2007). Social Facilitation Effects of Virtual Humans. *Human Factors, 49*(6), 1054-1060.

Parsons, J. (2010, January 6). *No Russian? No Thanks*. Retrieved from venturebeat: https://venturebeat.com/community/2010/01/06/no-russian-no-thanks/

Patel, H. (2015). *The persuasiveness of humanlike computer interfaces varies more through narrative characterization than through the uncanny valley*. (Doctoral dissertation).

Pedersen, T. (2018, September 21). *Theory of Mind*. Retrieved from Psych Central: https://psychcentral.com/encyclopedia/theory-of-mind/

Petrides, M. (2005). Lateral prefrontal cortex: architectonic and functional organization. *Philosophical Transactions of the Royal Society B.*

Piaget, J. (1929). *The Child's Conception of the World.* London: Routledge & Kegan Paul.

Piaget, J. (1936). *The origins of intelligence in children.* London: Routledge & Kegan Paul.

Piaget, J. (1955). The construction of reality in the child. *Journal of Consulting Psychology*, *19*(1), 77.

Piaget, J. (1965). *The Child's Conception of Number*. New York: W. W. Norton & Company, Inc.

Picard, W. R. (1997). Affective Computing. Cambridge, MA: MIT Press.

Pitsch, K., & Koch, B. (2010). How infants perceive the toy robot Pleo. An exploratory case study on infant-robot-interaction. *AISB 2010 Symposium "New Frontiers in Human-Robot-Interaction"*, (pp. 80-87). Leicester, UK.

Powers, A., & Kiesler, S. (2006). The advisor robot: tracing people's mental model from a robot's physical attributes. *1st ACM SIGCHI/SIGART conference on Human-Robot Interaction*, (pp. 218-225).

Pransky, J. (2019, August 30). *The Essential Interview: Maja Mataric, USC and Embodied.* Retrieved from Robotics Business Review: https://www.roboticsbusinessreview.com/service/the-essential-interview-maja-mataric-usc-and-embodied/

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A Default Mode of Brain Function. *Proceedings of the National Academy of Sciences of the United States of America, 98*(2), 676-682.

Rauschnabel, P. A., & Ahuvia, A. C. (2014). You're so lovable: Anthropomorphism and Brand Love. *Journal of Brand Management*, *21*(5), 372-395.

Reeves, B., & Nass, C. (1996). *The media equation: How people treat coputers, television, and new media like real people and places.* Stanford, CA: CSLI Publications & Cambridge University Press.

Renesse, R. D. (2017, May 17). *Virtual digital assistants to overtake world population by 2021*. Retrieved from ovum.informa.com: https://ovum.informa.com/resources/product-content/virtual-digital-assistants-to-overtake-world-population-by-2021

Riek, L. D., Rabinowitch, T.-C., Chakrabarti, B., & Robinson, P. (2009). Empathizing with Robots: Fellow Feeling along the Anthropomorphic Spectrum. *In 2009 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops* (pp. 1-6). IEEE.

Riek, L. D., Rabinowitch, T.-C., Chakrabarti, B., & Robinson, P. (2009). How Anthropomorphism Affects Empathy Toward Robots. *Proceedings of the 4th ACM/IEEE International Conference on Human Robot Interaction*, 245-246.

Riether, N., Hegel, F., Wrede, B., & Horstmann, G. (2012). Social Facilitation with Social Robots? *2012 7th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 41-47.

Riva, P., Sacchi, S., & Brambilla, M. (2015). Humanizing machines: Anthropomorphization of slot machines increases gambling. *Journal of Experimental Psychology: Applied, 21*(4), 313.

Rizzolatti, G., & Craighero, L. (2004). The Mirror-Neuro System. *Annual Review of Neuroscience, 27,* 169-192.

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research, 3*(2), 131-141.

Rizzolatti, G., Fogassi, L., & Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action. *Nature Reviews Neuroscience, 2*(9), 661-670.

Robinson, H., MacDonald, B., & Broadbent, E. (2014). The Role of healthcare Robots for Older People at Home: a Review. *International Journal of Social Robotics, 6*(4), 575-591.

Robotics, I. F. (2014). *World Robotics Report 2014.* Retrieved from http://www.diag.uniroma1.it/~deluca/rob1_en/2014_WorldRobotics_ExecSummary.pdf

Rocca, K. A., & McCroskey, J. (1999). The interrelationship of student ratings of instructors' immediacy, verbal aggressiveness, homophily, and interpersonal attraction. *Communication education, 48*(4), 308-316.

Rothmann, S., & Coetzer, E. P. (2003). The Big Five Personality Dimensions and Job Performance. *SA Journal of Industrial Psychology, 29*(1), 68-74.

Rotter, J. B. (1990). Internal versus External Control of Reinforcement: A Case History of a Variable. *American Psychologist, 45*(4), 489-493.

Sabelli, A., & T., K. (2015). Robovie as a mascot: a qualitative study for long-term presence of robots in a shopping mall. *International Journal of Social Robotics, 8*(2), 211-221.

Saerbeck, M., Schut, T., Bartneck, C., & Janse, M. D. (2010, April). Expressive Robots in Education: Varying the degree of social supportive behavior of a robotic tutor. *Proceedings of the SIGCHI conference on human factors in computing systems*, 1613-1622.

Sah, Y. J., & Peng, W. (2015, April). Effects of visual and linguistic anthropomorphic cues on social perception, self-awareness, and information disclosure in a health website. *Computers in Human Behavior, 45*, 392-401.

Salem, M., Eyssel, F., Rohlfing, K., Kopp, S., & Joubling, F. (2011). Effects of gesture on the perception of psychological anthropomorphism: a case study with a humanoid robot. In B. Mutlu, C. Bartneck, J. Ham, V. Evers, & T. Kanda, *Lecture Notes in Computer Science* (Vol. 7072). Berlin: Springer, Berlin, Heidelberg.

Salem, M., Lakatos, G., Amirabdollahian, F., & Dautenhahn, K. (2015). Would You Trust a (Faulty) Robot?: Effects of Error, Task Type, and Personality on Human-robot Cooperation and Trust. *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction*, 141-148.

Salem, M., Ziadee, M., & Sakr, M. (2014). Marhaba, how may I help you? Effects of Politeness and Culture on Robot Acceptance and Anthropomorphization. *9th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 74-81.

Salmela, M., & Nagatsu, M. (2017). How does it really feel to act together? Shared emotions and the phenomenology of we-agency. *Phenomenology and the Cognitive Sciences, 16*(3), 449-470.

Samson, D., Apperly, I. A., Chiavarino, C., & Humphreys, G. W. (2004). Left Temporoparietal Junction is Necessary for Representing Someone Else's Belief. *Nature Neuroscience, 7*(5), 499-500.

Sarkar, A., Sarkar, J. G., & Bhatt, G. (2019). Store Love in Single Brand Retailing: the Rolesof Relevant Moderators. *Marketing Intelligence & Planning*.

Saxe, R. (2005). Against simulation: the argument from error. *TRENDS in Cognitive Sciences, 9*(4), 171-179.

Schaafsma, S. M., Pfaff, D. W., Spunt, R. P., & Adolphs, R. (2015). Deconstructing and reconstructing theory of mind. *Trends in Cognitive Sciences, 19*(2), 65-72.

Schaefer, K. E., Chen, J. Y., Szalma, J. L., & Hancock, P. A. (2016). A Meta-Analysis of Factors Influencing the Development of Trust in Automation: Implications for Understanding Autonomy in Future Systems. *Human Factors, 58*(3), 377-400.

Schechtman, N., & Horowitz, L. M. (2003). Media Inequality in Conversation: How People Behave Differently When Interacting with Computers and People. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 281-288.

Schlosser, M. (2015, August 10). *Agency*. (E. N. Zalta, Editor) Retrieved from The Stanford Encyclopedia of Philosophy: https://plato.stanford.edu/entries/agency/

Schmitt, M. T., Silvia, P. J., & Branscombe, N. R. (2000). The Intersection of Self-Evaluation Maintenance and Social Identity Theories: Intragroup Judgment in Interpersonal and Intergroup Contexts. *Personality and Social Psychology Bulletin, 26*(12), 1598-1606.

Schroeder, J., & Epley, N. (2016). Mistaking minds and machines: How speech affects dehumanization and anthropomorphism. *Journal of Experimental Psychology: General*, *145*(11), 1427.

Schroeder, J., & Schroeder, M. (2018). Trusting in machines: How mode of interaction affects willingness to share personal information with machines. *Proceedings of the 51st Hawaii International Conference on System Sciences.*

Schweitzer, F., Belk, R., Jordan, W., & Ortner, M. (2019). Sevant, friend or master? The relationships users build with voice-controlled smart devices. *Journal of Marketing Management, 35*, 693-715.

Senior, T. (2012, August 09). *Modern Warfare 2 designer explains the thinking behind No Russian mission*. Retrieved from pcgamer: https://www.pcgamer.com/modern-warfare-2-designer-explains-the-thinking-behind-no-russian-mission/

Sergent, J., Ohta, S., & Macdonlad, B. (1992). Functional neuroanatomy of face and object processing: a positron emission tomography study. *Brain, 115*(1), 15-36.

Serpell, J. A. (2003). Anthropomorphism and Anthropomorphic Selection - Beyond the "Cute Response". *Society & Animals, 11*(1), 83-100.

Severson, R. L., & Lemm, K. M. (2016). Kids See Human Too: Adapting an Individual Differences Measure of Anthropomorphism for Child Sample. *Journal of Cognition and Development*, *17*(1), 122-141.

Severson, R. L., & Woodard, S. R. (2018). Imagining Others' Minds: The Positive Relation Between Children's Role Play and Anthropomorphism. *Frontiers in Psychology, 9*, 2140.

Shahid, S., Krahmer, E., & Swerts, M. (2014). Child–robot interaction across cultures: How does playing a game with a social robot compare to playing a game alone or with a friend? *Computers in Human Behavior, 40,* 86-100.

Shank, D. B., Graves, C., Gott, A., Gamez, P., & Rodriguez, S. (2019). Feeling our way to machine minds: People's emotions when perceiving mind in artificial intelligence. *Computers in Human Behavior, 98,* 256-266.

Shaw, J. A., Bryant, L. K., Malle, B. F., Povinelli, D. J., & Pruett Jr., J. R. (2017). The relationship between joint attention and theory of mind in neurotypical adults. *Consciousness and Cognition*, 268-278.

Shulman, G. L., Corbetta, M., Buckner, R. L., & Fiez, J. A. (1997). Common blood flow changes across visual tasks: I. Increases in subcortical structures and cerebellum but not in nonvisual cortex. *Journal of Cognitive Neuroscience*, 624-647.

Shultz, S., Lee, S. M., Pelphrey, K., & McCarthy, G. (2011). The posterior superior temporal sulcus is sensitive to the outcome of human and non-human goal-directed actions. *Social Cognitive and Affective Neuroscience, 6*(5), 602-611.

Silver, D., Huang, A., Maddison, C. J., Guez, A., Sifre, L., van den Driessche, G., . . . al., e. (2016). Compensating for the loss of human. *Nature, 529*(7587), 484-489.

Simut, R., Vanderfaeillie, J., Peca, A., Perre, G., & Vanderborght, B. (2016). Children with Autism Spectrum Disorders make a fruit salad with Probo, the social robot: an interaction study. *Journal of Autism and Developmental Disorders, 46*(1), 113-126.

Sloutsky, V. M., & Fisher, A. V. (2004). Induction and Categorization in Young Children: A Similarity-Based Model. *Journal of Experimental Psychology: General, 133*(2), 166.

Sloutsky, V. M., Kloos, H., & Fisher, A. V. (2007). When Looks are Everything: Appearance Similarity Versus Kind Information in Early Induction. *Psychological Science, 18*(2), 179-185.

Smith, D. G. (2018, May 24). *Daydreaming May Help You Become More Socially Adept*. Retrieved from Scientific American: https://www.scientificamerican.com/article/daydreaming-may-help-you-become-more-socially-adept/

Smith, E. (2017, March 4). *There's No Reason for 'No Russian' to Exist in 'Modern Warfare 2'*. Retrieved from Vice: https://www.vice.com/en_us/article/4x44yp/theres-no-reason-for-no-russian-to-exist-in-modern-warfare-2

Spunt, R. P., & Lieberman, M. D. (2012). An Integrative model of the neural systems supporting the comprehension of observed emotional behavior. *NeuroImage, 59*(3), 3050-3059.

Spunt, R. P., & Lieberman, M. D. (2012). Dissociating Modality-Specific and Supramodal Neural Systems for Action Understanding. *The Journal of Neuroscience*, *32*(10), 3575-3583.

Spunt, R. P., & Lieberman, M. D. (2012). The Busy Social Brain: Evidence for Automaticity and Control in the Neural Systems Supporting Social Cognition and Action Understanding. *Psychological Science, 24*(1), 80-86.

Spunt, R. P., Ellsworth, E., & Adolphs, R. (2017). The Neural Basis of Understanding the Expression of the Emotions in Man and Animals. *Social Cognitive and Affective Neuroscience, 12*(1), 95-105.

Spunt, R. P., Falk, E. B., & Lieberman, M. D. (2010). Dissociable Neural Systems Support Retrieval of How and Why Action Knowledge. *Psychological Science*, *21*(11), 1593-1598.

Spunt, R. P., Meyer, M. L., & Lieberman, M. D. (2015). The Default Mode of Human Brain Function Primes the Intentional Stance. *Journal of Cognitive Neuroscience*, 1116-1124.

Spunt, R. P., Satpute, A. B., & Lieberman, M. D. (2011). Identifying the What, Why, and How of an Observed Action: An fMRI Study of Mentalizing and Mechanizing during Action Observation. *Journal of Cognitive Neuroscience, 23*(1), 63-74.

Sreejesh, S., & Anusree, M. (2017). Effects of Cognition Demand, Mode of Interactivity and Brand Anthropomorphism on Gamers' Brand Attention and Memory in Advergames. *Computers in Human Behavior, 70*, 575-588.

Sreejesh, S., & Anusree, M. R. (2017). Effects of Cognition Demand, Mode of Interactivity and Brand Anthropomorphism on Gamers' Brand Attention and Memory in Advergames. *Computers in Human Behavior, 70*, 575-588.

Statista. (2018). *www.statista.com*. Retrieved from Size of the virtual digital assistant (VDA) market worldwide from 2015 to 2021 (in million U.S. dollars): https://www.statista.com/statistics/589079/worldwide-virtual-digital-assistants-consumer-market/

Steketee, G., O., F. R., & Kyrios, M. (2003). Cognitive aspects of compusive hoarding. *Cognitive Therapy and Research, 27*, 463-479.

Strauss, A., & Corbin, J. (1998). *The Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.* London: Sage.

Stryker, S. (1980). *ymbolic Interactionism: A Social Structural Version.* Menlo Park, CA: Benjamin/Cummings.

Sullins, J. P. (2006). When Is a Robot a Moral Agent? *Machine ethics*, *6*, 23-30.

Sundar, S. (2004). Loyalty to Computer Terminals: Is It Anthropomorphism or Consistency. *Behaviour & Information Technology, 23*(2), 107-118.

Sundar, S. (2004). Loyalty to Computer Terminals: is it Anthropomorphism or Consistency? *Behavior & Information Technology*, *23*(2), 107-118.

Sundar, S., Jung, E. H., Waddell, T. F., & Kim, K. J. (2017). Cheery companions or serious assistants? Role and demeanor congruity as predictors of robot attraction and use intentions among senior citizens. *International Journal of Human-Computer Studies, 97*, 88-97.

Süßenbach, F., & Schönbrodt, F. (2014). Not afraid to trust you: trustworthiness moderates gaze cueing but not in highly anxious participants. *Journal of Cognitive Psychology*, *26*(6), 670-678.

Synofzik, M., Vosgerau, G., & Newen, A. (2008). Beyond the Comparator Model: A Multifactorial Two-Step Account of Agency. *Consciousness and Cognition*, 219-239.

Syrdal, D. S., Dautenhahn, K., Walters, M. L., & Koay, K. L. (2008). Sharing Spaces with Robots in a Home Scenario - Anthropomorphic Attributions and their Effect on Proxemic Expectations and Evaluations in a Live HRI Trial. *AAAI fall Sympossium: AI in Eldercare: new solutions to old problems*, 116-123.

Szafir, D., & Mutlu, B. (2012, May). Pay Attention! Designing Adaptive Agents that Monitor and Improve User Engagement. *Proceedings of the SIGCHI conference on human factors in computing systems*, 11-20.

Tahiroglu, D., & Taylor, M. (2018, November 20). Anthropomorphism, social understanding, and imaginary companions. *British Journal of Developmental Psychology*.

Tam, K.-P. (2015). Are Anthropomorphic Persuasive Appeals Effective? The Role of the Recipient's Motivations. *British Journal of Social Psychology*, *54*(1), 187-200.

Taylor, S., & Todd, P. A. (1995). Understanding Information Technology Usage: A Test of Competing Models. *Information Systems Research*, 144-176.

Timpano, K. R., & Shaw, A. M. (2013). Conferring Humanness: The Role of Anthropomorphism in Hoarding. *Personality and Individual Differences, 54*(3), 383-388.

Tipples, J. (2006). Fear and fearfulness potentiate automatic orienting to eye gaze. *Cognition & Emotion*, *20*(2), 309-320.

Traeger, M. L., Sebo, S. S., Jung, M., Scassellati, B., & Christakis, N. A. (2020). Vulnerable robots positively shape human conversational dynamics in a human-robot team. *Proceedings of the National Academy of Sciences*, *117*, pp. 6370-6375.

Turing, A. (1950). Computing Machinery and Intelligence. *Mind, 59*(236), 433-460.

Turkle, S. (1984). *The Second Self: Computers and the Human Spirit.* Cambridge, Massachusetts: The MIT Press.

Tussyadiah, I. (2013). When cell phones become travel buddies: Social attribution to mobile phones in travel. In L. Cantoni, & Z. Xiang, *Information and communication technologies in tourism* (pp. 82-93). Heidelberg, Germany: Springer.

Tussyadiah, I. (2013). When cell phones become travel buddies: Social attribution to mobile phones in travel. *Information and Communicatino Technologies in Tourism*, 82-93. doi:http://dx.doi.org/10.1007/978-3-642-36309-2_8

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, *211*(4481), 453-458.

Uddin, L. (2016). *Salience Network of the Human Brain.* Academic Press.

Urquiza-Haas, E. G., & Kotrschal, K. (2015). The mind behind anthropomorphic thinking: attribution of mental states to other species. *Animal Behaviour*, 167-176.

Vincent, J. (2006). Emotional Attachment and Mobile Phones. *Knowledge, Technology & Policy, 19*(1), 39-44.

Visser, E. J., Monfort, S. S., Goodyear, K., Lu, L., O'Hara, M., Lee, M. R., . . . Krueger, F. (2017). A little anthropomorphism goes a long way: Effects of oxytocin on trust, compliance, and team performance with automated agents. *Human Factors, 59*(1), 116-133.

Visser, E. J., Monfort, S. S., Goodyear, K., Lu, L., O'Hara, M., Lee, M. R., . . . Krueger, F. (2017). De Visser, Ewart J., et al. "A little anthropomorphism goes a long way: Effects of oxytocin on trust, compliance, and team performance with automated agents. *Human Factors, 59*(1), 116-133.

Voelcker-Rehage, C., Niemann, C., Hübner, L., Godde, B., & H.Winneke, A. (2016). Benefits of Physical Activity and Fitness for Lifelong Cognitive and Motor Development—Brain and Behavior. In M. Raab, P. Wylleman, R. Seiler, A.-M. Elbe, & A. Hatzigeorgiadis, *Sport and Exercise Psychology Research: From Theory to Practice* (pp. 43-73). Elsevier.

Vollmer, A.-L., Read, R., Trippas, D., & Belpaeme, T. (2018). Children conform, adults resist: A robot group induced peer pressure on normative social conformity. *Science Robotics, 3*(21).

von der Pütten, A. M., Krämera, N. C., Gratch, J., & Kang, S.-H. (2010). "It doesn't matter what you are!" explaining social effects of agents and avatars. *Computers in Human Behavior, 26*(6), 1641-1650.

von Zitzewitz, J., Boesch, P., Wolf, P., & Riener, R. (2013). Quantifying the Human Likeness of a Humanoid Robot. *International Journal of Social Robotics, 5*(2), 263-276.

Vossel, S., Geng, J. J., & Fink, G. R. (2014). Dorsal and Ventral Attention Systems: Distinct Neural Circuits but Collaborative Roles. *The Neuroscientist*, 150-159.

Walters, M., Syrdal, D., Dautenhahn, K., & Te Boekhorst, R. (2009). Preferences and perceptions of robot appearance and embodiment in human-robot interaction trials. *Adaptive and emergent bejaviour and complex systems-proceedings of the 23rd Convention of the society for the study of artificial intelligence and simulation of behaiour* (pp. 136-143). Edinburgh: AISB.

Wang, E., Lignos, C., Vatsal, A., & Scassellati, B. (2006, March). Effects of head movement on perceptions of humanoid robot behavior. *Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-Robot Interaction*, 180-185.

Wang, W. (2015). *Social Disposition and Anthropomorphism of Smartphones.* Doctoral dissertation. Retrieved from https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/19285/Wang_oregon_0171N_11301.pdf?sequence=1&isAllowed=y

Wang, W. (2017). Smartphones as Social Actors? Social Dispositional Factors in Assessing Anthropomorphism. *Computers in Human Behavior, 68*, 334-344.

Watt, D. F. (2005). Social Bonds and the Nature of Empathy. *Journal of Consciousness Studies, 12*(8-9), 185-209.

Waytz, A., & Epley, N. (2012). Social connection enables dehumanization. *Journal of Experimental Social Psychology, 48*(1), 70-76.

Waytz, A., Cacioppo, J., & Epley, N. (2010). Who Sees Human? The Stability and Importance of Individual Differences in Anthropomorphism. *Psychological Science, 5*(3), 219-232.

Waytz, A., Cacioppo, J., Hurlemann, R., & Castelli, F. (2019). Anthropomorphizing Without Social Cues Requires the Basolateral Amygdala. *Journal of Cognitive Neuroscience, 31*(4), 482-496.

Waytz, A., Epley, N., & Cacioppo, J. T. (2010). Social cognition unbound: Insights into anthropomorphism and dehumanization. *Current Directions in Psychological Science, 19*(1), 58-62.

Waytz, A., Gray, K., Epley, N., & Wegner, D. M. (2010). Causes and Consequences of Mind Perception. *Trends in Cognitive Sciences, 14*(8), 383-388.

Waytz, A., Klein, N., & Epley, N. (2013, April 2). Imagining Other Minds: Anthropomorphism Is Hair-Triggered but Not Hare- Brained. *The Oxford handbook of the development of imagination*, p. 272.

Waytz, A., Morewedge, C. K., Epley, N., Monteleone, G., Gao, J. H., & Cacioppo, J. T. (2010). Making sense by making sentient: effectance motivation increases anthropomorphism. *Journal of personality and social psychology, 99*(3), 410.

Weber, M., Thompson-Schill, S. L., Osherson, D., Haxby, J., & Parsons, L. (2009). Predicting Judged Similarity of Natural Categories from Their Neural Representations. *Neuropsychologia, 47*(3), 859-868.

Wegner, D. M. (2002). *The Illusion of Conscious Will.* Cambridge, MA: MIT Press.

Wegner, D. M., & Gray, K. (2017). *The mind club: Who thinks, what feels, and why it matters.* Penguin.

Wegner, D. M., & Wheatley, T. P. (1999). Apparent Mental Causation: Sources of the Experience of Will. *American Psychologist, 54*(7), 480-92.

Wegner, D., & Gray, K. (2016). *The Mind Club: Who Thinks, What Feels, and Why It Matters.* Penguin Group (USA) LLC.

Weick, K. E. (1995). *Sensemaking in organizations* (Vol. 3). Sage.

Welder, A. N., & Graham, S. A. (2001). The Influence of Shape Similarity About Nonobvious Object Properties. *Child Development, 72*(6), 1653-1673.

Wen, W., Kuroki, Y., & Asama, H. (2019). The Sense of Agency in Driving Automation. *Frontiers in Psychology, 10*.

Wicker, B., Keysers, C., Plailly, J., Royet, J. P., Gallese, V., & Rizzolatti, G. (2003). Both of us disgusted in my insula: The common neural basis of seeing and feeling disgust. *Neuron*, 655-664.

Wiese, E., Shaw, T., Lofaro, D., & Baldwin, C. (2017). Designing Artificial Agents as Social Companions. *Proceedings of the Human Factors and Ergonomics Society. 61*. Los Angeles, CA: Sage Publications.

Wiese, E., Wykowska, A., & Müller, J. (2014). What we obsere is biased by what other people tell us: Beliefs about the reliability of gaze behavior modulate attentional orienting to gaze cues. *PloS ONE, 9*(4).

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, 103-128.

Winograd, T., & Flores, F. (1987). *Understanding Computers and Cognition: A New Foundation for Design.* Reading, MA: Addison-Wesley.

Wohlschläger, A., Haggard, P., Gesierich, B., & Prinz, W. (2003). The perceived onset of time of self and other generated actions. *Psychological Science, 14*(6), 586-591.

Woods, S., Dautenhahn, K., & Kaouri, C. (2005). Is someone watching me? - consideration of social facilitation effects in human-robot interaction experiments. *CIRA 2005, IEEE International Symposium on computational Intelligence in Robotics and Automation,* (pp. 53-60).

Wu, J., & Kraemer, P. (2017). Positive Preferences: The Emotional Valence of What an Avatar Says Matters. *Cyberpsychology, Behavior, and Social Networking, 20*(1), 17-21.

Xu, K. (2018). Action Speaks Louder than Words: Users’ Social Responses to Robots’ Movements and Voices. *Proceedings of the 18th conference of the International Society for Preence Research (ISPR).*

Xu, K., & Lombard, M. (2016). Media are social actors: expanding the CASA paradigm in the 21st Century. *Annual Conference of the International Communication Association.*

Xu, K., & Lombard, M. (2017). Persuasive computing: Feeling peer pressure from multiple computer agents. *Computers in Human Behavior, 74*, 152-162.

Yogeeswaran, K., & Dasgupta, N. (2014). The Devil is in the Details - Abstract Versus Concrete Construals of Multiculturalism Differentially Impact Intergroup Relations. *Journal of Personality and Social Psychology, 106*(5), 772.

You, S., & Robert Jr., L. P. (2018). Emotional Attachment, Performance, and Viability in Teams Collaborating with Embodied Physical Action (EPA) Robots. *Journal of the Association for Information Systems, 19*(5), 377-407.

Yu, C.-E., & Ngan, H. F. (2019). The power of head tilts: gender and cultural differences of perceived human vs human-like robot smile in service. *Tourism Review*.

Zaki, J., & Ochsner, K. N. (2012). The neuroscience of empathy: Progress, pitfalls and promise. *Nature, 15*(5), 675-680.

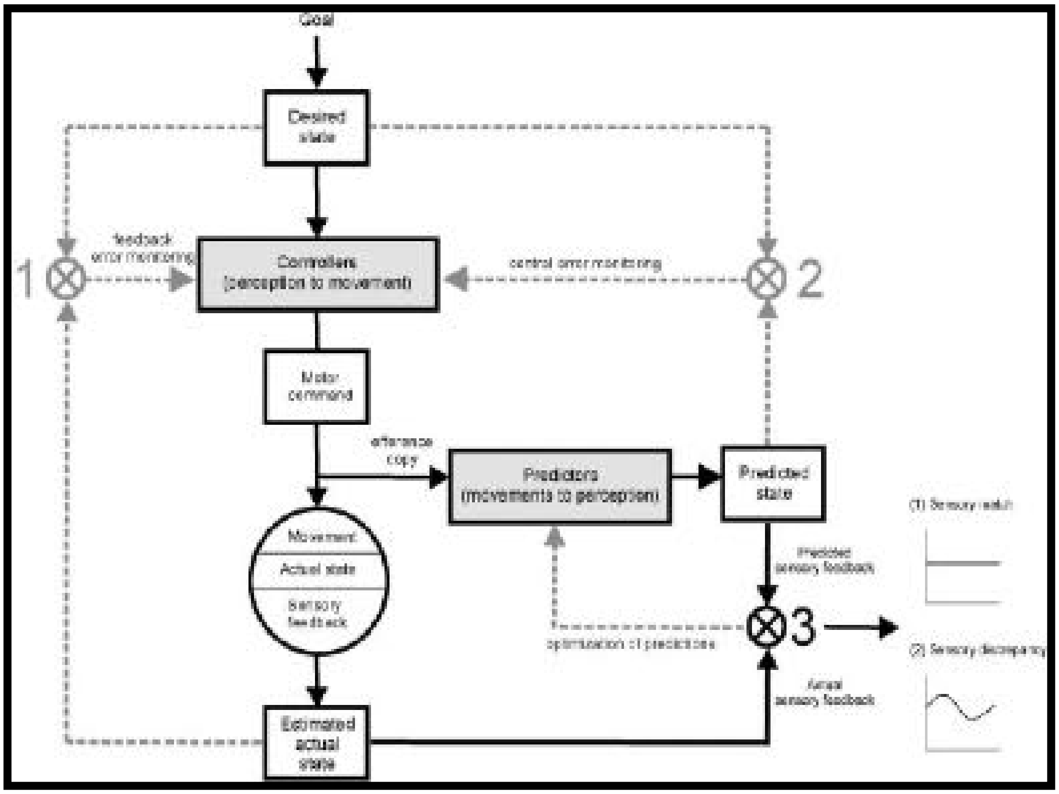
Zlotowski, J. (2015). Understanding Anthropomorphismm in the Interaction Between Users and Robots. *University of Canterbury*.

Zlotowski, J., Proudfoot, D., Yogeeswaran, K., & Bartneck, C. (2015). Anthropomorphism: Opportunities and Challenges in Human-Robot Interaction. *International Journal of Social Robotics*, 347-360.

Zlotowski, J., Stasser, E., & Bartneck, C. (2014). Dimensions of anthropomorphism: from humanness to humanlikeness. *Proceedings of the 2014 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 66-73). ACM.

Zlotwski, J., Sumioka, H., Bartneck, C., Nishio, S., & Ishiguro, H. (2017). Understanding anthropomorphism: Anthropomorphism is not a reverse process of dehumanization. *International Conference on Social Robotics* (pp. 618-627). Springer, Cham.

Figure 23 Comparator Model of Motor Control as defined by Synofzik, Vosgerau, & Newen (2008).



1. The hybrid model of Perception of Agency

Figure 24 The Hybrid model of Agency Perception as presented by Moore in (Moore J. W., 2016).

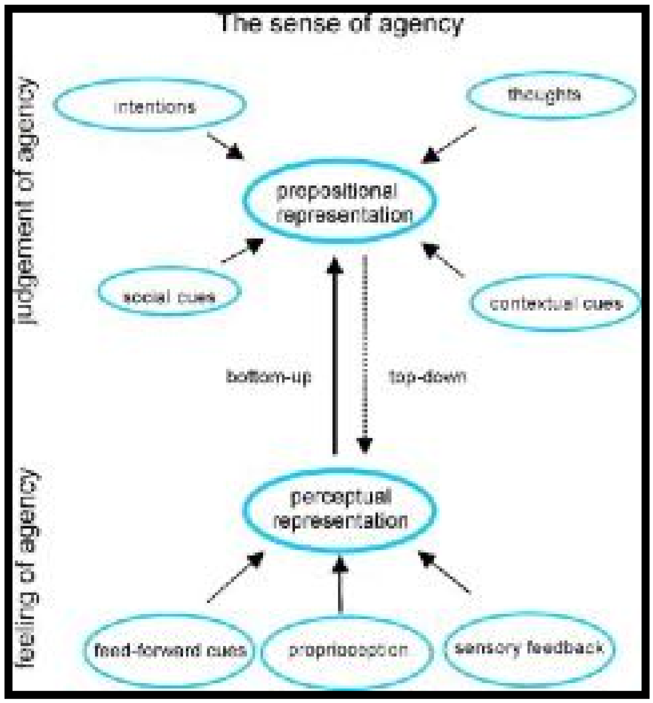


Figure 25 Model of Theory of Mind presented by Yoshida and Colleagues (Yoshida, Seymour, Friston, & Dolan, 2010).

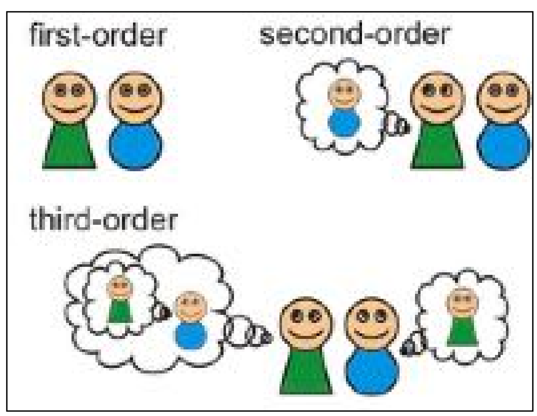
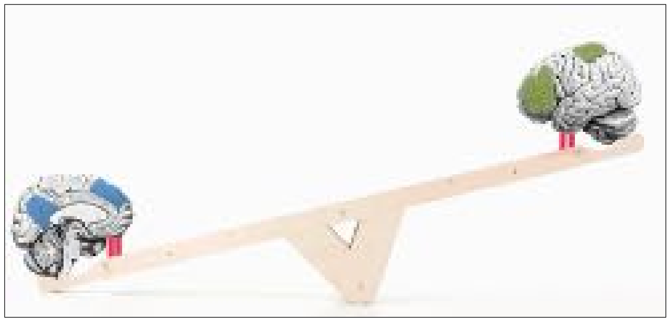


Figure 26 Social and analytical cognition operating at odds with each other as if on a see-saw *(Lieberman M. D., 2013)*.



2. Components of Theory of Mind (TOM)

Figure 27 Model detailing the components of Theory of Mind as presented by Gage, & Baars *(2018)*.

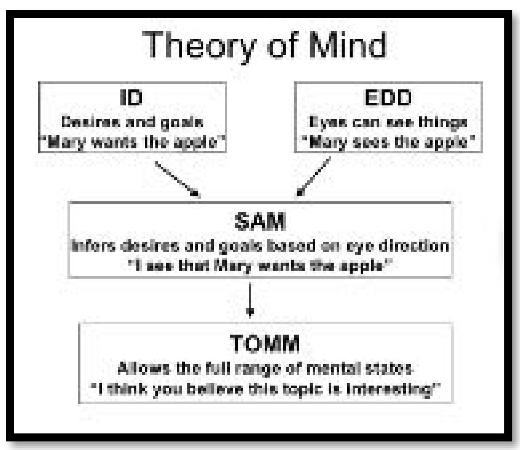


Table 17 Hypotheses referenced throughout the document.

Hypothesis ID	IV	Mediator	Moderator	DV	Result	Paper
1	Presence/Absence	-	-	Mindful Anthropomorphism	**Significant**. Participants exposed to virtual agent (human-like) reported lesser degree of mindful anthropomorphism;	(Kim & Sundar, 2012)
2	Presence/Absence	-	-	Mindless Anthropomorphism	**Inconclusive. "Marginally Significant**" aka support at 0.1 level rather than 0.05;	(Kim & Sundar, 2012)
3	Presence/Absence	-	-	Social Presence	****Significant**. Direction was tested so consider as exploratory rather than confirmatory. Exposure to humanlike character led to a lesser reported degree of social presence;	(Kim & Sundar, 2012)
4	Presence/Absence	-	-	Information Credibility Judgement	**Not Supported;**	(Kim & Sundar, 2012)
5	Presence/Absence	Social Presence	-	Information Credibility Judgement	**Not Supported;**	(Kim & Sundar, 2012)

6	Interactivity	-	-	Mindful Anthropomorphism	**Not Supported;**	(Kim & Sundar, 2012)
7	Interactivity	-	-	Mindless Anthropomorphism	**Significant.** Higher Interactivity led to higher mindless anthropomorphism**;**	(Kim & Sundar, 2012)
8	Interactivity	-	-	Social Presence	**Inconclusive.** Direction was tested so consider as exploratory rather than confirmatory. Hypothesized: Higher Interactivity led to a lesser reported degree of social presence; Result: NO MAIN EFFECT, SIGNIFICANT INTERACTION WAS FOUND & POST HOC ANALYSIS SHOWS PARTICIPANTS NOT EXPOSED TO THE CHARACTER BUT WERE IN HIGH INTERACTIVITY REVEALED SIGNIFICANTLY GREATER LEVELS OF SOCIAL	(Kim & Sundar, 2012)

					PRESENCE COMPARED TO NO-CHARACTER AND LOW INTERACTIVITY GROUP AS WELL AS THE CHARACTER, HIGH INTERACTIVITY GROUP;	
9	Interactivity	-	-	Information Credibility Judgement	**Significant.** Higher Interactivity led to higher Information Credibility;	(Kim & Sundar, 2012)
10	Interactivity	Social Presence	-	Information Credibility Judgement	**Not Supported;**	(Kim & Sundar, 2012)
11	Framing	-	-	Mindful Anthropomorphism	**Inconclusive.** No significant main effects. Significant effects for some categories;	(Araujo, 2018)
12	Framing	-	-	Mindless Anthropomorphism	**Inconclusive.** No significant main effects. Significant effects for some categories;	(Araujo, 2018)
13	Framing	-	-	Social Presence	**Inconclusive.** No significant main effects. Significant effects for some categories;	(Araujo, 2018)

14	Framing	Mindful Anthropomorphism	-	Attitudes Toward Company	**Not Supported;**	(Araujo, 2018)
15	Framing	Mindful Anthropomorphism	-	Customer Satisfaction	**Not Supported;**	(Araujo, 2018)
16	Framing	Mindful Anthropomorphism	-	Emotional Connection with Company	**Not Supported;**	(Araujo, 2018)
17	Framing	Mindless Anthropomorphism	-	Attitudes Toward Company	**Not Supported;**	(Araujo, 2018)
18	Framing	Mindless Anthropomorphism	-	Customer Satisfaction	**Not Supported;**	(Araujo, 2018)
19	Framing	Mindless Anthropomorphism	-	Emotional Connection with Company	**Not Supported;**	(Araujo, 2018)
20	Framing	Social Presence	-	Attitudes Toward Company	**Not Supported;**	(Araujo, 2018)
21	Framing	Social Presence	-	Customer Satisfaction	**Not Supported;**	(Araujo, 2018)
22	Framing	Social Presence	-	Emotional Connection with Company	**Not Supported;**	(Araujo, 2018)
23	Anthropomorphic Cues	-	-	Mindful Anthropomorphism	**Significant**. More anthropomorphic cues led to higher (mindless)	(Araujo, 2018)

	[Language Style, Name]				perceived anthropomorphism;	
24	Anthropomorphic Cues [Language Style, Name]	-	-	Mindless Anthropomorphism	**Significant**. More anthropomorphic cues led to higher (mindful) reported anthropomorphism;	(Araujo, 2018)
25	Anthropomorphic Cues [Language Style, Name]	-	-	Social Presence	**Not Supported;**	(Araujo, 2018)
26	Anthropomorphic Cues [Language Style, Name]	Mindful Anthropomorphism	-	Attitudes Toward Company	**Not Supported;**	(Araujo, 2018)
27	Anthropomorphic Cues [Language Style, Name]	Mindful Anthropomorphism	-	Customer Satisfaction	**Not Supported;**	(Araujo, 2018)
28	Anthropomorphic Cues [Language Style, Name]	Mindful Anthropomorphism	-	Emotional Connection with Company	**Not Supported;**	(Araujo, 2018)
29	Anthropomorphic Cues [Language Style, Name]	Mindless Anthropomorphism	-	Attitudes Toward Company	**Not Supported;**	(Araujo, 2018)

30	Anthropomorphic Cues [Language Style, Name]	Mindless Anthropomorphism	-	Customer Satisfaction	**Not Supported;**	(Araujo, 2018)
31	Anthropomorphic Cues [Language Style, Name]	Mindless Anthropomorphism	-	Emotional Connection with Company	**Not Supported;**	(Araujo, 2018)
32	Anthropomorphic Cues [Language Style, Name]	Social Presence	-	Attitudes Toward Company	**Not Supported;**	(Araujo, 2018)
33	Anthropomorphic Cues [Language Style, Name]	Social Presence	-	Customer Satisfaction	**Not Supported;**	(Araujo, 2018)
34	Anthropomorphic Cues [Language Style, Name]	Social Presence	-	Emotional Connection with Company	*****Supported. Shouldn't be supported** even though the authors claim it is as Anthropomorphic cues didn't have a significant effect over social presence [**THIS IS AN ERROR**]. Reported Anthropomorphic Cues affecting emotional connection through social presence;	(Araujo, 2018)

35	Social Presence	-	-	Attitudes Toward Company	**Not Supported;**	(Araujo, 2018)
36	Social Presence	-	-	Customer Satisfaction	**Not Supported;**	(Araujo, 2018)
37	Social Presence	-	-	Emotional Connection with Company	**Significant direct effects. Higher social presence led to higher emotional connection with the company;**	(Araujo, 2018)
38	Anthropomorphic Visual Cue [Picture of Person]	-	-	Social Presence	**Not Supported;**	(Go & Sundar, 2019)
39	Anthropomorphic Visual Cue [Picture of Person]	-	-	Perceived Homophily	**Not Supported;**	(Go & Sundar, 2019)
40	Anthropomorphic Visual Cue [Picture of Person]	Social Presence	-	Attitudes	**Not Supported;**	(Go & Sundar, 2019)
41	Anthropomorphic Visual Cue [Picture of Person]	Social Presence	-	Behavioral Intention to Return to Website	**Not Supported;**	(Go & Sundar, 2019)
42	Anthropomorphic Visual Cue	Perceived Homophily	-	Attitudes	**Not Supported;**	(Go & Sundar, 2019)

	[Picture of Person]					
43	Anthropomorphic Visual Cue [Picture of Person]	Perceived Homophily	-	Behavioral Intention to Return to Website	**Not Supported;**	(Go & Sundar, 2019)
44	Identity Cues	-	-	Social Presence	**Not Supported;**	(Go & Sundar, 2019)
45	Identity Cues	-	-	Perceived Homophily	**Not Supported;**	(Go & Sundar, 2019)
46	Identity Cues	Social Presence	-	Attitudes	**Not Supported;**	(Go & Sundar, 2019)
47	Identity Cues	Social Presence	-	Behavioral Intention to Return to Website	**Not Supported;**	(Go & Sundar, 2019)
48	Identity Cues	Perceived Homophily	-	Attitudes	**Not Supported;**	(Go & Sundar, 2019)
49	Identity Cues	Perceived Homophily	-	Behavioral Intention to Return to Website	**Not Supported;**	(Go & Sundar, 2019)
50	Interactivity	-	-	Social Presence	**Significant.** Higher Interactivity led to higher social presence;	(Go & Sundar, 2019)

51	Interactivity	-	-	Perceived Homophily	**Significant.** Higher Interactivity led to greater perceptions of homophily;	(Go & Sundar, 2019)
52	Interactivity	-	-	Perceived Contingency	**Significant.** Higher Interactivity led to greater perceived contingency;	(Go & Sundar, 2019)
53	Interactivity	-	-	Perceived Dialogue	**Significant.** Higher Interactivity led to greater perceived dialogue;	(Go & Sundar, 2019)
54	Interactivity	Social Presence	-	Attitudes	**Significant.** Higher Interactivity led to better attitudes towards website through social presence;	(Go & Sundar, 2019)
55	Interactivity	Social Presence	-	Behavioral Intention to Return to Website	**Significant.** Higher Interactivity led to higher behavioral intention through social presence;	(Go & Sundar, 2019)
56	Interactivity	Perceived Homophily	-	Attitudes	**Significant.** Higher Interactivity led to better attitudes towards website through perceived homophily;	(Go & Sundar, 2019)

57	Interactivity	Perceived Homophily	-	Behavioral Intention to Return to Website	**Significant.** Higher Interactivity led to higher behavioral intention through perceived homophily;	(Go & Sundar, 2019)
58	Interactivity	Perceived Contingency	-	Attitudes	**Not Supported;**	(Go & Sundar, 2019)
59	Interactivity	Perceived Contingency	-	behavioral Intention to Return to Website	**Not Supported;**	(Go & Sundar, 2019)
60	Interactivity	Perceived Dialogue	-	Attitudes	**Significant.** Higher Interactivity led to better attitudes towards website through perceived Dialogue;	(Go & Sundar, 2019)
61	Interactivity	Perceived Dialogue	-	behavioral Intention to Return to Website	**Significant.** Higher Interactivity led to higher behavioral intention through perceived Dialogue;	(Go & Sundar, 2019)
62	Emotional Priming	-	-	activation in Mirror Neuron (social perception)	**Significant.** The more aggressive the situation, and the more compassion felt towards the robot, the more activity in the Mirror	(Hoenen, Lübke, & Pause, 2016)

					Neuron System increased;	
63	Visual Anthropomorphic Cues	-	-	Social Perception	**Not Supported;**	(Sah & Peng, 2015)
64	Linguistic Anthropomorphic Cues	-	-	Social Perception	**Significant.** Personal Linguistic style induced higher social perception than impersonal linguistic style;	(Sah & Peng, 2015)
65	Visual Anthropomorphic Cues	-	-	Public Self-awareness	**Significant.** Visual anthropomorphic cues increased public self-awareness compared to non-anthropomorphic visual cues;	(Sah & Peng, 2015)
66	Linguistic Anthropomorphic Cues	-	-	Public Self-awareness	**Not Supported;**	(Sah & Peng, 2015)
67	Linguistic Anthropomorphic Cues	-	-	Private Self-awareness	**Not Supported;**	(Sah & Peng, 2015)
68	Visual Anthropomorphic Cues	-	-	Private Self-awareness	****Opposite Direction.** Contrary to what was expected, Visual Anthropomorphic Cues induced higher private self-awareness than non-	(Sah & Peng, 2015)

					anthropomorphic visual cues;	
69	Visual Anthropomorphic Cues	-	-	Information Disclosure	**Not Supported;**	(Sah & Peng, 2015)
70	Visual Anthropomorphic Cues	-	Question Type	Information Disclosure	**Not Supported;**	(Sah & Peng, 2015)
71	Linguistic Anthropomorphic Cues	-	Question Type	Information Disclosure	**Not Supported;**	(Sah & Peng, 2015)
72	Public Self-awareness	-	-	Information Disclosure	**Significant**. Increases in public self-awareness led to more questions the participants refused to answer;	(Sah & Peng, 2015)
73	Private Self-awareness	-	-	Information Disclosure	**Signiicant**. The more the particiapnts felt private self-awareness, the more they disclosed;	(Sah & Peng, 2015)
74	Visual Anthropomorphic Cues	Private Self-awareness	-	Information Disclosure	****[was not a priori hypothesis] Not Supported;**	(Sah & Peng, 2015)
75	Visual Anthropomorphic Cues	Public Self-awareness	-	Information Disclosure	****[was not a priori hypothesis] Significant.** Visual anthropomorphic cues caused an increased in public self-awareness	(Sah & Peng, 2015)

					that in turn caused a decline in disclosure;	
76	Handheld Device Viewing (opposed to Non-handheld Device Viewing)	-	-	Explicit Assessment of Personhood	**Significant.** Argues for Lower Explicit Assessment of Personhood for the Profiled Person;	(Banks, Westerman , & Sharabi, 2017)
77	Handheld Device Viewing (opposed to Non-handheld Device Viewing)	-	-	Implicit Assessment of Personhood	**Significant.** Argues for Lower Implicit Assessment of Personhood for the Profiled Person;	(Banks, Westerman , & Sharabi, 2017)
78	Handheld Device Viewing (opposed to Non-handheld Device Viewing)	-	-	Psychological Ownership	**Partial Support.** Positively associated with dimensions of psychological ownership over the profile person; Partial support because the elements of psychological ownership were measured independently. Specifcally, Holding the	(Banks, Westerman , & Sharabi, 2017)

					device in hand reduces belonging and self-efficacy dimensions of psychological ownership, while territoriality, accountability, and self-identity were not affected;	
79	Head posture	-	-	Perceived Human likeness	**Significant.** Head tilts increased the attributed human-likeness of the robot;	(Mara & Appel, 2015)
80	Head posture	-	-	Dominance	**Not Supported;**	(Mara & Appel, 2015)
81	Head posture	-	-	Attractiveness	**Not Supported;**	(Mara & Appel, 2015)
82	Head posture	-	-	Interpersonal Warmth	**Not Supported.** Though results for the telenoid robot alone were significant suggesting that the specific appearance of the robot was playing some effect here**;**	(Mara & Appel, 2015)

83	Head posture	-	-	Cuteness	**Significant.** Robots with head tilted were rated as cuter;	(Mara & Appel, 2015)
84	Behavioral Realism	-	-	Psychological Copresence	**Not Supported;**	(Kang & Watt, 2013)
85	Behavioral Realism	-	-	Social Richness of Medium	**Significant.** Higher behavioral realism of avatar will create greater social richness of the medium;	(Kang & Watt, 2013)
86	Behavioral Realism	-	-	Interactant Satisfaction with Communication	**Not Supported;**	(Kang & Watt, 2013)
87	Higher Fidelity (Visual Realism)	-	-	Psychological Copresence	**Not Supported;**	(Kang & Watt, 2013)
88	Higher Fidelity (Visual Realism)	-	-	Social Richness of Medium	**Significant.** Higher fidelity avatars (quality of avatar image) lead to greater reports of social richness of the medium;	(Kang & Watt, 2013)
89	Higher Fidelity (Visual Realism)	-	-	Interactant Satisfaction with	**Not Supported;**	(Kang & Watt, 2013)

				Communication		
90	Anthropomorphism of Avatar (Visual Realism)	-	-	Psychological Copresence	**Significant.** More anthropomorphic avatars led to greater psychological copresence;	(Kang & Watt, 2013)
91	Anthropomorphism of Avatar (Visual Realism)	-	-	Social Richness of Medium	**Not Supported;**	(Kang & Watt, 2013)
92	Anthropomorphism of Avatar (Visual Realism)	-	-	Interactant Satisfaction with Communication	**Significant. More anthropomorphic avatars led to greater Satisfaction with Communication;**	(Kang & Watt, 2013)
93	Anonymity of Avatars (Visual Realism)	-	-	Psychological Copresence	**Significant.** Non-anonymous avatars led to greater reports of psychological copresence;	(Kang & Watt, 2013)
94	Anonymity of Avatars (Visual Realism)	-	-	Social Richness of Medium	**Significant.** Non-anonymous avatars led to greater reports of Social Richness of the Media;	(Kang & Watt, 2013)
95	Anonymity of Avatars	-	-	Interactant Satisfaction with	**Significant.** Non-anonymous avatars led to greater reports of	(Kang & Watt, 2013)

	(Visual Realism)			Communication	Satisfaction with Interaction;	
96	Presence of Avatar (Visual Realism)	-	-	Psychological Copresence	**Partial Support.** The effect of the avatar presence varied depending of the avatar characteristics and could be positive, negative or null;	(Kang & Watt, 2013)
97	Presence of Avatar (Visual Realism)	-	-	Social Richness of Medium	**Partial Support.** The effect of the avatar presence varied depending of the avatar characteristics and could be positive, negative or null;	(Kang & Watt, 2013)
98	Presence of Avatar (Visual Realism)	-	-	Interactant Satisfaction with Communication	**Partial Support.** The effect of the avatar presence varied depending of the avatar characteristics and could be positive, negative or null;	(Kang & Watt, 2013)
99	**Actual Partner's Behaviour**, **Perception of Partner**;	-	-	Participant's Strategy Selection Behavior	****Significant.** Participants are influenced to a greater degree by the representation of the partner (perceived	(Miwa & Terai, 2012)

					Partner) than by the partner's actual behavior; **[How do we graph or write this? Also, it conflicts with the 2nd Hypothesis meaning that they cannot be considered confirmatory, instead consider exploratory]**	
100	**Actual Partner's Behaviour**, **Perception of Partner**;	-	-	Participant's Strategy Selection Behavior	**** Not Supported.** Participants were not influenced to a greater degree by the behavior of the partner rather than the perception;	(Miwa & Terai, 2012)
101	**Actual Partner's Behaviour**, **Perception of Partner**;	-	-	Participant's Strategy Selection Behavior	**** Not Supported.** Didn't find support to the hypothesis that the influence of one aspect of the partner (actual behavior and perception of partner) varied depending on the other;	(Miwa & Terai, 2012)
102	**Actual Partner's Behaviour**, **Perception of Partner**;	-	-	Impressions about the partner (Social Desirability,	**** Not Supported.** No support for the hypothesis (H4) that participants will be influenced to a greater	(Miwa & Terai, 2012)

				Individual Likeability)	degree by the representation of the partner than by the actual behavior;	
103	**Actual Partner's Behaviour**, **Perception of Partner**;	-	-	Impressions about the partner (Social Desirability, Individual Likeability)	**** Partial Support.** (H5) Participants' likeability of the partner was significantly affected by the partner's actual behavior. No support was found for the social desaribility however;	(Miwa & Terai, 2012)
104	**Participant's Strategy Selection Behavior**	-	-	Impressions about the partner (Social Desirability, Individual Likeability)	**** Partial Support.** (H6) Participants' social desirability of the partner was significantly affected by the partner's participant's own behavior. No support was found for the likeability however;	(Miwa & Terai, 2012)
105	Agent Type	-	-	Social Perception	**Not Supported.** No support for most dependent variables. Only one main effect found: artificial agent experience more negative feelings with	(von der Pütten, Krämera, Gratch, & Kang, 2010)

					Low-Dominance than Avatar (equivalent to more social presence on Artificial Agent than Avatar which is contrary to hypothesis)**;**	
106	Behavioral Realism	-	-	Social Perception	**Significant.** Specifically in the forms of a change in the person perception (higher negative low-dominance), and increase in feelings of social presence (mutual awareness), and an increase in use of words during the interaction; **[NO EFFECTS WERE FOUND FOR SELF-DISCLOSURE OF INFORMATION]**	(von der Pütten, Krämera, Gratch, & Kang, 2010)
107	Behavioral Realism	-	-	Agent Type	****[representation is probably incorrect] Not Supported;** No Interaction was found between agency and behavioral realism;	(von der Pütten, Krämera, Gratch, & Kang, 2010)
108	Anthropomorphic Appearance	-	-	Positive Social Judgement	**Significant.** The more anthropomorphic a computer representation,	(Gong, 2008)

					the more positive the social judgement it receives;	
109	Anthropomorphic Appearance	-	-	Homophily (group perception)	**Significant.** The more anthropomorphic a computer representation, the greater homophily it generated;	(Gong, 2008)
110	Anthropomorphic Appearance	-	-	Social Influence	**Significant.** The more anthropomorphic a computer representation, the higher the social influence it generated;	(Gong, 2008)
111	Anthropomorphic Appearance	-	-	Competence	****[significant for most levels, except it dropped slightly for medium and high anthropomorphic levels] Significant.** The more anthropomorphic a computer representation, the more competence participants perceived;	(Gong, 2008)
112	Anthropomorphic Appearance	-	-	Trustworthiness	**Significant.** The more anthropomorphic a computer representation, the more thrust worthy it was perceived;	(Gong, 2008)

113	Anthropomorphic Appearance (of Avatar representing Participant)	-	-	Credibility (of Avatar)	**Significant.** The more anthropomorphic the appearance of the Avatar the more credible it was deemed;	(Nowak & Rauh, 2008)
114	Androgyny (of Avatar representing Participant)	-	-	Credibility (of Avatar)	**Not Supported.** No direct link between Androgyny (middle between appearing male and female) and credibility;	(Nowak & Rauh, 2008)
115	Androgyny (of Avatar representing Participant)	-	-	Credibility (of Avatar)	**Sinificant.** People that are perceived as more androgynous are also perceived as less credible;	(Nowak & Rauh, 2008)
116	Androgyny (of Avatar representing Participant)	-	-	Anthropomorphic Perception (of Avatar)	**Significant. The m**ore androgynous an avatar is, the less anthropomorphic it is perceived;	(Nowak & Rauh, 2008)
117	Use of Instant Messaging	-	-	Computer Efficacy	**Significant.** Users who use more Instant Messaging, feel more computer efficacy;	(Nowak & Rauh, 2008)
118	Computer Efficacy (of User)	-	-	Anthropomorphic Perception (of Avatar)	**Not Supported**. Computer Efficacy had no effect on	(Nowak & Rauh, 2008)

					anthropomorphic perception of Avatar;	
119	Computer Efficacy (of User)	-	-	Androgyny (of Avatar)	**Not Supported**. Computer Efficacy had no effect on Androgyny perception of Avatar;	(Nowak & Rauh, 2008)
120	Androgyny (of Avatar representing Participant)	-	-	Androgyny Perception of Participant	**Significant.** Participants represented by Androgynous avatars were perceived as being more androgynous than participants represented by less androgynous avatars;	(Nowak & Rauh, 2008)
121	Credibility (of Avatar representing Participant)	-	-	Credibility (of Participant)	**Significant.** Participants represented by more credible avatarswere perceived as being less credible than participants represented by less credible avatars;	(Nowak & Rauh, 2008)
122	----	----	-----	-----	SIGNIFICANT EFFECTS FOUND BETWEEN ANTHRO AND TRUST, COMPLIANCE, AND TEAM PERFORMANCE; REVIEW ARTICLE	(de Visser, et al., 2017)

					AGAIN TO SPECIFY HYPOTHESES;	
123	----	----	-----	-----	Intrument Development on Moral Agency;	(Banks, 2019)
124	Mind Perception	-	-	Co-Presence (Social Presence)	**Significant**. Increases in perception of mind led to increases in perception of co-presence;	(Lee, Lee, & Sah, 2019)
125	Mind Perception	-	-	Closeness	Significant. Mind Perception within a chatbot leads to greater experience of closeness;	(Lee, Lee, & Sah, 2019)
126	Mind Perception	-	-	Intention to Use	Significant. Mind Perception lead to increased intention to use;	(Lee, Lee, & Sah, 2019)
127	Mind Perception	Co-Presence (Social Presence)	-	Intention to Use	**Not Supported;**	(Lee, Lee, & Sah, 2019)
128	Mind Perception	Closeness	-	Intention to Use	Partial Support. All paths were supported except that the effect was contingent on back-channeling cues and paralinguistic cues so that when neither was present, the indirect effect of mind	(Lee, Lee, & Sah, 2019)

					perception on intention to use was not significant. Additionally, the direct effect of mind perception on intention to use was not significant when testing for the mediating effect of closeness;	
129	Paralinguistic Cues	-	-	Co-Presence (Social Presence)	**Not Supported;**	(Lee, Lee, & Sah, 2019)
130	Paralinguistic Cues	-	-	Closeness	Partial Support. Paralinguistic Cues increased closeness only in the high mind-perception condition without back-channeling cues;	(Lee, Lee, & Sah, 2019)
131	Paralinguistic Cues	-	-	Intention to Use	**Not Supported;**	(Lee, Lee, & Sah, 2019)
132	Back-channeling Cues	-	-	Co-Presence (Social Presence)	**Not Supported;**	(Lee, Lee, & Sah, 2019)
133	Back-channeling Cues	-	-	Closeness	Partial Support. Back-channeling cues increased closeness	(Lee, Lee, & Sah, 2019)

					when paralinguistic cues were absent and mind perception was high;	
134	Back-channeling Cues	-	-	Intention to Use	**Not Supported;**	(Lee, Lee, & Sah, 2019)
135	Game Cognition Demand	-	-	Brand Attention	Significant. (H1) Higher Cognition Demand leads to lower Brand Attention;	(Sreejesh & Anusree, 2017)
136	Game Cognition Demand	-	-	Recall	Significant. (H1) Higher Cognition Demand leads to lower Brand Recall;	(Sreejesh & Anusree, 2017)
137	Game Cognition Demand	-	-	Recognition	Significant. (H1) Higher Cognition Demand leads to lower Brand Recognition;	(Sreejesh & Anusree, 2017)
138	High Game Cognition Demand	-	Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity)	Brand Attention	Significant. (H2a) In high cognition demand, brand interactivity (as opposed to game interactivity and no interactivity) generated higher brand attention, recall, and recognition;	(Sreejesh & Anusree, 2017)
139	High Game Cognition Demand	-	Mode of Interactivity (Brand Interactivity vs	Recall	Significant. (H2a) In high cognition demand, brand interactivity (as	(Sreejesh &

			Game Interactivity vs No Interactivity)		opposed to game interactivity and no interactivity) generated higher brand recall;	Anusree, 2017)
140	High Game Cognition Demand	-	Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity)	Recognition	Significant. (H2a) In high cognition demand, brand interactivity (as opposed to game interactivity and no interactivity) generated higher brand recognition;	(Sreejesh & Anusree, 2017)
141	Low Game Cognition Demand	-	Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity)	Brand Attention	**Not Supported;**	(Sreejesh & Anusree, 2017)
142	Low Game Cognition Demand	-	Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity)	Recall	**Not Supported;**	(Sreejesh & Anusree, 2017)
143	Low Game Cognition Demand	-	Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity)	Recognition	**Not Supported;**	(Sreejesh & Anusree, 2017)

144	Game Cognition Demand	-	Brand Anthropomorphism; Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity);	Brand Attention	Significant. (H3) Brand Anthropomorphism moderated the 2 way interaction between cognition demand and mode of interactivity on Brand Attention;	(Sreejesh & Anusree, 2017)
145	Game Cognition Demand	-	Brand Anthropomorphism; Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity);	Recall	Significant. (H3) Brand Anthropomorphism moderated the 2 way interaction between cognition demand and mode of interactivity on Brand Recall;	(Sreejesh & Anusree, 2017)
146	Game Cognition Demand	-	Brand Anthropomorphism; Mode of Interactivity (Brand Interactivity vs Game Interactivity vs No Interactivity);	Recognition	Significant. (H3) Brand Anthropomorphism moderated the 2 way interaction between cognition demand and mode of interactivity on Brand Recognition;	(Sreejesh & Anusree, 2017)
147	-	-	-	-	[Exploratory]	(Shank, Graves, Gott, Gamez, & Rodriguez, 2019)
148	----	----	-----	-----	No explicit hypothesis. Significant support for	(Cha, et al., 2020)

					the argument that people overcompensate for lack of distinctiveness in some factors by reporting increased distinctiveness in other factors when comparing humans and machines;	
149	Criticism (Direction feedback)	-	Task Difficulty	Perceived Ability to complete task	**Not Supported.** (H1) Participants receiving criticism from computer on task percieved to be easy perceive their ability to complete the task as higher;	(Bracken, Jeffres, & Neuendorf, 2004)
150	Criticism (Direction feedback)	-	-	Intrinsic Motivation	**Not Supported.** (H2) Participants receiving criticism will be more intrinsically motivated than those receiving dispositional praise;	(Bracken, Jeffres, & Neuendorf, 2004)
151	Criticism (Direction feedback)	-	-	Recall	**Not Supported.** (h3) Participants receiving criticism have lower recall scores than those receiving dispositional praise;	(Bracken, Jeffres, & Neuendorf, 2004)

152	Criticism (Direction feedback)	-	-	Perceive Intelligence	**Not Supported.** (H4) Participants receiving criticism evaluate computer as more intelligent than those receiving praise from it;	(Bracken, Jeffres, & Neuendorf, 2004)
153	Dispositional Praise (Direction feedback)	-	-	Perceive Niceness	**Significant.** (H5) Participants receiving dispositional praise evaluate computer as nicer than those receiving criticism;	(Bracken, Jeffres, & Neuendorf, 2004)
154	----	----	-----	-----	(H6) Participants receiving verbal feedback will report higher levels of the relationship predicted in H1 - H5. Significant for Perceived ability to complete task. Significant but in opposite direction such that text communication led to higher levels of intrinsic motivation. H4 (voice condition effect on perception of intelligence of the computer) was not	(Bracken, Jeffres, & Neuendorf, 2004)

					supported. H5 (praise effect on perception of niceness) was not significant;	
155	Group Membership	-	-	Interpersonal Warmth	Significant. Participants perceived in-group robot as being warmer than the out-group robot;	(Eyssel & Kuchenbrandt, 2012)
156	Group Membership	-	-	Mind Attribution	**Significant. Participants attributed more mind to the in-group robot. However, when controling for Warmth, the main effects dissapear;	(Eyssel & Kuchenbrandt, 2012)
157	Interpersonal Warmth	-	-	Mind Attribution	Partial Support. When exploring the correlation between Warmth and mind attribution, a positive partial correlation was found;	(Eyssel & Kuchenbrandt, 2012)
158	Group Membership	-	-	Psychological Closeness	Significant. Participants reported feeling closer to in-group robot than out-group robot;	(Eyssel & Kuchenbrandt, 2012)
159	Group Membership	-	-	Contact Intentions	Significant. Participants reported more positive contact intentions	(Eyssel & Kuchenbrandt, 2012)

					towards the in-group robot;	
160	Group Membership	-	-	Design Preference	Significant. Participants reported a preference for the design of the in-group robot rather than the out-group robot;	(Eyssel & Kuchenbrandt, 2012)
161	Aid Condition	-	-	Decision Accuracy	Partial Support. Both aid conditions led to increases in decision accuracy, though there was no significant difference between the non-anthropomorphic and the anthropomorphic aid conditions;	(Pak, Fink, Price, Bass, & Sturre, 2012)
162	Age Group	-	-	Decision Accuracy	Not Supported;	(Pak, Fink, Price, Bass, & Sturre, 2012)
163	Gender	-	-	Decision Accuracy	Not Supported;	(Pak, Fink, Price, Bass, & Sturre, 2012)
164	Aid Condition	-	-	Task Time	Partial Support. Participants in aid	(Pak, Fink, Price,

					condition answered questions faster, but there is no significant difference between the non-anthropomorphic and anthropomorphic aids;	Bass, & Sturre, 2012)
165	Aid Condition	-	-	Answer Time	Partial Support. Anthropomorphic Aid led to faster answer time compared to both non-anthropomorphic and no aid, but non-anthropomorphic and no aid did not differ;	(Pak, Fink, Price, Bass, & Sturre, 2012)
166	Aid Condition	-	-	Confidence in Answer	Partial Support. Anthropomorphic Aid led to significantly higher confidence in the answer compared to no-aid condition, but no other effect was found;	(Pak, Fink, Price, Bass, & Sturre, 2012)
167	Aid Condition	-	-	Expressed Trust in Aid	Partial Support. No main effect, however, younger adults reported significantly lower trust in the non-anthropomorphic aid than on the	(Pak, Fink, Price, Bass, & Sturre, 2012)

					anthropomorphic aid condition when compared to older adults;	
168	Gender	-	-	Expressed Trust in Aid	Not Supported;	(Pak, Fink, Price, Bass, & Sturre, 2012)
169	Age Group	-	-	Expressed Trust in Aid	Not Supported;	(Pak, Fink, Price, Bass, & Sturre, 2012)
170	Aid Condition	-	-	Behavioral Trust	Significant. Participants in the non-anthropomorphic condition exhibited lower levels than those in the anthropomorphic aid condition. Neither Age Group nor Gender affected this relationship;	(Pak, Fink, Price, Bass, & Sturre, 2012)
171	Character (anthropomorphic Appearance)	-	-	Sensitivity	Significant.	(Chaminade, Hodgins, & Kawato, 2007)

172	Sessions (biological movement vs artificial movement)	-	-	Sensitivity	Significant.	(Chaminade, Hodgins, & Kawato, 2007)
173	Character (anthropomorphic Appearance)	-	-	Response Bias	Significant.	(Chaminade, Hodgins, & Kawato, 2007)
174	Sessions (biological movement vs artificial movement)	-	-	Response Bias	Not Supported;	(Chaminade, Hodgins, & Kawato, 2007)
175	Anthropomorphic Messages	-	Effectance Motivation	Message Responses		(Tam, 2015)
176	Anthropomorphic Messages	-	Social Connection	Message Responses		(Tam, 2015)
177	Anthropomorphic Messages	-	Effectance Motivation	Conservation Behaviour	Significant. Anthropomorphic messages were more effective in motivating environmental movement participation (conservation behaviour) for participants with high desire for control	(Tam, 2015)

					(effectance motivation), but these anthropomorphic messages were less effective for participants with low desire for control (effectance motivation);	
178	Anthropomorphic Messages	-	Social Connection	Conservation Behaviour	Significant. The anthropomorphic message was significantly more effective for participants with a high desire for social connection (strong attachment anxiety), but the reverse pattern was observed for low social connection;	(Tam, 2015)
179	Anthropomorphism of Machine	-	-	Gambing Behaviours	Significant. Presenting the slot machine in an anthropomorphic manner increased gambling beahviors even when using real money;	(Riva, Sacchi, & Brambilla, 2015)
180	Anthropomorphism of Machine	-	-	Gambing Outcomes	Not supported. Presenting the slot machine in an	(Riva, Sacchi, &

					anthropomorphic manner did not lead to more losses on the part of the participant;	Brambilla, 2015)
181	Anthropomorphism of Machine	Emotional Experience	-	Gambing Behaviours	**Significant. Positive emotional reactions mediated the relationship between the anthropomorphic presentation of the slot machines and the increased gambling behaviours. The negative emotional reactions had no such effect;	(Riva, Sacchi, & Brambilla, 2015)
182	Anthropomorphism of Machine	Emotional Experience	-	Gambing Outcomes	Significant. Anthropomorphic presentation led to an increase in gambling behaviours which in turn led to an increase in gambling outcomes (the more participants played, the less they won);	(Riva, Sacchi, & Brambilla, 2015)
183	Anthropomorphism of Machine	Emotional Experience	-	Gambing Outcomes	**Partial Support. Feeling alert, confident, and excited indirectly	(Riva, Sacchi, &

					mediated the link between the anthropomorphic presentation of slot machines and the gambling behaviour;	Brambilla, 2015)
184	Robot Personality	-	-	Robot Preference	Significant. Users reported significant preferences for specific robots based on their personality and regardless of them possessing the same functionality [there was significant effects of anthropomorphization, suggesting this was due to anthropomorphism]	(Mayer & Panek, 2016)
185	Valence	-	-	Preferred Interaction Partner	**Significant. Participants reported a preference to interact with the avatar with positive valence rather than the negative valence regardless of appearance. There were 2 exceptions with amazon Turk respondents which	(Wu & Kraemer, 2017)

					reported lower significance in the cases of the male avatar associated with positive language and the tiger avatar associated with negative language ($p>0.05$);	
186	Appearance	-	-	Ascription of human control	No support. There were no difference regardless of group;	(Wu & Kraemer, 2017)
187	Voice (audio vs text vs subtitled)	-	-	Judgement of Script Creator	Significant. [experiment 1] Readers of the speech were significantly less likely to estate the script was human-made rather than computer-made when compared to those participants who heard the speech [achieves dehumanization];	(Schroeder & Epley, 2016)
188	Visual Cues	-	-	Judgement of Script Creator	Not supported. [experiment 1] Observers exposed to visual cues were not significantly different from those who were not exposed to visual cues in judging whether	(Schroeder & Epley, 2016)

					a human or a machine created the speech;	
189	Voice (audio vs text vs subtitled)	-	-	Judgement of Script Creator	Significant. [experiment 2] observers who listened to the speech were more likely to anthropomorphize and attribute the speech to a human than those who read the speech [achieves anthropomorphization];	(Schroeder & Epley, 2016)
190	Visual Cues	-	-	Judgement of Script Creator	Not supported. [experiment 2] Observers exposed to visual cues were not significantly different from those who were not exposed to visual cues in judging whether a human or a machine created the speech;	(Schroeder & Epley, 2016)
191	Voice (audio vs text vs subtitled)	-	-	Judgement of Script Creator	Significant. [experiment 3] observers who listened to the speech were more likely to anthropomorphize and attribute the speech to a human than those who	(Schroeder & Epley, 2016)

						read the speech [achieves anthropomorphization];	
192	Voice (audio vs text)	Paralinguistic Cues [Mindless read of essay vs mindless read of essay] (e.g., volume, pitch, rate of speech)	-		Judgement of Script Creator	Significant. [experiment 4] Significantly more participants attributed the essay to a human writer when they listened to the mindful voice compared to when the listened to the mindless voice, or the read the text. No significant difference was found between the mindless voice and the text;	(Schroeder & Epley, 2016)

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Pineda, I., & Pineda, J. (2017). An Analysis of the Future of Measures of Internationalization and Performance: An Outcome-Based Approach. CLAS Tri-University Graduate Student Conference. Boca Raton, FL.

Pineda, J., & Bouayad, L. (2017). Presentation of Clinical Pathways for Improved Provider-Patient Shared Decision Making. American Medical Informatics Association (AMIA).