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# On Seeing Human: A Three-Factor Theory of Anthropomorphism

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Anthropomorphism describes the tendency to imbue the real or imagined behavior of nonhuman agents with humanlike characteristics, motivations, intentions, or emotions. Although surprisingly common, anthropomorphism is not invariant. This article describes a theory to explain when people are likely to anthropomorphize and when they are not, focused on three psychological determinants—the accessibility and applicability of anthropocentric knowledge (elicited agent knowledge), the motivation to explain and understand the behavior of other agents (effectance motivation), and the desire for social contact and affiliation (sociality motivation). This theory predicts that people are more likely to anthropomorphize when anthropocentric knowledge is accessible and applicable, when motivated to be effective social agents, and when lacking a sense of social connection to other humans. These factors help to explain why anthropomorphism is so variable; organize diverse research; and offer testable predictions about dispositional, situational, developmental, and cultural influences on anthropomorphism. Discussion addresses extensions of this theory into the specific psychological processes underlying anthropomorphism, applications of this theory into robotics and human–computer interaction, and the insights offered by this theory into the inverse process of dehumanization.

*Keywords:* anthropomorphism, social cognition, animal cognition, agency, mind perception

Our planet is currently inhabited by approximately 1.75 million known species with unique phylogenetic characteristics (UNEP Biodiversity Assessment, as cited in Heywood, 1995), at least 10,000 distinct religions each describing its own set of supernatural beings (D. Barrett, Kurian, & Johnson, 2001), and an exponentially expanding number of technological devices designed to ease the burdens of everyday life. This diversity of living, spiritual, and technological agents is staggering, yet people's representations of these agents often take on a suspiciously familiar appearance. Animals are imbued with humanlike intentions, motivations, and goals. Spiritual deities are embodied with fingers and facial hair, complete with personality strengths and occasionally personality weaknesses. And even the most technologically savvy have wondered, at least for a moment, whether their computer is plotting against them.

Scholars from a wide array of disciplines have long noted that people tend to see nonhuman agents as humanlike (Darwin, 1872/2002; Feuerbach, 1873/2004; Freud, 1930/1989; Hume, 1757/1956). Debates have ensued about whether such anthropomorphism represents accurate or fallacious thinking, whether anthropomorphic descriptions have any place in scientific discourse, and whether anthropomorphism can account for phenomena ranging from religious belief to effective marketing campaigns (Aggarwal & McGill, in press). Empirical investigations have demonstrated the ease with which people provide anthropomorphic descriptions of agents ranging from God (J. L. Barrett & Keil, 1996) to geometric shapes (Heider & Simmel, 1944) to moving plants and computer-animated blobs (Morewedge, Preston, & Wegner, 2007; see Guthrie, 1993, for additional examples). As we note later, treating agents as human versus nonhuman has a powerful impact on whether those agents are treated as moral agents worthy of respect and concern or treated merely as objects, on how people expect those agents to behave in the future, and on people's interpretations of these agents' behavior in the present. Anthropomorphized agents can act as powerful agents of social connection when human connection is lacking, and anthropomorphizing technological agents appears to aid in effectively learning how to use those agents. But these existing observations and empirical research do not provide a psychological account of anthropomorphism itself, nor do they explain or predict systematic variability in the tendency to anthropomorphize nonhuman agents. This article attempts to do so by synthesizing a widely dispersed literature that predicts variability in anthropomorphism across dispositional, situational, cultural, and developmental sources of influence. This account should provide testable predictions not only about anthropomorphism—when people "see" nonhumans as human—but also about the inverse process of dehumanization as well—when people "see" human agents as nonhuman.

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## Anthropomorphism: Historical Issues and Current Concerns

Imbuing the imagined or real behavior of nonhuman agents with humanlike characteristics, motivations, intentions, and emotions is

the essence of anthropomorphism. These nonhuman agents may include anything that acts with apparent independence, including nonhuman animals, natural forces, religious deities, and mechanical or electronic devices. As the Oxford Dictionary (Soanes & Stevenson, 2005) more simply puts it, anthropomorphism is the "attribution of human characteristics or behavior to a god, animal, or object" (p. 66).

Derived from the Greek words *anthrōpos* (meaning "human") and *morphē* (meaning "shape" or "form"), anthropomorphism involves more than simply attributing life to the nonliving (i.e., animism). Anthropomorphism involves going beyond behavioral descriptions of imagined or observable actions (e.g., *the dog is affectionate*) to represent an agent's mental or physical characteristics using humanlike descriptors (e.g., *the dog loves me*). At its core, anthropomorphism entails attributing humanlike properties, characteristics, or mental states to real or imagined nonhuman agents and objects. The attributes involved in the perception of mind—such as conscious experience, metacognition, and intentions (Gray, Gray, & Wegner, 2007)—are therefore central to anthropomorphism but are not exhaustive. Anthropomorphism also entails attributing humanlike emotional states (Leyens et al., 2003), behavioral characteristics, or humanlike forms to nonhuman agents. Xenophanes (6th century B.C., as cited in Lesher, 1992), for instance, was the first to use "anthropomorphism" when describing the similarities between religious agents and their believers, noting that Greek gods were invariably fair skinned and blue-eyed whereas African gods were invariably dark skinned and dark-eyed (joking that cows would surely worship gods that were strikingly cowlike). 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.

Very little of the existing research on anthropomorphism tries to provide a psychological account of when and why people are likely to anthropomorphize nonhuman agents, but rather it investigates the accuracy and functionality of these anthropomorphic descriptions. Most existing research therefore addresses the actual mental states and abilities of nonhuman agents by detailing the extent to which these agents really are humanlike and the extent to which anthropomorphism represents accurate insight versus fanciful illusion (e.g., Cheney & Seyfarth, 1990; Hauser, 2000; Morgan, 1894; Thorndike, as cited in Gates, 1949). Indeed, 104 of the 182 articles that emerge when "anthropomorphism" is searched in the PsycINFO database (April 2007) involve discussions of, or empirical work on, the capacities of nonhuman animals.

This existing research on anthropomorphism therefore tends to overlook the very psychological phenomenon in its midst by studying either the extent to which people anthropomorphize or the accuracy of these beliefs rather than by providing a psychological account of the beliefs themselves. Although interesting, the accuracy of anthropomorphic beliefs is simply orthogonal to understanding the psychological processes that give rise to these intuitive beliefs in the first place. Psychologically, anthropomorphism has been generally considered an invariant and automatic psychological process that is simply a chronic feature of human judgment (Guthrie, 1993; see also Mitchell, Thompson, & Miles, 1997). We attempt to fill this gap by providing a psychological account of anthropomorphism itself. The major benefit of this account is the ability to predict variability in anthropomorphism, and therefore variability in the consequences that follow from anthropomorphism as well. Some nonhuman agents are anthropomorphized more than others. Children appear to anthropomorphize nonhuman agents more than adults. Some people anthropomorphize nonhuman agents more than other people. Some situations seem to elicit anthropomorphic beliefs more than others, and some cultures seem especially fond of anthropomorphic descriptions compared with others. A psychological account of anthropomorphism explains why people are likely to anthropomorphize in the first place and in so doing predicts when people are likely to anthropomorphize nonhuman agents and when they are not.

## SEEK: A Psychological Account of Anthropomorphism

Anthropomorphism represents a process of inductive inference about nonhuman agents, and the basic cognitive operations that perform such inferences should be no different for anthropomorphic inferences than for any other inductive inferences. These basic cognitive operations include the acquisition of knowledge, the activation or elicitation of stored knowledge, and the application of activated knowledge to a given target (Higgins, 1996). This last application process includes attempts to correct or adjust highly accessible knowledge in order to integrate alternative knowledge structures that are coactivated at the time of judgment. Such correction processes are generally insufficient such that final judgments are influenced in the direction of the most readily accessible information. These process accounts are best known in domains of dispositional inference, belief formation, and social comparison (Gilbert, 1998) but have also been applied to judgmental anchoring (Epley, 2004), affective forecasting (Gilbert, Gill, & Wilson, 2002), overconfidence (Griffin & Tversky, 1992), self-assessment (Kruger, 1999), and a variety of egocentric biases in social cognition (Epley, Keysar, Van Boven, & Gilovich, 2004; Keysar & Barr, 2002).

As a basic process of induction, anthropomorphism works through a similar process of starting with highly accessible knowledge structures as an anchor or inductive base that may be subsequently corrected and applied to a nonhuman target. The extent to which people anthropomorphize should therefore be determined by the three major parts of the inductive process: (a) the likelihood of activating, either chronically or situationally, knowledge about humans when making inferences about nonhuman agents; (b) the likelihood of correcting or adjusting anthropomorphic representations to accommodate nonanthropomorphic knowledge about nonhuman agents; and (c) the likelihood of applying activated and possibly corrected anthropomorphic representations to nonhuman agents. Our account seeks to explain when and why knowledge about the self or humans in general is likely to be highly accessible and subsequently applied with little correction when reasoning about nonhuman agents, and when that knowledge is likely to be relatively inaccessible or unlikely to be applied. Our theoretical account is therefore not a theory of the basic process that underlies induction itself but is rather a theory of a particular kind of inductive inference—the attribution of human characteristics or traits to nonhuman agents (i.e., anthropomorphism)—and what we believe are the three key psychological determinants that will influence this particular kind of inference.

### *Key Psychological Determinants*

Like any complicated phenomena, we propose that anthropomorphism is multiply determined, involving both cognitive and motivational determinants. In anthropomorphism, knowledge about humans in general, or self-knowledge more specifically, functions as the known and often readily accessible base for induction about the properties of unknown agents. A primary determinant of anthropomorphism is therefore the elicitation of agent knowledge itself. Knowledge about humans in general, or the self in particular, is likely to serve as the basis for induction primarily because such knowledge is acquired earlier and is more richly detailed than knowledge about nonhuman agents. Such acquired knowledge about human characteristics or qualities is therefore likely to be more readily accessible at the time of judgment. As knowledge about nonhuman agents is acquired, however, knowledge about humans or the self should be less likely to be used as a basis for induction simply because of the coactivation (and perhaps eventual substitute activation) of alternate knowledge structures at the time of judgment. Such activation of alternate knowledge structures will then influence the application of accessible knowledge to a given target either through a process of correction to incorporate competing knowledge or through an integration of accessible knowledge (Gilbert, 1991; Gilbert & Malone, 1995; Trope & Gaunt, 2000). Understanding how knowledge about human and nonhuman agents is acquired, activated (or elicited), corrected, and applied to a target is therefore a central feature of our theoretical account of anthropomorphism.

We propose that this cognitive mechanism of elicited agent knowledge works in concert with two additional motivational mechanisms—effectance and sociality. Effectance describes the need to interact effectively with one's environment (White, 1959). Applied to anthropomorphism, effectance involves the motivation to interact effectively with nonhuman agents (or perceived agents) and operates in the service of enhancing one's ability to explain complex stimuli in the present and to predict the behavior of these stimuli in the future. Attributing human characteristics and motivations to nonhuman agents increases the ability to make sense of an agent's actions, reduces the uncertainty associated with an agent, and increases confidence in predictions of this agent in the future. At the very least, anthropomorphism provides a rich source of testable hypotheses to guide a person's behavior toward an unknown agent or stimulus. The anxiety associated with uncertainty and the importance of predicting an agent's behavior should therefore influence people's tendency to anthropomorphize a nonhuman agent. Sociality, in contrast, describes the need and desire to establish social connections with other humans. Anthropomorphism enables satisfaction of this need by enabling a perceived humanlike connection with nonhuman agents. In the absence of social connection to other humans, in other words, people create human agents out of nonhumans through anthropomorphism to satisfy their motivation for social connection. This predicts that anthropomorphism will increase when people feel a lack of social connection to other humans and decrease when people feel a strong sense of social connection.

These three determinants (Sociality, Effectance, and Elicited agent Knowledge—SEEK), we propose, work in concert to increase or decrease the extent to which a person anthropomorphizes a nonhuman agent at any one time by altering the activation, correction, or application of anthropomorphic knowledge to a given target during this inductive reasoning process. The cognitive factor of elicited agent knowledge specifies which cognitive variables, independent of motivational influences, are likely to render knowledge about humans or the self highly accessible; when correction of an anthropomorphic representation is likely and when it is not; what cognitive factors are likely to increase the application of anthropomorphic representations to nonhuman agents; when accessible anthropomorphic representations are likely to be corrected by competing representations and when they are not; and when accessible anthropomorphic representations are likely to be applied to a given target. Each part of this inductive process, however, may be guided or modified by effectance or sociality motivations. High levels of sociality motivation, we suggest, can increase the accessibility of anthropomorphic or humanlike representations of nonhuman agents as a result of the attempt to identify a potential source of social connection, diminish the tendency to correct an initial anthropomorphic or humanlike representation of a nonhuman agent, and thereby increase the tendency to apply anthropomorphic representations to nonhuman agents. High levels of effectance motivation should similarly exert influence on the activation, correction, and application of anthropomorphic representations. Each of these factors therefore makes unique predictions about variables that will influence the tendency to anthropomorphize nonhuman agents. In this article, we first discuss predictions derived from each of these three factors independently and later discuss predictions derived from the interrelation between these factors.

### *Categories of Independent Variables*

The major benefit of a psychological account of anthropomorphism is the ability to predict variability across the major categories of independent variables in everyday life, namely dispositional, situational, developmental, and cultural. Our theory is designed to make unique predictions about how specific independent variables within each of these categories will influence anthropomorphism through each of the key psychological determinants. Table 1 presents the specific independent variables within each of the four major categories for each of the three factors that we predict will influence anthropomorphism.

Dispositional variables, at least those described in this account, are stable individual differences or personality traits that alter the extent to which certain knowledge representations or motivational states are chronically active. Situational variables represent transitory aspects of the environment that can alter the accessibility of knowledge representations or can increase or decrease effectance and sociality motivations. Finally, developmental and cultural variables can alter anthropomorphism by influencing the content of agent representations and the strength of effectance motivation across developmental time and cultural place. We believe that understanding these three psychological factors—sociality, effectance, and elicited agent knowledge—and how they are influenced by specific variables within each of these major categories of influence—dispositional, situational, developmental, and cultural—is critical for understanding anthropomorphism in daily life.

Table 1
*Key Psychological Determinants (Elicited Agent Knowledge, Effectance, and Sociality), Categories of Independent Variables, and Predicted Sources of Influence From Specific Independent Variables on Anthropomorphism*

| Categories of independent variables | Key psychological determinants | | |
|---|---|---|---|
| | Elicited agent knowledge | Effectance motivation | Sociality motivation |
| Dispositional | Need for cognition | Need for closure, desire for control | Chronic loneliness |
| Situational | Perceived similarity | Anticipated interaction, apparent predictability | Social disconnection |
| Developmental | Acquisition of alternative theories | Attaining competence | Attachment |
| Cultural | Experience, norms, and ideologies | Uncertainty avoidance | Individualism and collectivism |

*Note.* The predicted sources of influence presented in this table, and in the article more generally, are meant to be illustrative rather than exhaustive.

### *Varieties of Anthropomorphic Experience*

Like any set of beliefs, from stereotypes to politics to simple preferences, the strength of anthropomorphic beliefs can vary along a continuum, from those held very strongly to those held more weakly. Religious believers, for instance, frequently speak of God's will, intentions, or desires—beliefs about the mental states of religious agents that are held by many with the deepest and most sincere conviction. So too do people regularly speak of pets as being thoughtful and considerate, and they would certainly respond harshly if one were to suggest that they must be joking. But weaker forms of anthropomorphism may emerge as well that appear to be metaphorical ways of thinking rather than firmly held beliefs that an agent has humanlike traits. People may try to verbally cajole a stalled car into starting or explain that one's computer hates them. Even physicists may refer to particles as charming or shy.

Our contention is certainly not that all instances of anthropomorphic language reflect the same degree or strength of explicit belief about actual humanlike characteristics, just as researchers studying stereotyping and prejudice don't suggest that all of their research participants hold their beliefs with the same degree of explicit endorsement (Fazio & Olson, 2003), or that a person who refuses to eat a piece of chocolate shaped like a cockroach somehow confuses the chocolate for an actual cockroach (Rozin & Nemeroff, 2002). Strong forms of anthropomorphism entail behaving as if a nonhuman agent has humanlike traits or characteristics along with explicit endorsement of those beliefs (such as with religious agents), whereas weaker forms may only entail "as if" metaphorical reasoning (such as with one's malevolent computer). We do contend, however, that our theoretical account explains the occurrence of both strong and weak forms of anthropomorphism equally well and that the antecedents to these weak and strong forms of beliefs are the same and are captured well within our theoretical account.

What is more, weak versions of anthropomorphism in which inferences may appear to be simple metaphorical reasoning may matter more than intuition would suggest. Metaphors that might represent a very weak form of anthropomorphism can still have a powerful impact on behavior, with people behaving toward agents in ways that are consistent with these metaphors. As Lakoff and Johnson (1980) noted, using metaphors such as "Inflation *has attacked* the foundation of our economy" provides both a way of thinking about an event and also "a way of acting towards it. The INFLATION IS AN ADVERSARY metaphor therefore gives rise to and personifies political and economic actions on the part of our government; declaring war on inflation, setting targets, calling for sacrifices, installing a new chain of command, etc." (pp. 33–34). Indeed, stock market analysts in one recent line of research quite naturally invoked agentic and anthropomorphic descriptions of the stock market (e.g., *the NASDAQ flirted with the 2,000 mark*), and these descriptions influenced participants' experimental investments in those markets in ways consistent with the metaphoric implications (Morris, Sheldon, Ames, & Young, in press). The difference between weak and strong versions of anthropomorphism, we suggest, is simply a matter of degree regarding the strength and behavioral consequences of a belief, not a fundamental difference in kind.

### *Overview*

Given the relatively small amount of research on anthropomorphic beliefs themselves, much of the supporting evidence that follows comes not from research investigating how people think about nonhuman agents but rather from research investigating how people think about other humans. Anthropomorphism itself involves a generalization from humans to nonhuman agents through a process of induction, and the same mental processes involved in thinking about other humans should also govern how people think about nonhuman agents. Indeed, the same neural systems involved in making judgments about other humans are also activated when making anthropomorphic judgments about nonhuman agents (Castelli, Happé, Frith, & Frith, 2000; Iacoboni et al., 2004). And people with deficits in the neural systems associated with difficulties attributing mental states to human agents, such as autism, show the same deficits when reasoning about nonhuman agents (Heberlein & Adolphs, 2004). This evidence suggests that one of the best ways to learn about when and why people are likely to think of nonhuman agents as humanlike is to consider how people think about other people.

The remainder of this article provides evidence for the three psychological determinants of anthropomorphism, provides support for how operational variables from four major categories of variance can impact each of these major mechanisms, and identifies unique and novel predictions about how dispositional, situational, cultural, and developmental factors should influence anthropomorphism (see Table 1). We end this review by describing interactions between the three psychological determinants and describe several important extensions of this theory into human–computer interaction and the inverse process of dehumanization.

## Cognitive Determinants of Anthropomorphism

### *Elicited Agent Knowledge*

Inductive inference operates much like an intuitive scientist, taking data from behavioral observations, mental simulations, or verbal reports and interpreting them within a framework of accessible hypotheses or theories (e.g., Barsalou, 1983; Holland, Holyoak, Nisbett, & Thagard, 1986; Murphy & Medin, 1985; Nisbett & Ross, 1980). Inferences about other agents are therefore not only a product of the other agent's actual or imagined behavior but also a product of knowledge representations accessible to the perceiver at the time of judgment and subsequently applied to a given target (Higgins, 1996). As such, anthropomorphism will be predicted in large part by cognitive factors that determine the likelihood of activating, either chronically or situationally, knowledge about humans when making inferences about nonhuman agents; the likelihood of correcting this anthropomorphic knowledge; and the likelihood of applying knowledge about humans to nonhuman agents.

There are three basic reasons to believe that knowledge about humans, or the self in general, is likely to serve as the base for inductive reasoning when considering nonhuman agents. First, simple physical constraints mean that humans have direct and immediate access to the phenomenological experience of being a human but do not have such immediate access to the phenomenological experience of any nonhuman agent. A person cannot truly know what it is like to be a bat (Nagel, 1974), a sloth (Gould, 1998), or any other nonhuman agent for that matter simply because humans' sensory experiences are in *here*, not in *there*. This invariant feature of sensory apparati means that knowledge about human experience will be directly experienced and thus be acquired more easily, more completely, and more quickly than any knowledge (however indirect) about what it is like to be a nonhuman agent. Of course, this physical constraint applies to knowing what it is like to be another person as well, and research has repeatedly demonstrated that people make inferences about others' mental states by relying inordinately on their own mental states as a starting point for induction (e.g., Epley, Keysar, et al., 2004; Keysar & Barr, 2002; Nickerson, 1999). Using one's own mental states and characteristics as a guide when reasoning about other humans is egocentrism. Using one's own mental states and characteristics as a guide when reasoning about nonhuman agents is anthropomorphism.

Second, watching another agent's action appears to activate a phenomenological experience directly consistent with the agent's action, providing a default that is likely to guide subsequent reasoning about that agent. Neuroscientific evidence has identified a system of mirror neurons in the prefrontal cortex whose sole job is to mimic the same neural regions that would be active if the perceiving agent had performed these actions him or herself (e.g., Buccino et al., 2001; for a review, see Rizzolatti & Craighero, 2004). This mirror neuron system is the foundation for people's ability to empathize—or simultaneously experience—another person's emotional state (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003). This rapid and automatic mirror system is therefore likely to provide a rapid phenomenological experience that would need to be undone or overcome by subsequent reasoning.

Finally, newborn infants are notorious in their need for intensive care giving. Except in extremely rare cases, this care is provided by other humans. The social life of infants in nearly every human culture on the planet, no matter how primitive, is therefore dominated by exposure to and contact with other humans. This exposure and contact is exactly the kind of experience necessary to create detailed, interconnected, and rich representations of human characteristics and traits and to create relatively vague, disconnected, and sparse representations of nonhuman agents' characteristics and traits. As children age and are exposed to a wider array of nonhuman agents, richer representations of these agents are more likely to develop, and anthropomorphism toward such agents should diminish as a result of the coactivation of alternate nonanthropomorphic representations.

Beyond these basic theoretical reasons, a wide variety of empirical findings also suggest that knowledge about humans in general, or self-knowledge in particular, is likely to serve as a readily accessible base for induction when reasoning about nonhuman agents. The dominance of self-knowledge or egocentric experience when reasoning about other agents is evident very early in human development. Children younger than 4 years of age, for instance, do not distinguish between what they know and what others know (Perner, 1991; Wimmer & Perner, 1983), fail to provide enough information to identify referents in ambiguous communication (Deutsch & Pechmann, 1982; Sonnenschein & Whitehurst, 1984), and fail to distinguish between the way an object appears to them and its objective reality (Flavell, 1986). As Piaget (1929) characterized, at "the starting point in the life of thought, we find a protoplasmic consciousness unable to make any distinction between the self and things" (p. 235).

A key step in cognitive development involves learning to distinguish the self from other humans, and presumably from nonhuman agents as well (e.g., Amsterdam, 1972; Flavell, 1973; Gopnik & Meltzoff, 1994; Piaget, 1929, 1932, 1962, 1969; Piaget & Inhelder, 1948). Understanding others as distinct entities requires first developing a more sophisticated self-concept, and then using this knowledge to simulate another agent' experiences and therefore infer another person's mental states (e.g., Heal, 1986; Meltzoff & Brooks, 2001; Piaget, 1929). The development of this capacity further contributes to the emergence of distinct cognitive representations of oneself, others, and the superordinate category of human beings more generally. In addition to the self-concept, categorical knowledge about humans in general also provides an elaborate and accessible cognitive representation that may be easily applied when making inferences about nonhuman agents (Carey, 1985; Inagaki & Hatano, 1987).

Although most full-grown adults develop the ability to recognize that others have unique mental states of their own, they do not appear to outgrow their childish ways altogether. A person's own knowledge and phenomenological experience are so automatically accessible and richly organized that they continue to serve as an automatic base for induction that needs to be overcome and corrected when reasoning about others, rather than being a childhood tendency that is outgrown. Insufficient correction of this egocentric base appears to explain, at least in part, the robustness of egocentric biases even among full-grown adults (Epley Keysar, et al., 2004; Epley, Morewedge, & Keysar, 2004; Keysar & Barr, 2002).

Reducing either the motivation or cognitive capacity to engage in this effortful correction process increases egocentric biases in judgment, whereas increasing the motivation or capacity to engage

in effortful correction reduces egocentric biases (Epley, Keysar, et al., 2004). This suggests that people reason about the mental states of others through a process of egocentric simulation and correct that simulation to incorporate abstract knowledge about the mental states of others only when they have the capacity, motivation, and requisite representations about others to do so (see also Meltzoff & Brooks, 2001). Such a correction or adjustment process is likely to operate on a test–operate–test–exit fashion (G. A. Miller, Galanter, & Pribram, 1960), in which one corrects or adjusts a default judgment some amount and then tests whether the adjusted value if plausible. If plausible, adjustment terminates. If not plausible, another adjustment away from the default is made, its plausibility assessed, and so on until a satisfactory value is reached (Epley & Gilovich, 2006).

When reasoning about the mental states of nonhuman agents, this simulation process is likely to take on a similar form, with people using themselves as a guide and only correcting that egocentric simulation when they have the motivation, capacity, and requisite nonegocentric information to do so. Our model therefore predicts that variability in the acquisition, activation, adjustment, and subsequent application of these egocentric or homocentric defaults in induction should therefore influence the tendency to anthropomorphize nonhuman agents. In the next sections we derive predictions of such variability from dispositional, situational, developmental, and cultural influences.

### *Dispositional Influences: Need for Cognition*

The ready accessibility of self-knowledge and one's own phenomenology makes an anthropomorphic inference a likely intuitive anchor or starting point when reasoning about nonhuman agents, and correction of this anchor is possible to the extent that people are motivated and able to do so. This implies that chronic differences in the extent to which people are motivated to expend such attentional resources should influence the extent to which people anthropomorphize nonhuman agents. Such stable and chronic differences are indexed as a person's *need for cognition*. Those who are high in need for cognition tend to enjoy engaging in effortful thinking and are more likely to overcome readily accessible defaults in judgment more than those low in need for cognition (Cacioppo, Petty, Feinstein, & Jarvis, 1996; D'Agostino & Fincher-Kiefer, 1992; Epley & Gilovich, 2005).

Engaging in more effortful processing when considering other agents should lead to less reliance on readily accessible egocentric or anthropomorphic information and instead lead to an increased activation of alternate representations that may be more applicable to a given stimulus through a process of correction or integration. Indeed, those high in need for cognition tend to respond equally quickly when answering questions about themselves versus others, whereas those low in need for cognition are markedly faster to answer questions about themselves than to answer questions about others (Mueller, Haupt, & Grove, 1988). These findings suggest that those high in need for cognition should show weaker evidence of anthropomorphism, assuming the presence of alternate nonanthropomorphic representations exists and can be accessed.

### *Situational Influences: Perceived Similarity*

People tend to rely on egocentric knowledge more heavily when reasoning about other humans when the target appears similar to the self. When the target appears dissimilar, people instead rely on alternate forms of information to make inferences about their mental states, such as stereotypes (Ames, 2004). This is consistent with our SEEK model of anthropomorphism, in which the perceived similarity of targets to humans should likewise influence the extent to which people anthropomorphize nonhuman agents. Any apparent similarity of the stimulus with one's concept of the self or of *human* implies that unknown properties of the stimulus should, in Rips's (1975) terms, "mirror the distribution" (p. 665) of other properties known to be possessed by humans. Readily observable humanlike features should therefore influence the accessibility of egocentric or anthropomorphic knowledge structures, thereby increasing the likelihood that such knowledge is applied to a nonhuman target of judgment (Mussweiler, 2003).

At least two dimensions of similarity seem particularly important for anthropomorphism to occur—similarity in motion and similarity in morphology. Children as young as 12 months appear to understand that autonomous motion is a defining feature of living agents (Poulin-Dubois, Lepage, & Ferland, 1996), and children until at least age 5 use motion to determine whether a stimulus is alive (Richards & Siegler, 1986). Among adults, nonhuman agents such as toy robots and amorphous blobs are attributed mental states when they move at speeds that approximate normal human motion but appear mindless when they move either faster or slower than normal human motion (Morewedge et al., 2007). Plants, for instance, appear to move intentionally toward the sun only when time-lapsed photography gives their movement a humanlike speed (Morewedge et al., 2007). And hummingbirds suddenly appear more deliberate and thoughtful when their natural quickness (and apparent mindless behavior) is slowed to a humanlike speed. Motion that appears biologically driven (Dittrich & Lea, 1994) or socially interactive (Bassili, 1976; Heider & Simmel, 1944; S. C. Johnson, Slaughter, & Carey, 1998; Michotte, 1946/1963) even influences anthropomorphic descriptions of such simple stimuli as two-dimensional shapes and letters.

Morphological similarity is simply the extent to which a nonhuman agent's observable features look humanlike. The more similar in appearance, the more people are likely to use themselves as a source of induction and anthropomorphize these nonhuman agents. Children as young as 9 months, for instance, behave as if they attribute intentions to an action when it is performed by a humanlike hand, but not when performed by a wooden rod (Woodward, 1999). Robots and other mechanical devices are also anthropomorphized more readily when given humanlike faces and bodies (Burgoon et al., 2000; DiSalvo, Gemperle, Forlizzi, & Kiesler, 2002). Marketers design anthropomorphic products and characters in advertisements to elicit desired emotions from consumers, to convey specific social relations, and to increase sales (Welsh, 2006). And nonhuman agents in literature and in everyday discourse are attributed mental states consistent with their morphological similarity to humans (Guthrie, 1993). Judgments of similarity therefore influence anthropomorphism by activating human- or self-relevant representations or by activating specific stereotypes associated with humans. The importance of morphological similarity for attributing mental states to other agents appears early in human life and does not appear to diminish with age (S. C. Johnson, 2003).

### *Developmental Influences: Acquisition of Alternate Theories*

Assessing the similarity of a nonhuman agent to humans or to the self requires that assessors have a sense of humans or self to begin with and do not already have a fully elaborated representation of the nonhuman agent to use in place of induction. Such representations are at least partly acquired through a process of direct or indirect learning and are therefore subject to a variety of developmental influences. As already mentioned, most children appear to reason egocentrically before developing the tendency to reason from another person's perspective, and some have further argued that children also develop a conceptual understanding of the self before an understanding of others (e.g., Chandler, 1977; P. Harris, 1992; Piaget, 1929, 1932, 1962, 1969; Piaget & Inhelder, 1948; Shantz, 1975; Tomasello, 1999). Most important for the present theoretical account is simply that the self clearly emerges in most children as an elaborate and early guide for inductive reasoning about other agents.

Not all children, however, develop these representations, and perturbations in the development of knowledge about the self and others provide insights into the process of anthropomorphism itself. Autistic individuals who have difficulty acquiring the understanding that other humans have mental states at all tend to describe commonly anthropomorphized objects in purely mechanical terms (Castelli, Frith, Happé, & Frith, 2002). Acquiring the representation of others and the self as mental agents—a theory of mind—appears critical for anthropomorphism to occur. What is more, individuals with autism also do not appear to use their own beliefs egocentrically as a guide to others' beliefs (e.g., Baron-Cohen, Leslie, & Frith, 1985; Baron-Cohen, Tager-Flusberg, & Cohen, 1993), a finding that may be due to difficulties representing the self and problems introspecting about one's own mental states (Carruthers, 1996; Pennington & Ozonoff, 1996). The lack of sophisticated theories about the self, about others, and about human-typical mental capacities demonstrated in people with autism seem to at least partly explain their lack of anthropomorphism in descriptions of animated stimuli. Research on this population suggests that a person cannot project properties typical of humans onto nonhuman agents without first developing representations of oneself and of others.

Not only does development bring an understanding of the self and other humans, but it also brings with it an understanding of nonhuman agents. Because social experience in early human life is primarily with other human agents (including the self), understanding of other agents in nonanthropomorphic terms should develop later in life. Indeed, young children show a particular penchant for attributing life and mental states to nearly all stimuli in the environment, from angry clouds to a happy sun to a stuffed animal that is treated as a living companion (Piaget, 1929). Such extreme anthropomorphism is not shown by most adults primarily because they acquire alternate representations of these agents either through direct or indirect experience and are therefore more likely to use these representations when reasoning about nonhuman agents. Anthropomorphism should therefore vary over the course of development as a function of the representation of the self, other humans, and nonhuman agents, being most anthropomorphic early in life as representations of the self and others are learned and then diminishing as alternate representations of nonhuman agents are acquired.

Notice, however, that the development of alternate representations does not necessarily mean that adults will outgrow their childish ways altogether. For instance, adults tend to show considerably weaker egocentric biases in judgment than do children, but this difference appears to arise because adults are more likely to correct an automatic egocentric interpretation of the world than are children rather than because adults are less likely to start with an egocentric interpretation to begin with (Epley, Morewedge, & Keysar, 2004). The reduction in anthropomorphism that comes with age may similarly reflect the deliberate correction of an automatic anthropomorphic interpretation, rather than a change in the general extent to which adults are likely to anthropomorphize nonhuman agents per se. Consistent with this possibility, adults' explicitly reported beliefs about God tend to differ quite markedly from their intuitively recalled memories of God's actions. In Protestant religions, for instance, God is explicitly described as disembodied, unbound by space and time, and omniscient, all clearly nonanthropomorphic traits. People's explicit descriptions of God tend to match these beliefs, but their more informal descriptions of God's actual behavior show strong evidence of anthropomorphism, with God moving from one place to another, answering prayers in a serial fashion, or being unaware of certain events in the world (J. L. Barrett & Keil, 1996). Religious believers' intuitive and automatic inferences about God's nature appear to be considerably more anthropomorphic than their deliberate and explicit reports. People may acquire nonanthropomorphic representations and knowledge about nonhuman agents ranging from dogs to gods to electronic gadgets, but this does not guarantee that people will use them.

### *Cultural Influences: Experience, Norms, and Ideologies*

Culture influences anthropomorphism, we predict, in much the same way as development by influencing representations of the self, of other humans, and of nonhuman agents. Culture therefore alters both the acquisition and accessibility of egocentric or homocentric representations during the process of inductive inference. Such cultural influence appears to emerge fairly quickly, as children as young as 4 years from Christian backgrounds differentiate between the capabilities of God, humans, and dogs (J. L.Barrett, Newman, & Richert, 2003). Similar results emerge among Mayan children 4–7 years old for culturally prescribed beliefs about God versus humans (Knight, Sousa, Barrett, & Atran, 2004).

Culture may exert its influence by providing distinct norms and ideologies about how people relate to others and the natural world, or by influencing the general level of experience with particular nonhuman agents and the acquisition of nonanthropomorphic representations. Nonindustrialized cultures tend to rely more closely on the natural world for their daily needs, and members of those cultures would be more likely than members of more modern or urbanized cultures to interact with and use nonhuman animals. Members of nonindustrialized cultures are therefore more likely to acquire independent representations of these nonhuman animals and be less likely, according to our theory, to anthropomorphize these agents than would members of modern cultures. Members of modern cultures, in contrast, are more likely to interact with

sophisticated mechanical devices (cars, computers, etc.) than are members of nonindustrialized cultures and would therefore be more likely to acquire nonanthropomorphic representations of their inner workings and less likely to anthropomorphize these mechanical agents. The fewer distinct cognitive representations one has developed for nonhuman agents, the more likely representations of the self or humans in general are to become activated when encountering any nonhuman agent and the greater the likelihood that human attributes are projected toward the stimulus as a result.

Indirect support for this hypothesis comes from separate lines of research that have previously appeared inconsistent with each other. One line demonstrates anthropomorphism when reasoning about the biological functioning of nonhuman animals among children from industrialized cultures (namely, the United States; Carey, 1985). A second line demonstrates that children from less developed and rural populations show relatively little anthropomorphism when reasoning about local nonhuman animals (Atran et al., 2001; Ross, Medin, Coley, & Atran, 2003). Whereas individuals from industrialized cultures reasoned about nonhuman animals on the basis of their knowledge of humans, individuals from less industrialized cultures reasoned about nonhuman animals using their more advanced knowledge of the animal world. These results are consistent with the accessibility of agent representations influencing anthropomorphism (Medin & Atran, 2004) and demonstrate how culture can influence anthropomorphism.

Although a cognitive representation of humans might be equally accessible for individuals from both urban industrialized and rural underdeveloped populations, the extent to which this concept is deemed applicable for reasoning about a nonhuman agent may differ. Differences in perceived applicability of this concept may then account for cross-cultural differences in nearly identical processes of inductive reasoning about a nonhuman animal. The presence of alternative knowledge structures for the perceiver appears to explain at least some of the cross-cultural differences that emerge in reasoning about nonhuman animals on the basis of knowledge about humans. When alternate knowledge structures are accessible, individuals devote attention to judging their applicability to a particular stimulus (Higgins, 1989). For children from rural cultures, knowledge of multiple biological kinds (additional to humans) may be more readily accessible and deemed applicable for reasoning about nonhuman animals. For urban industrialized children, knowledge of biological kinds is more limited, and so these children instead rely on the readily accessible concept of human agency to reason about nonhuman animals.

## Motivational Determinants of Anthropomorphism

We propose that anthropomorphism is, at its core, a process of induction that utilizes existing knowledge representations to guide inferences about the properties, characteristics, and mental states of nonhuman agents. We suggest that this inductive process of anthropomorphism can also be substantially influenced by two major motivational factors. The first is effectance—the motivation to interact effectively in one's environment. Effectance motivation entails understanding, predicting, and reducing uncertainty about one's environment and the agents that inhabit it. The second is sociality—the motivation for social contact, social connection, and social approval from other agents (human or otherwise). We discuss each of these motivational determinants in turn, along with the predictions made by each regarding dispositional, situational, developmental, and cultural sources of variability for anthropomorphism.

The critical distinction between motivational and cognitive determinants in our theory is that motivational determinants operate like typical drive states, increasing in strength as a function of deprivation and decreasing when the drive is satisfied, whereas cognitive determinants operate off typical principles of cognitive activation, increasing in strength at the point of activation and then decreasing over time. Like hunger or thirst, depriving people of a sense of efficacy or social connection should activate a goal to repair or decrease this deprived state. This goal should then remain active, or even increase in strength over time, until the goal is satisfied (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Heckhausen, 1991; Wicklund & Gollwitzer, 1982). Motivational states can influence basic cognitive operations such as attention and cognitive accessibility and can therefore independently influence the higher order cognitive processes involved in social cognition (Maner et al., 2005). Anthropomorphism, we suggest, serves as one way of satisfying a goal to feel efficacious in one's environment, or to increase a sense of social connection, and should therefore increase as a function of these two motivational states.

### *Effectance Motivation as a Determinant of Anthropomorphism*

Developmental psychologists (e.g., Gopnik, Meltzoff, & Kuhl, 2001) have made it patently clear that William James (1890/1950) underestimated the faculties of human infants when he suggested that their first sensory experiences were a "blooming, buzzing confusion" (p. 442). But what James's sentiment did capture is the overwhelming complexity and uncertainty that exists in the child's environment and the inherent difficulty in making sense of that complexity from scratch. From natural phenomena such as the weather and tides, to biological phenomena such as death and reproduction, to social phenomena such as the behavior of human and nonhuman agents, observations of the external world are fraught with uncertainty and ambiguity that must be explained in order to operate effectively in one's environment by children and adults alike. Following the Hurricane Katrina disaster of 2005, for instance, New Orleans Mayor Ray Nagin explained the city's misfortune by arguing, "Surely God is mad at America. Surely he's not approving of us being in Iraq under false pretense. But surely he's upset at Black America, too. We're not taking care of ourselves" (Martel, 2006, p. A04). Although Nagin later retracted these statements under political pressure, the intuitive attempt to make sense of this natural disaster highlights the possible appeal of anthropomorphism to reduce uncertainty and increase comprehension of events in one's environment.

Anthropomorphism provides an intuitive and readily accessible method for reducing uncertainty in contexts in which alternative nonanthropomorphic models of agency do not exist (such as those provided by science or culture). Charles Darwin, for instance, advocated anthropomorphism as a necessary tool for understanding nonhuman agents. So too did Donald Hebb (1946), a seminal contributor to cognitive psychology and neuroscience, who argued

for anthropomorphism as a procedural tool in his laboratory studies of chimpanzees as a practical aid to understanding:

> A thoroughgoing attempt to avoid anthropomorphic description in the study of temperament was made over a two-year period at the Yerkes laboratories. All that resulted was an almost endless series of specific acts in which no order or meaning could be found. On the other hand, by the use of frankly anthropomorphic concepts of emotion and attitude one could quickly and easily describe the peculiarities of individual animals . . . . Whatever the anthropomorphic terminology may seem to imply about conscious states in chimpanzee, it provides an intelligible and practical guide to behavior. (p. 88)

Notice that Hebb's experience suggests that anthropomorphism can aid understanding regardless of its accuracy by serving a more utilitarian function. This utilitarian function is perhaps best described by Dennett (1987) as the "intentional stance," whereby clearly unintentional agents (such as thermostats) are attributed humanlike intentions simply to increase the ease with which people can reason about those agents or communicate about them with others, and thereby interact with them more effectively. Indeed, Kiesler and Goetz (2002) have argued that an anthropomorphic model for robots may help advance knowledge in the human–computer interaction domain just as anthropomorphic theories have arguably enhanced psychological studies of nonhuman animals.

These arguments suggest that anthropomorphism may be utilized to increase the predictability and comprehension of what would otherwise be an uncertain world, much in the way that egocentric knowledge about one's own preferences can serve as a useful guide to another person's preference in the absence of any additional information (Dawes & Mulford, 1996). Anthropomorphism should therefore be influenced by the human motivation to resolve uncertainty, seek meaning, and feel efficacious. This general motivation to "interact effectively with [one's] environment" (White, 1959, p. 297) deemed *effectance motivation* by White, suggests that humans are driven to master their environments (e.g., Harter, 1978) by increasing the environment's predictability (e.g., Averill, 1973; Lazarus, 1966) and apparent controllability (e.g., Burger & Cooper, 1979; Rothbaum, Weisz, & Snyder, 1982; Rotter, 1966). Knowledge about the self in particular, or humans in general, can serve as a rich representation for gaining a sense of predictability and controllability when reasoning about nonhuman agents. Indeed, induction itself has been conceptualized as satisfying one's effectance motivation by including "all inferential processes that expand knowledge in the face of uncertainty" (Holland et al., 1986, p. 1). Anthropomorphism, as a specialized process of induction, should therefore be influenced by one's effectance motivation. When effectance motivation is high, anthropomorphism should increase. When effectance motivation is low, anthropomorphism should decrease.

These predictions are in line with at least some classic philosophical and historical accounts of anthropomorphism in religious agents and supernatural explanations for everyday phenomena (e.g., Feuerbach, 1873/2004; Freud, 1927/1961; Hume, 1757/1956; Marx, 1844/1959). The tendency to see humanlike figures among the constellations, humanlike religious agents guiding weather patterns, or humanlike ghosts and spirits causing madness and psychological dysfunction has long been explained as a logical attempt by humans to understand and predict the complicated world around them using existing knowledge about human agents (see Preus, 1987). "The whole frame of nature bespeaks an intelligent author," Hume (1757/1956, p. 21) observed, an inference many have suggested arises intuitively from the sheer complexity and diversity of life on the planet. It is almost certainly no accident that the intelligent author in many religious systems resembles an extremely intelligent human.

The predicted role of effectance motivation in the context of nonhuman agents, however, goes beyond these intuitive observations and suggests that anthropomorphism should be heightened by two major factors. First, anthropomorphism should be heightened by uncertainty regarding the behavior of a real or presumed nonhuman agent, usually activated by observing the agent's behavior or by observing behavior attributed to a nonhuman agent (such as with natural phenomena attributed to religious agents). This uncertainty may arise because the agent is novel and unknown, because the agent appears unpredictable, because the agent violates one's expectations, or because the causal mechanisms underlying an observed behavior are unknown or unobservable. Second, by the incentives associated with accurately understanding or predicting the behavior of a nonhuman agent. When incentives for understanding and predictability are high, anthropomorphism should increase. When incentives are low, anthropomorphism should decrease. Agents perceived as threatening or able to influence one's welfare, for instance, may be anthropomorphized more readily than nonthreatening or powerless agents. Agents one is likely to interact with in the future are likely to be anthropomorphized more readily than agents unlikely to be seen again. These two main factors make specific predictions regarding dispositional, situational, development, and cultural influences on the role of effectance motivation in anthropomorphism.

*Dispositional influences: Need for closure and desire for control.* Effectance motivation entails the desire to reduce uncertainty and ambiguity, at least in part with the goal of attaining a sense of predictability and control in one's environment. Stable individual differences have been identified and validated for both of these features of effectance motivation, and both should influence the tendency to anthropomorphize nonhuman agents.

The need for closure (e.g., Dittes, 1961; Kruglanski & Mayseless, 1988; Kruglanski & Webster, 1996) indexes stable individual differences in the extent to which a person desires "an answer on a given topic . . . compared to confusion and ambiguity" (Kruglanski, 1990, p. 337; Kruglanski & Webster, 1991). Those high in need for closure tend to demonstrate primacy effects in forming impressions of stimuli, relying on early information in making judgments of other people instead of relying on more recent information (e.g., Kruglanski & Freund, 1983; Kruglanski & Webster, 1991) and tend to seize on immediately accessible information when making judgments about others in an attempt to reach a quick resolution (Kruglanski & Webster, 1996). This tendency toward primacy in impression formation suggests that need for closure indexes a drive toward attaining a sense of comprehension and understanding within a situation. Coupled with the tendency to seize upon information immediately accessible in judgment, this motivation for comprehension and understanding suggests that those high in need for closure should be more likely to activate anthropomorphic representations and less likely to subsequently correct those representations when making an inference about a

nonhuman agent. Individuals high in need for closure may therefore be particularly inclined to anthropomorphism.

Similarly, individuals differ consistently in their desire for control—the "extent to which people generally are motivated to see themselves in control of the events in their lives" (Burger, 1992, p. 6)—and this variable should motivate anthropomorphism as a means both to organize the present and to establish predictability in future interactions with a nonhuman agent. Those with a strong desire for control exhibit more vigorous attributional activities to explain others' behavior, usually focusing on typically anthropomorphic concepts such as intentions and desires (Burger & Hemans, 1988; Liu & Steele, 1986; Pittman & Pittman, 1980). What is more, this attributional activity appears to increase the feeling of efficacy in social interaction. Desire for control should therefore facilitate the activation and application of anthropomorphic representations in the service of attaining both an explanation for an agent's behavior in the present and an increased sense of predictability for an agent's behavior in the future.

*Situational influences: Anticipated future interaction and apparent predictability.* The motivation to interact effectively with agents in one's environment should be activated primarily for agents one actually expects to encounter in the environment. The likelihood of future interaction should therefore serve as a situational influence on anthropomorphism because it alters the incentives associated with understanding an agent in the present and predicting its behavior in the future and increases the likelihood of activating existing anthropomorphic representations when reasoning about nonhuman agents. Agents one is expected to interact with in the future should be anthropomorphized more extensively than agents one never expects to see again.

When reasoning about other humans, anticipated future interaction increases the amount of information people seek about others (Berger & Douglas, 1981; Berscheid, Graziano, Monson, & Dermer, 1976; Kellerman & Reynolds, 1990), increases the likelihood of making dispositional inferences about others (Feldman & Ruble, 1981; D. T. Miller, Norman, & Wright, 1978), increases the egocentric projection of one's beliefs and attitudes onto others (N. Miller & Marks, 1982), and generally increases people's interests in knowing others' thoughts and motivations (Douglas, 1990). All of these results are consistent with future interaction increasing the tendency to seek additional understanding about an individual and a tendency to activate and apply accessible (egocentric) knowledge structures to enable that understanding. When reasoning about nonhuman agents, this additional information is likely to focus on the agents' intentions, goals, emotional states, and underlying personality characteristics to gain a sense of predictability and understanding (Gilbert, 1998; Heider & Simmel, 1944), thereby increasing the extent to which people anthropomorphize these nonhuman agents.

In addition to altering the incentives associated with effective interaction, situational variables that introduce uncertainty regarding a nonhuman agent should also stimulate effectance motivation and increase anthropomorphism. There are a variety of situational factors that may increase uncertainty, but perhaps the most common is when agents violate one's expectations. Such expectancy violations require one to rethink preexisting beliefs about an agent's behavior or mental states and are likely to stimulate anthropomorphic thoughts about an agent's underlying intentions, motivations, or goals—the very features commonly associated with anthropomorphism. When reasoning about other humans, expectancy violations can activate counterfactual thinking (Sanna & Turley, 1996) and tend to increase the amount of information people seek regarding a target person (Russell, Buckworth, Case, & Upshaw, 1977).

Although expectancy violations do not necessitate an increase in anthropomorphic thinking if people are anthropomorphizing a nonhuman agent already, expectancy violations are likely to increase the attention paid to a nonhuman agent's goals, intentions, or underlying motivations and therefore produce a general increase in anthropomorphism. One's dog may not be anthropomorphized until it violates a routine command and begins behaving less like an agent under one's own control and more like an agent guided by its own goals or intentions. Or one's computer may seem like a complicated but mindless device when it enables word processing exactly as it is programmed to do but may quickly acquire malevolent intentions and motives the moment it crashes or freezes unexpectedly. Indeed, the more participants in one experiment reported their computers to malfunction, the more willing they were to attribute mental states, beliefs, and desires to these computers (Morewedge, 2007). In another experiment, participants were more likely to attribute intentionality to the movement of marbles when they were unable to control them (with a magnet) than when they were able to control them (J. L. Barrett & Johnson, 2003). Humanlike mental states are unnecessary to explain an agent that behaves perfectly predictably or is controllable but may be activated and applied to make sense of an agent once it starts behaving unpredictably.

More direct support for this prediction comes from two recent experiments investigating anthropomorphism directly (Epley, Waytz, Akalis, & Cacioppo, in press). In one, 132 participants were asked to watch a 30-s video of and evaluate the behavior of two different dogs, one of which had been rated as significantly more unpredictable and uncontrollable than the other by an independent sample of 54 participants. Participants watched this video twice, rating one dog after watching the video the first time and the other dog after watching it the second time. Participants then evaluated both dogs on four items related to anthropomorphism: the extent to which each dog is "aware of its emotions," has "a conscious will," and has "a personality" and an item asking them to rate the dog on its similarity to other life forms with one side of the scale representing "bacteria" and the other representing "humans." Participants also completed a scale to measure their "desire for control" (Burger & Cooper, 1979). These items were highly intercorrelated and therefore standardized and averaged together to create a single composite measure. As expected, participants rated the unpredictable dog as significantly more humanlike on this composite measure than the predictable dog, and those high in desire for control rated the dogs as more humanlike than those low in desire for control. These two main effects were qualified by a marginally significant interaction ($p = .052$), demonstrating that those high in desire for control were especially likely to anthropomorphize the unpredictable dog.

A second experiment extended these findings by measuring the anthropomorphism of electronic gadgets (Waytz, Cacioppo, & Epley, 2007), by manipulating predictability independent of the particular stimulus, and by asking participants to rate the gadgets on both anthropomorphic qualities and nonanthropomorphic qualities to demonstrate that effectance motivation influences anthro-

pomorphism specifically rather than any rating of a nonhuman agent. In this experiment, 32 participants evaluated 30 different consumer devices on five items measuring anthropomorphism ("To what extent does [this device] have intentions, experience emotion, have free will, have consciousness, and have a mind of its own?") and three behavioral descriptors that do not reflect anthropomorphism "To what extent is [this device] attractive, efficient, and strong?"). These devices (such as Clocky, a fuzzy alarm clock on small wheels) were described either as being relatively predictable and controllable (e.g., "You can program Clocky so that when you press snooze it runs away from you or you can program it so that when you press snooze, it will jump on top of you.") or as being relatively unpredictable and uncontrollable (e.g., "When you press snooze, Clocky either runs away from you, or it jumps on top of you . . . [and is] unpredictable in this way."). Participants read the predictable description for half of the devices and the unpredictable description for the other half (counterbalanced across participants).

As expected, participants rated the devices significantly higher on the anthropomorphism measures when they were described as unpredictable than when they were described as predictable. This pattern did not emerge on any of the single nonanthropomorphic ratings or on the composite average of all three ratings. This difference produced the predicted significant interaction, demonstrating that predictability only influenced ratings on the anthropomorphic items in the expected direction. Both predictability and control are related to effectance motivation, and agents that possess neither of these appear to induce anthropomorphism.

The one limitation to this general prediction comes from more extreme cases in which an agent is so unpredictable that it appears completely random and therefore mindless. However, we suspect that such cases of extreme unpredictability are rather rare given people's well-documented penchant for providing nonrandom and systematic accounts of truly random behavior, such as random shooting in a basketball game being ascribed to a systematic "hot hand" (Gilovich, Vallone, & Tversky, 1985) or the random roll of a dice to any number of superstitious mechanisms (e.g., Heltzer & Vyse, 1994; Vyse, 1997; Zusne & Jones, 1982).

*Developmental influences: Attaining competence.* If effectance motivation entails the desire to interact effectively with one's environment by increasing comprehension in the present and a sense of predictability and control for the future, then the strength of this motivation should be influenced both by the extent to which one experiences a sense of comprehension of the environment and the incentives associated with accurate predictions and by effective control. Both of these are likely to vary systematically over one's lifespan.

Children may not be in the midst of a "blooming, buzzing, confusion," but few will debate that infants have more to learn about their external environment than adults. Children appear more likely to anthropomorphize than adults (e.g., Bering & Bjorklund, 2004), and we suggest that children's penchant for anthropomorphism is at least partly a function of their heightened effectance motivation. As White (1959) suggested, young children are often "occupied with the agreeable task of developing an effective familiarity with his environment . . . build[ing] up an increased competence in dealing with the environment" (p. 321) by constantly exploring and manipulating their surroundings (Harlow, 1953; Piaget, 1952; Woodworth, 1958). While attempting to gain this familiarity and competence, children attribute intentions and causal agency widely to the simplest and most abstract of nonhuman stimuli (Dasser, Ulbaek, & Premack, 1989; Gergely, Nádasdy, Csibra, & Bíró, 1995; S. C. Johnson, Booth, & O'Hearn, 2001; Leslie, 1982; Leslie & Keeble, 1987; Scholl & Tremoulet, 2000; Shimizu & Johnson, 2004). Because ascribing these mental characteristics aids children's attempts to make sense of a wide variety of stimuli, those who have not yet attained a full sense of competence with their environment should be particularly likely to activate anthropomorphic representations and less likely to subsequently correct or adjust those representations. Anthropomorphism should therefore be especially helpful in these early stages of life as a means of reducing uncertainty.

The opposite pattern of effectance motivation may emerge, however, for the incentives associated with predicting and controlling ones' environment. As children become more independent and in control of their own and others' actions, the need to maintain a sense of predictability and control may increase with age. This increase would suggest that effectance motivation would be more readily activated among adults than children and that anthropomorphism of nonhuman agents would therefore increase as well. This speculation suggests that anthropomorphism may occur in daily life at reasonably high levels for children and adults, albeit for different reasons. Children may be motivated to attain comprehension and understanding more often than adults, and adults may be more motivated to attain a sense of predictability and control overall than children. We offer this predicted interaction between uncertainty and control as a tentative prediction that is clearly in need of empirical investigation.

*Cultural influences: Uncertainty avoidance.* As mentioned earlier, culture influences anthropomorphism through the same mechanisms as do developmental influences, but the specific independent variables that manipulate effectance motivation at the cultural level differ from those at the individual level. At the cultural level, uncertainty avoidance (akin to individual need for closure) was one of the five unique value dimensions to emerge from factor analyses of over 116,000 questionnaire responses from 66 nationalities in 50 different countries (Hofstede, 1980, 2001). Uncertainty avoidance represents "the extent to which the members of a culture feel threatened by uncertain or unknown situations" (Hofstede, 2001, p. 161) and is tightly linked to effectance motivation. This cross-cultural variable should therefore influence anthropomorphism in the same manner that need for closure influences individual-level responses. Namely, individuals from cultures that score high on this dimension should be more prone to activate and apply anthropomorphic representations as a means to establish comprehensibility and predictability than those from cultures that score low. People in cultures high in uncertainty avoidance "look for structure . . . which makes events clearly interpretable and predictable" (Hofstede, 2001, p. 148), and anthropomorphism is likely to be one readily available method of attaining this structure and reducing the anxiety from uncertainty.

Findings at least consistent with this hypothesis come from differences in the religious traditions of cultures high versus low in uncertainty avoidance. Cultures high in uncertainty avoidance, for instance, tend to believe more strongly in the theological concept of immanence—the extent to which a god is "incorporated, is immanent, in persons, organizations, or various objects in the natural world" (Swanson, 1967, p. 1)—that reflects a more anthro-

pomorphic and embodied view of religious agents. Immanence implies the possibility of a personal and intimate relationship with religious agents for those who devote themselves to their faith and implies a more tangible image of religious agents. This doctrine of immanence is explicitly endorsed by Catholicism but not by Protestantism, and all 20 of the Christian countries above the median in uncertainty avoidance in Hofstede's (2001) analysis were predominantly Catholic. In contrast, all but 3 of the low uncertainty avoidant Christian countries in Hofstede's analysis were predominantly Protestant or mixed. Although it is nearly impossible to find a religion that doesn't endorse some anthropomorphic notion of religious agents (Guthrie, 1993), these anthropomorphic beliefs exist on a continuum, and cultural values that endorse certainty and an avoidance of ambiguity should motivate depictions of a more humanlike religious agent. The same should be true of more secular nonhuman agents as well.

Additional suggestive evidence also comes from apparent cultural differences in anthropomorphism between Japanese and American scientists (Asquith, 1996), countries ranked, respectively, in the top 10 and bottom 10 of Hofstede's (2001) uncertainty avoidance index. American scientists, for instance, have criticized Japanese researchers for their highly anthropomorphic descriptions of primates (Asquith, 1986; de Waal, 2003). Although these differences may arise for a variety of reasons, it is at least possible that cultural differences in uncertainty avoidance between these two groups of sciences were playing an important role, and the Japanese effort to anthropomorphize was a deliberate effort to increase predictability and understanding of nonhuman primates as both Darwin and Hebb suggested was practically useful to do.

### *Sociality Motivation as a Determinant of Anthropomorphism*

Aristotle noted some time ago that "man is a social animal," and those attempting to understand the human condition in the intervening centuries have not simply echoed this basic sentiment but have enhanced it (e.g., Bowlby, 1969, 1973; Freud, 1930/1989; Maslow, 1954, 1968). Establishing and maintaining a sense of social connection with others demonstrates all the hallmarks of a basic human need akin to hunger or thirst—it appears to be universal across individuals and cultures, is evident at birth, creates strong negative affect and adverse health outcomes when thwarted, and elicits a search for social connection when one is deprived or excluded from it (for a review, see Baumeister & Leary, 1995). For nearly all of human evolutionary history, being shunned or ostracized by other humans was tantamount to a death sentence for one's genetic inheritance, either because an individual was unable to survive or was unable to reproduce. Possessing a keen sensitivity to one's social relations, and a strong motivation to establish and maintain social connections, therefore confers obvious survival and reproductive benefits (Axelrod & Hamilton, 1981; Buss, 1991; Cacioppo, Hawkley, et al., 2006; Harlow, 1958; Kling, Lancaster, & Benitone, 1970).

This social monitoring system appears to work through some of the very same neural mechanisms as physical pain, meaning that depriving a person of social connection hurts in much the same way as physical pain (MacDonald & Leary, 2005). What is more, social pain also leads people to actively search for effective ways to alleviate this pain, in much the same way as people seek to alleviate physical pain. Those experiencing social pain from a lack of social connection, compared with those not experiencing social pain, spontaneously imagine important social relationships (Twenge, Catanese, & Baumeister, 2003), focus their attention on social symbols and reminders of loved ones such as photographs and mementos (Gardner, Pickett, & Knowles, 2005), attend to others' social behavior more carefully (Pickett, Gardner, & Knowles, 2004), and seek out new contacts with other people (Maner, DeWall, Baumeister, & Schaller, 2007).

Importantly for anthropomorphism, this need for social connection appears to be satisfied by connections with two of the most commonly anthropomorphized nonhuman agents, namely pets and religious agents. Elderly pet owners, for instance, appear to be buffered from the negative impact of stressful life events and visit their doctor less often compared with elderly people without pets (Siegel, 1990), and those diagnosed with AIDS are less likely to become depressed if they own a pet than if they do not (Siegel, Angulo, Detels, Wesch, & Mullen, 1999). In fact, the presence of one's pet in stressful evaluative circumstances can have a more positive influence on reducing anxiety and psychophysical responses to stress than the presence of one's spouse (Allen, Blascovich, & Mendes, 2002). So too do people form strong attachments to religious agents, which take on the same attachment characteristics as their relationships with other people (Birgegard & Granqvist, 2004). Those who suffer a profound loss of social connection, namely through the death of a spouse, tend to increase their connection to religious agents, such as God (Brown, Nesse, House, & Utz, 2004), and those who already feel a strong connection to a religious agent appear to be buffered from common symptoms of social pain, including grief (McIntosh, Silver, & Wortman, 1993; Walsh, King, Jones, Tookman, & Blizard, 2002), depression (Azhar & Varma, 1995), and more general dissatisfaction with life (McFadden, 1995).

This need to establish and maintain a sense of social connection with others, and the apparent ease with which nonhuman agents can satisfy this need, forms the basis of the second motivational determinant of anthropomorphism. In particular, we suggest that sociality motivation increases the tendency to anthropomorphize nonhuman agents in two distinct ways. First, sociality motivation increases the baseline accessibility of social cues including humanlike traits and characteristics (Gardner, Pickett, Jefferis, & Knowles, 2005), thereby increasing the tendency to perceive humanlike characteristics and traits even in nonhuman agents. Considerable evidence suggests that people selectively attend to human-typical features from birth, showing a preference for face-like stimuli compared with nonface stimuli (Mondloch et al., 1999), and 4-month-olds prefer looking at motion displays that resemble human walking compared with displays simulating random motion (Bertenthal, 1993). Studies with older participants also demonstrate a biased allocation of processing resources toward social stimuli (Farah, Wilson, Drain, Tanaka, 1998; Ito & Cacioppo, 2000). Perhaps more important, depriving people of a sense of social connection increases attention to social cues in the environment, presumably as a result of an increased interest in forming new relationships (Pickett et al., 2004).

Second, sociality motivation increases the tendency to anthropomorphize nonhuman agents by increasing the tendency to actively search for sources of social connection in one's environment. A person feeling lonely, isolated, or lacking social

connection may attempt to recover from this social pain by anthropomorphizing nonhuman agents—essentially creating social connection by making it up in nonhuman agents. This clever method of turning ambiguous nonhuman agents into avenues for social connection may help to alleviate social pain and a sense of disconnection when one is most in need. Notice, however, that this particular mechanism is unlikely to influence anthropomorphism in general but rather increases anthropomorphic descriptions that facilitate social connection more specifically. One may be more likely to perceive a pet as thoughtful and considerate when one is feeling alone and isolated but may be unlikely (or even less likely) to also perceive the pet as vindictive and deceitful. Variation in one's sense of social connection stemming from dispositional, situational, developmental, or cultural sources should therefore influence anthropomorphism by altering the accessibility of human-typical traits, by reducing the tendency to correct an intuitive anthropomorphic inference, or by increasing the tendency to apply anthropomorphic representations to nonhuman agents.

*Dispositional influences: Chronic loneliness.* Although most people are well acquainted with feelings of loneliness and social isolation, some are more chronically acquainted than others (Boomsma, Willemsen, Dolan, Hawkley, & Cacioppo, 2005; Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006). All else equal, those who are chronically lonely should be more likely to anthropomorphize nonhuman agents than those who are more chronically connected. For chronically lonely individuals who are routinely seeking agents of social connection, anthropomorphic representations will be more readily accessible and thus more likely to be activated and applied to nonhumans. This should be especially true for novel nonhuman agents for whom the influence of chronic loneliness should be the clearest. Although theories about anthropomorphism and loneliness have existed since the time of Freud (1927/1961), very little research has tested this dispositional prediction directly.

In one exception (Epley, Waytz, et al., in press), 164 university undergraduates were asked to rank order the traits that best described their pet (or a friend's pet, if they didn't have one of their own) from a list that included supportive anthropomorphic traits (thoughtful, considerate, sympathetic), nonsupportive anthropomorphic traits (devious, embarrassable, jealous, creative), and behavioral traits (aggressive, agile, active, energetic, fearful, lethargic, muscular). There was a small but statistically reliable ($r = -.18$, $p = .02$) negative relationship between one's loneliness as measured by the Revised UCLA Loneliness Scale and the average rank of the supportive anthropomorphic traits. The more lonely participants reported being, the higher they ranked the supportive anthropomorphic traits as accurate descriptors of either their own or a friend's pet. There was no significant correlation (and slightly in the opposite direction), however, between chronic loneliness and rankings of either the nonsupportive anthropomorphic traits ($r = .10$, $p = .17$) or the behavioral traits ($r = .07$, $p < .35$), and none of these individual items approached significance. These data are at the very least consistent with our theoretical predictions about the relationship between sociality motivation and anthropomorphism.

*Situational factors: Social disconnection.* Hungry people seek food. Thirsty people seek water. And socially disconnected people seek social connection. As just discussed, the strength of these drive states vary consistently from one person to another, but they also vary from one moment to another. People feel hungry and thirsty over time as they go without food and water. And people become socially disconnected over time as they go without meaningful social contact. Isolation, exclusion, or a feeling of disconnection from others is the hallmark of social pain, and people experiencing this social pain take active steps toward alleviation by seeking out meaningful social connections with others (Maner et al., 2007). One method for regaining social connection, we have suggested, is to anthropomorphize nonhuman agents, essentially creating humans out of nonhumans. People may be especially likely, then, to anthropomorphize nonhuman agents when they are feeling socially disconnected.

Most readers will resonate with this prediction from daily life, as stereotypes about the relationships between loneliness and anthropomorphism are widespread. From the elderly person who treats his or her cat as a bit too much like a spouse to cinematic depictions such as *Cast Away* in which the shipwrecked protagonist (Tom Hanks) anthropomorphizes a volleyball (named Wilson) after being marooned on an island, those who are lacking human connection appear to seek it out in nonhuman connections. Loukatos (1976) even suggested that the personified names given to coastal rocks and capes by Greek sailors were attempts to create social contact in a context of extreme isolation. It may be no coincidence that those who are deeply religious, such as monks and priests, often go into isolation from other humans in order to more effectively find God.

Consistent with these observations, experimental evidence suggests that momentary feelings of social rejection or isolation can increase the tendency to anthropomorphize one's pet in a manner that may effectively alleviate social disconnection and also increase the extent which people report believing in anthropomorphized supernatural agents (Epley, Akalis, Waytz, & Cacioppo, in press). In one experiment, participants were induced to feel lonely, afraid, or neither by watching video clips intended to induce these emotional experiences. Participants in the lonely condition were asked to identify with the protagonist in *Cast Away* just at the moment when he discovers his true isolation and loneliness. Participants in the fear condition watched a fear-inducing clip from the *Silence of the Lambs*. Participants in the control condition watched a clip that was neither socially isolating nor fear inducing from *Major League.* Participants then picked the three traits that best described their own pet (or a well-known pet) out of a list that included supportive anthropomorphic traits (thoughtful, considerate, sympathetic), nonsupportive anthropomorphic traits (devious, embarrassable, jealous, creative), and behavioral traits (aggressive, agile, active, energetic, fearful, lethargic, muscular). Participants also indicted the extent to which they believed in a set of commonly anthropomorphized religious agents (God, angels, ghosts, and the devil).

Those induced to feel lonely, compared with those in both the fear and control conditions, were more likely to select supportive anthropomorphic traits to describe their pet, with no differences emerging on either the nonsupportive anthropomorphic or behavioral traits. This suggests that anthropomorphism of these pets, when possible, may be oriented toward creating more socially supportive agents that can especially alleviate the pain of social disconnection. Participants induced to feel lonely also reported a stronger belief in the entire set of religious agents than either those induced to feel fear or those in the control condition. It is inter-

esting to note that belief in these individual supernatural agents was highly correlated, so people did not distinguish between supportive supernatural agents (God, angels, perhaps ghosts) and nonsupportive agents (the devil). These findings suggest that situationally activated isolation or loneliness can increase anthropomorphism in a manner that may alleviate social disconnection and that these results are not simply attempts to repair a negative mood because participants in the fear condition in this experiment looked no different than participants in the control condition on these measures.

These findings are consistent with naturally occurring incidents that induce social disconnection, such as the loss of a spouse or loved one. Such events are particularly likely to increase the strength of one's religious beliefs (e.g., Glick, Weiss, & Parks, 1974; McIntosh et al., 1993; Spilka, Hood, & Gorsuch, 1985; Wuthnow, Christiano, & Kuzlowski, 1980), and those who are widowed appear to use their religious beliefs as a method to cope with their loss (Michael, Crowther, Schmid, & Allen, 2003). Consistent with Freud's (1927/1961, 1930/1989) suggestion that religion can act as a social buffer against loss, increasing the strength of one's religious beliefs appears to be a useful tactic for coping with loneliness (Rokach & Brock, 1998), divorce (Cain, 1988), or merely being single (Granqvist & Hagekull, 2000). Coping appears to be especially facilitated by construing God in particularly anthropomorphic terms as a partner or collaborator rather than as a more personally distant social agent (Pargament, 1997; Pargament et al., 1988; Pargament, Smith, Koenig, & Perez, 1998). In a less extreme example, a *Newsweek* poll of religious beliefs in America found that 40% of survey respondents indicated that they felt closer to God when praying alone and only 2% indicated feeling closer to God when praying with others (reported in Adler, 2005). Religious agents—like pets or other anthropomorphized agents—clearly serve as effective sources of social connection when human connection is lacking. Lacking social support from other humans, our theory predicts that people may try to create a sense of connection by anthropomorphizing nonhuman agents.

*Developmental influences: Attachment.* The extent to which a person is likely to feel socially isolated versus socially connected depends on the quality of their social relationships. Systematic differences in the quality of social relationships produced by developmental influences are reflected in a person's *attachment style* (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969, 1973; Hazan & Shaver, 1987). Attachment styles are likely to be related to anthropomorphism by altering the extent to which a person is likely to be actively seeking information about social relationships. In particular, those with insecure–anxious attachment styles with close others are likely to be vigilantly monitoring and appraising the environment for cues that suggest a supportive and interested relationship partner, whereas those with secure attachment styles are likely to be less vigilant (Fraley, Niedenthal, Marks, Brumbaugh, & Vicary 2006; Mikulincer & Shaver, 2003). Much like those who feel chronically or momentarily lonely, those with insecure–anxious attachment styles may compensate by seeking more secure or stable relationships from nonhuman agents and may do so by anthropomorphizing nonhuman animals or religious agents more intensely to create appropriate agents of social connection. The active search for social connection is likely to render anthropomorphic representations that would alleviate social disconnection highly accessible, thereby increasing the likelihood that they are applied to a given target.

Although research has not investigated this hypothesis directly, existing research suggests that those with insecure attachment styles seek compensatory relationships from parasocial or nonhuman agents (especially religious agents). Those with insecure–anxious attachment styles, for instance, are more likely than those with secure attachment styles to form perceived social bonds with television characters (Cole & Leets, 1999) and are more likely to report an increase in religious belief over a given time period than those with secure attachment styles (Kirkpatrick & Shaver, 1990). Those with insecure–avoidant attachment styles—those who have insecure attachments and actively avoid social contact—generally report stronger religious beliefs, report a stronger relationship with God, and are more likely to report sudden religious conversions later in life (Kirkpatrick & Shaver, 1990). Those with insecure attachment styles appear to actively seek social surrogates to form the basis of more secure social relationships, and anthropomorphizing non-human agents is one potentially successful strategy for obtaining such relationships.

*Cultural influences: Individualism and collectivism.* Culture is the conduit through which people experience social connection and relational connection, both at the local and at the national level. Cultural differences in relational affiliations are most evident in the distinction between individualist and collectivist value systems (e.g., Triandis, 1995). Although sociality appears to be a relatively universal motivation (Baumeister & Leary, 1995), the value placed on social relations and affiliation appears to be greater in collectivist cultures (Markus & Kitayama, 1991; Shweder & Bourne, 1984). The quality of one's relations with others is a central feature of the self in collectivist cultures, whereas autonomy, privacy, and individual initiative are regarded highly in addition to social needs within individualist cultures. Loneliness may therefore be a less chronic condition among people living in collectivist cultures, but the reaction to momentary isolation or social exclusion may be more severe in these cultures. The impact of culture on sociality motivation and anthropomorphism may be somewhat nuanced.

The focus on social relations among collectivist cultures means that the general level of felt social connection and support should be higher among collectivist cultures than among individualistic cultures and therefore should see more anthropomorphism resulting from general sociality motivation among individualistic cultures than among collectivistic cultures. However, the greater focus on social relations among collectivistic cultures means that members of collectivistic cultures may respond more intensely to momentary social isolation than members from individualistic cultures (D. P. Johnson & Mullins, 1987) and therefore be more likely to anthropomorphize in response to temporary feelings of social isolation or loneliness. These hypotheses would be in line with our SEEK theory of anthropomorphism, although experimental research investigating anthropomorphism across cultures has yet to be conducted systematically.

## Reiterations and Future Directions

Anthropomorphism in the perception of nonhuman agents is commonly observed but is poorly understood. Existing scholarly treatments have noted the extent to which people anthropomor-

phize nonhuman agents or have investigated the accuracy of anthropomorphic beliefs by studying the actual mental states of at least some nonhuman agents. But none of this existing research provides a psychological account of anthropomorphism itself to explain when people are likely to see humanlike characteristics or traits in nonhuman agents and when they are not. This article offers such an account.

Drawing from research examining beliefs about nonhuman animals, technological agents, religious deities, and other humans, we have suggested that anthropomorphism is largely determined by the operation of three major factors—the accessibility and applicability of egocentric or homocentric knowledge (elicited agent knowledge), the motivation to be effective social agents (effectance motivation), and the motivation for social connection (sociality motivation). These three factors in conjunction help to explain why anthropomorphism is both a common and a widespread phenomenon and, more important, predicts variability across four major categories of independent variables (dispositional, situational, developmental, and cultural).

Because experimental research on anthropomorphism is in its infancy, much of the evidence amassed to support our overall theory is extrapolated from research investigating inductive inferences about other human agents. Research on anthropomorphism, per se, is relatively scattered throughout the scientific literature and nowhere near as developed as related research programs in social cognition regarding other humans. This means that certain elements of our theoretical account are better supported by existing scientific research than others, and many of the predictions we have offered are as yet untested.

There are also at least three important issues within our theoretical account that we believe warrant direct research attention: (a) the specificity of the elicited agent knowledge that guides anthropomorphism, (b) empirical evidence of the inductive process guiding anthropomorphism itself, and (c) greater understanding of the interrelations between the three key psychological determinants. We discuss each briefly in turn.

### *The Specificity of Elicited Agent Knowledge*

The core cognitive component of our theoretical account is the agent knowledge elicited at the time of judgment, and we have suggested throughout this article that both categorical knowledge about humans in general and egocentric knowledge about the self in particular may serve as an inductive base for anthropomorphism. This naturally raises questions about which base is used more routinely, and there is at present no empirical evidence that would provide a clear answer. We suggest, however, three likely determinants of whether general or specific knowledge is accessed. First is the level at which a person categorizes another agent. Broad categorizations of an agent made, for instance, at the level of a species are likely to make broad categorical knowledge about humans in general more accessible, whereas low level categorizations made, for instance, at the individual level of one's unique pet are likely to activate more specific egocentric knowledge about the self. Determinants of the level at which an agent is categorized or construed should therefore determine the level of agent knowledge activated. Second, stimuli that are similar to other humans but not to oneself should increase the likelihood of homocentric rather than egocentric attributions. Finally, members of individualistic cultures tend to access egocentric information and use their own egocentric perspective more readily than members from collectivistic cultures (Cohen & Gunz, 2002; Wu & Keysar, 2007). Members of individualistic cultures should therefore be more likely to use egocentric representations, whereas members of collectivistic cultures should be more likely to use homocentric representations. Differentiating the activation and use of these two forms of knowledge should enable more specific predictions about the exact nature of anthropomorphic judgments.

### *Underlying Process Evidence*

We have suggested that anthropomorphism uses the same basic mechanisms of inductive inference that guide many attributional phenomena in social cognition. In particular, we have suggested that anthropomorphic knowledge is often rapidly activated for a variety or reasons, and final judgments are biased in the direction of this information compared with information that is not as readily accessible because subsequent correction processes are generally insufficient. Under such conditions, our account—like those from other domains—predicts that those without sufficient time or cognitive resources to engage in effortful correction will show stronger evidence of anthropomorphism than those given more time or ability to engage in more effortful thought. Such evidence would clearly demonstrate that people are reasoning about nonhuman agents from an inductive base of homocentric or egocentric knowledge and would provide compelling evidence that the process underlying the attribution of humanlike dispositions and traits to nonhuman agents (anthropomorphism) is indeed highly similar to the process underlying the attribution of human dispositions and traits to other humans (social cognition).

### *Interrelation Between Key Psychological Determinants*

We have thus far discussed each of the psychological determinants of anthropomorphism largely in isolation but have suggested that they work together and function synergistically in daily life. The inductive process of anthropomorphism works through the agent knowledge that is activated, applied, or adjusted when reasoning about nonhuman agents, but each part of this process can be guided or modified by motivations to understand and effectively interact with another agent or to perceive it as a source of social connection (Higgins, 1996). In this sense, acquiring and developing anthropocentric knowledge that can be activated and applied may be seen as a necessary condition for anthropomorphism to occur.

This relationship between the cognitive and motivational factors has two important implications for anthropomorphism. First, effectance and sociality motivation increase the likelihood of activating and directly applying anthropocentric knowledge to a nonhuman target but may operate differently if nonanthropomorphic knowledge representations are readily accessible. Effectance motivation is likely to increase the use of these alternate structures to attain a sense of understanding, thereby reducing the likelihood of anthropomorphism. For example, the Yukatek Mayan children described earlier (Medin & Atran, 2004) showed no preference for "human" as a base for induction toward other animals because they simply possessed better conceptual alternatives for reasoning about nonhuman animals. The urban industrialized children who

more readily exhibit anthropocentrism (Carey, 1985), on the other hand, relied on "human" as a guide to other animals because the concept *human* best served their comprehension needs. Sociality motivation, however, increases the general tendency to seek, notice, and attend to social behaviors in other agents, and sociality motivation is therefore likely to increase the tendency to anthropomorphize even if nonanthropocentric knowledge structures are readily accessible. A skilled computer technician is unlikely to anthropomorphize the well-known box of circuits compared with a novice computer user who lacks such knowledge, but the technician may nonetheless treat the computer as a pal if human social connection is severely lacking. Effectance should therefore increase anthropomorphism when nonanthropocentric knowledge is unavailable, but sociality motivation should increase anthropomorphism even in contexts when nonanthropocentric knowledge is readily accessible.

Second, these cognitive and motivational processes are likely to follow distinctly different time courses of activation and application and therefore have interesting implications for the expression of anthropomorphism. In particular, knowledge accessibility typically decays quickly over time (except in instance of chronic accessibility) and can be corrected or overcome by competing knowledge structures. As mentioned earlier, this suggests that anthropomorphic inferences may serve as an automatic base for induction that may be subsequently overcome by more deliberate and conscious reasoning. Motivational processes, in contrast, typically operate like drive states in the service of either general or specific goals and follow the opposite temporal pattern by increasing in strength over time until the activated goal is satisfied, at which point the motivation diminishes. Once activated, effectance and sociality motivation should therefore increase the tendency to anthropomorphize nonhuman agents until uncertainty or social deprivation is overcome. Factors that impact the accessibility of egocentric or homocentric knowledge should therefore influence anthropomorphism relatively quickly and be relatively localized in time and across stimuli, whereas factors that impact the motivational determinants of effectance and sociality may have longer lasting and wider ranging effects until these motivational goals are fully achieved (Bargh et al., 2001). Although we have specified conditions that account for variability in anthropomorphism and described some of the underlying psychological processes, further elucidation of the specific psychological processes that guide anthropomorphism through these cognitive and motivational factors is an especially promising area for future research.

### *Applications: Robotics and Human–Computer Interaction*

Beyond testing unique predictions about anthropomorphism and the psychological processes that guide it, we believe this theory also helps to inform applied fields involving human interaction with technological agents. From computers to interactive navigation systems to home alarms, life in the modern developed world involves frequent interaction with an ever-expanding array of lifelike technological and virtual agents (more frequent interaction for many, in fact, than with biological agents; Nowak, 2001). Our theory provides insights about how to conceptually design such agents to both facilitate understanding and learning and increase liking through the creation of a virtual social connection.

The inner workings of most modern technological agents are every bit as obtuse as the mental states of biological agents, but the incentives for understanding and effectively interacting with such agents are very high. This effectance motivation coupled with a general lack of understanding means that the tendency to anthropomorphize the workings of many nonhuman agents may be especially high.

Anthropomorphism can enable a sense of efficacy with these agents, a sense that actually increases one's apparent competence interacting with these agents. Indeed, artificial intelligence design appears to benefit from attempts to elicit anthropomorphism from users. People rate robots who appear to exhibit playful behavior as being more extroverted and outgoing than robots that appeared more serious, and people were more likely to cooperate and work with the playful robots than with the serious robots (Kiesler & Goetz, 2002). The nature of anthropomorphic traits projected onto these robots significantly influenced subsequent interactions. More closely related to effectance motivation, anthropomorphic virtual assistants within software programs (such as in Microsoft Word) improve users ability to learn the software by increasing their ability to cope with information overload (Moreale & Watt, 2004). Facilitating anthropomorphism may therefore serve as an effective method for improving the usefulness of certain technological agents.

Facilitating anthropomorphism may also increase the usefulness of technological agents by creating social bonds that increase a sense of social connection. Participants playing a desert survival task in one experiment reported feeling better understood in the task when more anthropomorphic faces and voices appeared in the interface (Burgoon et al., 2000). Such social bonds are likely to be facilitated by increasing the extent to which a technological agent is morphologically similar to selective human features (e.g., eyes), a technique long used by toy makers to create strong bonds between children and anthropomorphized toys such as the Furby (Turkle, 2000). Among adults, human-gender stereotypes can be activated by the presence of a male or female voice played through a computer: Female voices lead people to rate computers as friendlier than ones with male voices, but praise coming from a male voice makes the computer appear more compelling and persuasive than when the same praise comes from a female voice (Nass, Moon, & Green, 1997).

In addition to increasing a sense of efficacy, anthropomorphizing nonhuman agents enables social connection to develop—however anemic it may be compared with social connection with actual humans—that increases liking for technological agents that would otherwise evoke no sense of social connection (Nass, Isbister, & Lee, 2000; Nass, Moon, Fogg, Reeves, & Dryer, 1995). Such anemic relationships may have some appeal if human social connection is unavailable because of the increased control an individual can have over an anthropomorphized agent compared with another human, or simply because people settle for satisfactory (rather than optimal) outcomes.

Note that these social connections enabled by humanlike technologies can have some unforeseen consequences for computerized tasks designed to be devoid of social influence. Anonymous computerized surveys, for instance, are designed to elicit more honest responses from respondents to socially sensitive topics than would normally be offered in the presence of another human. But computerized voices increase socially desirable responding on

these questionnaires in much the same way that another actual human questioner would, including responding in more socially desirable ways to gender-attitude and personal drug use questions (Couper, Tourangeau, & Steiger, 2001; Tourangeau, Couper, & Steiger, 2003). Findings within this domain have revealed a great deal of variability, however, and discrepancies remain. Our model of anthropomorphism can again provide assistance by predicting the conditions under which the influence of human cues and particular social identity cues will be most powerful.

### *Inverting Anthropomorphism: Insights Into Dehumanization*

Finally, anthropomorphism is an act of humanization—of seeing humanlike characteristics and traits in nonhuman agents—and our theory identifies factors that can increase as well as decrease such humanization. Our theory might also yield some insights into the inverse process of dehumanization—ceasing to attribute humanlike characteristics to humans, treating them as if they were nonhuman agents or objects (Haslam, 2006). Anthropomorphism is of practical interest in most social spheres because it turns nonhuman agents into moral agents who deserve to be treated with respect and concern. Pollution takes on a different tone altogether when it is "harming Mother Earth," for instance, and it is no surprise that such framing is common among environmentalist groups who show the strongest concern for the environment. Eating beef would become morally repugnant for many if bovine neurologists were to determine—through rather large fMRI equipment—that cattle were every bit as sentient and self-aware as (at least some of) our family members and friends. Dehumanization is troublesome for most because of the very inverse process of stripping other humans of their moral agency and enabling them to be treated as objects (e.g., Bandura, Underwood, & Fromson, 1975; Kelman, 1995; Pines & Solomon, 1977). The psychological determinants that influence the perception of humanlike traits in nonhumans should be the same that influence the perception of these same traits—or the lack of these traits—in other humans as well.

Indeed, existing research provides considerable support consistent with the present theory. Consistent with predictions regarding similarity derived from elicited agent knowledge, people are notoriously likely to dehumanize outgroups, who are naturally seen and classified as being different from the ingroup (Demoulin et al., 2002; Gaunt, Leyens, & Demoulin, 2002; L. T. Harris & Fiske, 2006; Leyens et al., 2000) or whose members behave bizarrely or inexplicably, such as people with schizophrenia (Kramer & Buck, 1997). Consistent with predictions from effectance motivation, those whom people seek to exterminate and therefore have no motivation or desire to understand—or quite literally have no chance of future interaction with—are the most likely to be dehumanized (Osofsky, Bandura, & Zimbardo, 2005). And consistent with predictions from sociality motivation, strong social connections are necessarily had with ingroup members, and these strong connections may diminish the baseline sociality motivation that leads people to otherwise see humanlike traits in outgroup members. Those who live in particularly highly connected communities may be the least in need of social connection from outside group members and possibly the most likely to fail to attribute humanlike characteristics to more distant outgroup members (Marcu & Chryssochoou, 2005; Pérez, Chulvi, & Rosario, 2001). Understanding the psychological determinants that make people likely to see other agents as humanlike should also enable understanding into when people are unlikely to do so.

### *Concluding Thoughts: The Flexible Boundaries of Social Cognition*

> Give me one minute—just one minute—inside the skin of this creature. Hook me up for just sixty seconds to the perceptual and conceptual apparatus of this other being—and then I will know what natural historians have sought through the ages. . . . [But] I am stuck with a panalopy of ineluctably indirect methods." (Gould, 1998, p. 376)

Natural historians are not alone in their desire to understand what it is like to be another creature, and they suffer the very same limitations as the rest of us when trying to achieve such understanding. Human sensory experience is distinctly embodied, meaning that another agent's actual experience is forever out of reach and one can know the nature of another creature—including other human creatures—only through a process of indirect inference. When a person relies on egocentric or anthropocentric knowledge to guide reasoning about nonhuman agents—be they religious, mechanical, or animal agents—he or she is anthropomorphizing.

The theory we have outlined here provides a framework for understanding this process of anthropomorphism in a way that allows for predictions about when people will anthropomorphize and when they will not, when nonhuman agents will be treated as humanlike and when they will be treated as objects, and perhaps also when humanlike agents will be treated as nonhuman. This theory identifies three critical determinants of anthropomorphism and makes predictions about dispositional, situational, developmental, and cultural variability in the process of anthropomorphism. This theory does not provide a solution to Gould's (1998) frustration as an outside observer trying to peer into the mind of a nonhuman agent. It does, however, provide insight into what an outside observer trying to peer into the mind of a nonhuman agent is likely to see.

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