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Making Sense by Making Sentient: Effectance Motivation Increases Anthropomorphism

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People commonly anthropomorphize nonhuman agents, imbuing everything from computers to pets to gods with humanlike capacities and mental experiences. Although widely observed, the determinants of anthropomorphism are poorly understood and rarely investigated. We propose that people anthropomorphize, in part, to satisfy effectance motivation—the basic and chronic motivation to attain mastery of one's environment. Five studies demonstrated that increasing effectance motivation by manipulating the perceived unpredictability of a nonhuman agent or by increasing the incentives for mastery increases anthropomorphism. Neuroimaging data demonstrated that the neural correlates of this process are similar to those engaged when mentalizing other humans. A final study demonstrated that anthropomorphizing a stimulus makes it appear more predictable and understandable, suggesting that anthropomorphism satisfies effectance motivation. Anthropomorphizing nonhuman agents seems to satisfy the basic motivation to make sense of an otherwise uncertain environment.

Keywords: anthropomorphism, social cognition, motivation, mind attribution, unpredictability

> There is an universal tendency among mankind to conceive all beings like themselves, and to transfer to every object, those qualities, with which they are familiarly acquainted, and of which they are intimately conscious. . . . No wonder, then, that mankind, being placed in such an absolute ignorance of causes, and being at the same time so anxious concerning their future fortune, should immediately acknowledge a dependence on invisible powers, possessed of sentiment and intelligence. The unknown causes, which continually employ their thought, appearing always in the same aspect, are all apprehended to be of the same kind or species. Nor is it long before we ascribe to them thought and reason and passion, and sometimes even the limbs and figures of men, in order to bring them nearer to a resemblance with ourselves.
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> —David Hume (1757/1957, p. xix)

Hume was neither the first nor the last to note the seemingly chronic tendency for people to see humanlike agents in their environment. Xenophanes (6th century B.C.E., as cited in Lesher, 1992) first named this tendency anthropomorphism (*anthropos*) when describing the striking similarity between religious believers and depictions of the gods they worshiped, with African gods invariably being dark-haired and dark-eyed and Greek gods light-skinned and blue-eyed, even joking that cows would invariably worship cowlike gods. Feuerbach (1873/2004) and Freud (1930/1989) similarly argued that anthropomorphism played a critical role in religious belief, a claim present in many current psychological theories of religion (Barrett & Keil, 1996; Guthrie, 1993). Beyond religion, anthropomorphism has been observed in explanations of agents ranging from weather patterns (Hard, 2004) to physical objects (Heider & Simmel, 1944) to technological agents (Kiesler & Goetz, 2002) to nonhuman animals (Darwin, 1872/2002; R. W. Mitchell, Thompson, & Miles, 1997). Anthropomorphism is used by marketers to sell everything from car insurance to peanuts (Aaker, 1997; Aggarwal & McGill, 2007; Biel, 2000), by engineers to design technological agents that are user friendly (Breazeal, 2003; Duffy, 2003), and by computer scientists to identify nonhuman robots that might serve as sources of social connection to alleviate loneliness and depression (Kanamori, Suzuki, & Tanaka, 2002). Many ethical debates about the treatment of other agents hinge on arguments about the presence or absence of humanlike mental states, from environmental concern (Morewedge & Clear, 2008; E. O. Wilson, 2006) to animal rights

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(R. W. Mitchell et al., 1997; Singer, 1975) to the treatment of unborn human fetuses (Dennett, 1987).

Although both important and widespread, psychological research has generally addressed either the ease with which people anthropomorphize or the accuracy of anthropomorphic inferences. Largely unaddressed are the psychological determinants that explain and predict variability in the tendency to anthropomorphize. This research examined one potentially important determinant of anthropomorphism—the basic motivation to be an effective and competent social agent (White, 1959).[1]

What Is Anthropomorphism?

Anthropomorphism represents a process of inductive inference whereby people imbue the real or imagined behavior of other agents with humanlike characteristics, motivations, intentions, or underlying mental states (for a review, see Epley et al., 2007). This may occur by attributing humanlike physical features to another agent, as Xenophanes suggested, but more commonly by attributing mental states perceived to be uniquely human to other agents (experience and agency according to Gray, Gray, & Wegner, 2007—more loosely called “thought and reason and passion,” by Hume, 1757/1957, p. xix). Existing research suggests that people intuitively consider higher order mental capacities to be uniquely human. These include secondary emotions such as hope and guilt that implicate higher order mental process of self-awareness and prospection (Demoulin et al., 2004) and also traits that require higher order cognition and emotion such as analytic, imaginative, and insecure (Haslam, Bain, Douge, Lee, & Bastian, 2005; Haslam, Kashima, Loughnan, Shi, & Suitner, 2008).

These lay theories of personhood are consistent with philosophical definitions that also consistently focus on higher order mental states. One of the earliest definitions comes from Boethius (6th century), who defined *person* as “an individual substance of a rational nature” (quoted in Farah & Heberlein, 2007, p. 37). Locke (1841/1997) likewise defined *person* as “an intelligent being that has reason and reflection, and can consider itself the same thinking being in different times and places” (quoted in Farah & Heberlein, 2007, p. 37), and modern-day philosophical definitions have noted metarepresentation, unique conscious experience (Dennett, 1978), moral consideration, and enhanced memory (Kagan, 2004) to be essential properties of humanness. If anthropomorphism entails attributing humanlike attributes to nonhuman agents, then these intuitive and philosophical definitions of personhood all suggest that anthropomorphism should be operationalized as the attribution of humanlike mental states—a mind—to nonhuman agents (Epley et al., 2007). We therefore used this operationalization in the present research.

Variance in Anthropomorphism

Anthropomorphism is so easily recognized in so many domains of everyday life that it is easy to overstate its strength, as Hume (1757/1957) did by using terms like *universal, all,* and *every.* Hume was not alone in this respect, as anthropomorphism has historically been treated as a relatively invariant and automatic psychological process that itself requires little explanation (Guthrie, 1993; R. W. Mitchell et al., 1997). The bulk of existing research on anthropomorphism has therefore investigated either the extent to which people anthropomorphize particular nonhuman agents or its accuracy in describing the actual capacities of these agents (Cheney & Seyfarth, 1990; Hauser, 2000; Morgan, 1894; see Kwan & Fiske, 2008). A moment’s reflection, however, makes it clear that some agents are anthropomorphized more than others (Morewedge, Preston, & Wegner, 2007), some cultures seem more prone to anthropomorphism than others (Asquith, 1986), children are generally more likely to anthropomorphize than adults (Carey, 1985), and some situations increase the tendency to anthropomorphize compared to others (Epley, Akalis, Waytz, & Cacioppo, 2008; Norenzayan, Hansen, & Cady, 2008). Anthropomorphism is not an invariant feature of everyday life to be taken for granted but rather a wide-ranging and variable psychological process to be explained.

Because anthropomorphism involves perceiving humanlike states in other agents, it is also relevant when people make inferences about other humans. Indeed, the inverse of anthropomorphism—treating other humans as animals or objects through *dehumanization*—is a process that may engender private antipathy toward other humans as well as aggression and violence (Bandura, Underwood, & Fromson, 1975; Haslam, 2006). Understanding why people anthropomorphize nonhuman agents may therefore provide insight into the process by which people attribute mental states and capacities to other humans as well.

Theoretical Determinants of Anthropomorphism

At least three major constructs appear to account for variability in anthropomorphism: knowledge elicited by the agent being perceived, the perceiver’s motivation for social connection, and the perceiver’s motivation to be an effective and competent social agent (Epley et al., 2007). Existing research provides support for the first two constructs, whereas the link between anthropomorphism and effectance motivation has yet to be directly tested. The present research served as that direct test. We briefly review evidence suggesting elicited agent knowledge and sociality are determinants of anthropomorphism and then turn our attention to providing theoretical and empirical support for the influence of effectance motivation on anthropomorphism.

Elicited Agent Knowledge

Anthropomorphism represents a process of inductive inference about nonhuman agents and is guided by the basic properties of knowledge acquisition, activation, and application that guide inductive inferences more generally (Higgins, 1996). Factors that alter the acquisition, activation, and application of knowledge about the self or humans in general when considering nonhuman agents also influence anthropomorphism. Young children, who first develop a concept of self and of humans and only later develop more sophisticated understandings of other agents, rampantly anthropomorphize when reasoning about nonhuman animals (Carey, 1985; Inagaki & Hatano, 1987). Because the self is so readily available and richly elaborated early in development, it

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[1] Although anthropomorphic beliefs exist on a continuum—from weaker metaphorical forms to stronger explicit endorsements—the influence of effectance on anthropomorphism should not differ between these forms (see Epley, Waytz, & Cacioppo, 2007, for a review).

provides a highly accessible knowledge structure for reasoning about lesser known stimuli. This early anthropomorphic tendency, like self-centered biases in judgment more generally, subsides only when people learn more about nonhuman agents through direct experience or culture (e.g., Carey, 1985; Medin & Atran, 2004).

Anthropomorphism also increases for stimuli that bear a morphological similarity to humans and therefore increase the accessibility of egocentric or homocentric knowledge (e.g., Eddy, Gallup, & Povinelli, 1993; Johnson, Slaughter, & Carey, 1998; Morewedge et al., 2007). People are likely to project their own beliefs and desires anthropomorphically onto stimuli that look humanlike in their observable characteristics and movements (Guthrie, 1993; Morewedge et al., 2007), just as people are likely to project their beliefs and desires egocentrically onto people who appear similar to the self (Ames, 2004; Epley, Keysar, Van Boven, & Gilovich, 2004). Because the self often serves as the default concept for reasoning about unfamiliar agents (e.g., Davis, Hoch, & Ragsdale, 1986; Meltzoff, 2007; Nickerson, 1999), anthropomorphism is likely to result when reasoning about unfamiliar entities.

Sociality Motivation

Sociality motivation encompasses the basic need to affiliate with others and maintain a sense of belonging or relational connection (Baumeister & Leary, 1995). Anthropomorphism may operate as an attempt to satisfy this motivation by representing nonhuman agents as sources of humanlike social connection. Consistent with this possibility, chronically lonely individuals exhibit a propensity to anthropomorphize pets (Epley, Waytz, Akalis, & Cacioppo, 2008), technological gadgets (Epley, Akalis, et al., 2008), and celestial bodies (Waytz, Cacioppo, & Epley, 2007). People with insecure attachments to other people (i.e., individuals who fear rejection from close others) report stronger personal relationships with God (Kirkpatrick & Shaver, 1990). Finally, experimentally inducing loneliness increases belief in commonly anthropomorphized supernatural agents (e.g., God) and leads people to describe their pets as more humanlike (Epley, Akalis, et al., 2008). When lacking connection to other humans, people construct sources of connection by creating humanlike agents out of nonhumans.

Effectance Motivation

We suggest that anthropomorphism is also determined by effectance motivation—the basic motivation to be an effective and competent social agent (White, 1959). Effectance motivation entails a desire for understanding, predictability, and control over one's environment. Anthropomorphism may serve to satisfy effectance motivation because knowledge about the self and about humans more generally is readily accessible and richly represented in a way that may confer a strong sense of understanding, predictability, and control over nonhuman agents (Gallese & Goldman, 1998; Meltzoff, 2007; Nickerson, 1999). Just as people reason egocentrically when trying to understand other people, so too may people readily use self-knowledge when trying to understand, explain, and predict the behavior of nonhuman agents. When reflecting on his classic study of object motion (Heider & Simmel, 1944), for example, Heider (1958/1964) noted the sense of order provided by the projection of humanlike beliefs and desires toward nonhuman entities:

> As long as the pattern of events shown in the film is perceived in terms of movements as such, it presents a chaos of juxtaposed items. When, however, the geometrical figures assume personal characteristics so that their movements are perceived in terms of motives and sentiments, a unified structure appears. . . . But motives and sentiments are psychological entities. . . . They are "mentalistic concepts," so-called intervening variables that bring order into the array of behavior mediating them. (pp. 31–32)

Being motivated to explain or understand an agent's behavior may therefore increase the tendency to anthropomorphize that agent.[2]

Theoretical discussion from various domains including computer science and artificial intelligence (Kiesler & Goetz, 2002; J. McCarthy, 1983), religion (Guthrie, 1993), linguistics (Lakoff & Johnson, 1980), philosophy (Dennett, 1987), and marketing (Aggarwal & McGill, 2007) has argued for such an association between effectance and anthropomorphism based on anecdotal evidence. No existing experimental research, however, has directly tested the extent to which people anthropomorphize nonhuman agents in an attempt to explain, understand, and predict their behavior. Some supportive evidence for our hypothesis, however, comes from behavioral attribution research. The desire for understanding, predictability, and control has long been recognized as motivating people to explain their own and others' behavior. Indeed, a motivation to understand the causal forces active in the environment appears to drive behavioral explanation (Kelley, 1967; Lombrozo, 2006). Observers tend to make dispositional attributions (Jones & Nisbett, 1971), in part, to explain and understand others' behavior in terms of stable, internal, and thus predictable factors (Hamilton & Sherman, 1996). For example, increasing a person's need for understanding, predictability, or control increases the likelihood that he or she will explain others' behavior using dispositional attributions (Pittman & Pittman, 1980). Circumstances that require a person to predict and understand another person's future behavior, such as expecting a future interaction, also increase the tendency to explain that person's behavior using dispositional attributions (Berscheid, Graziano, Monson, & Dermer, 1976; Miller, Norman, & Wright, 1978).

Dispositional attributions and anthropomorphic attributions differ in many respects, most notably in that dispositional attributions need not involve any uniquely human properties at all. One may perceive a dog to be active, a computer sluggish, or a God powerful without attributing any uniquely human properties—particularly uniquely human mental capacities—to any of these agents. However, both dispositional and anthropomorphic attributions ascribe internal causality to other agents (Uleman, 2005). Perceivers' tendency to make dispositional attributions toward other human agents when effectance motivation increases suggests that effectance motivation may also engender anthropomorphic perceptions of nonhuman agents.

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[2] Of course, the stimulus in question must at least be capable of eliciting a humanlike representation for anthropomorphism to occur (Epley et al., 2007)—if the stimulus elicits some alternate, more applicable concept, then effectance motivation may stimulate sense making through other means.

Behavioral Attribution of Nonhuman Targets

Just as with human agents, situations that evoke the motivation for mastery should prompt attributions of internal, comprehensible properties—mental states such as intentions and desires—toward nonhuman agents. Empirical evidence for this idea, however, is scarce. One set of experiments demonstrated that people are more likely to judge both negative and unexpected events as having been caused by intentional agents (Morewedge, 2009). These experiments, however, did not directly measure whether people are more inclined to attribute intentions to nonhuman entities that violated their expectations or caused them harm. In another relevant experiment, participants who were denied control over a set of animate marbles attributed more intentional agency to their behavior than those given control over the marbles (Barrett & Johnson, 2003). Participants' description of the marbles, coded for anthropomorphic language, was the sole measure of attributions of intentional agency. Because this measure captures only the frequency of anthropomorphic terms spoken, it does not reveal whether those lacking control over the marbles simply had more to say about their marbles or had more marble-related thoughts in general.

In the closest test of the current hypothesis (Epley, Waytz, et al., 2008), individuals completed a measure of desire for control (Burger & Cooper, 1979) and evaluated two dogs—one predictable and one relatively unpredictable, as rated by an independent population. Participants rated the extent to which each dog possessed a number of anthropomorphic traits (e.g., a conscious will) and its similarity to other life-forms such as human beings and bacteria. Participants rated the relatively unpredictable dog more anthropomorphically than the predictable dog, and individuals with particularly high chronic control needs rated both dogs more anthropomorphically compared to individuals low in desire for control.

Although consistent with our hypothesis, this study is inconclusive. Because separate groups of people made judgments of the dogs' predictability and of the dogs' anthropomorphic attributes, the causal influence of predictability on anthropomorphism is unclear. Because the study included only measures related to anthropomorphic attributions, it is also unclear whether the unpredictable dog elicited only increased anthropomorphic attributions or increased dispositional attributions (including nonanthropomorphic traits) more generally. Furthermore, the study did not manipulate predictability independent of the stimulus, leaving ambiguity as to whether some idiosyncratic property unrelated to effectance differed between the two dogs (e.g., attractiveness) that produced differences in anthropomorphism.

The Present Research

We examined the relationship between effectance motivation and anthropomorphism in two different ways—by investigating whether increasing factors related to effectance motivation increases anthropomorphism (Studies 1–5) and by investigating whether anthropomorphism satisfies effectance motivation by increasing a sense of understanding and predictability (Study 6). We operationalized effectance motivation in Studies 1–4 in terms of its most commonly cited determinants, uncertainty and unpredictability. For instance, Berlyne (1950), a seminal figure in the study of motivation, identified uncertainty as the primary determinant of infants' motivation to master their environment, stating that effectance motivation "may be one that *all* stimuli originally evoke, but which disappears (becomes habituated) as the organism becomes familiar with them" (p. 72). Kagan (1972) likewise deemed uncertainty reduction a fundamental motive. Fiske's (2004) identification of social psychology's five core motives distinguishes between understanding and controlling but identifies uncertainty as a critical threat to both of these motivational forces.

Research across various domains in social psychology has also demonstrated that the experience of uncertainty and unpredictability stimulates attempts to regain control and mastery (Berlyne, 1962; Festinger, 1954; Pittman & D'Agostino, 1989; Plaks & Stecher, 2007; Sorrentino, Smithson, Hodson, Roney, & Walker, 2003; Weary & Edwards, 1996; Whitson & Galinsky, 2008). Operationalizing effectance motivation in terms of stimulus uncertainty and unpredictability is therefore an appropriate and effective method for stimulating this motivation for mastery. We manipulated effectance motivation more directly in Study 5 by incentivizing people to make accurate predictions about an agent's future behavior, thereby increasing the motivation for mastery over the stimulus. Across all five studies, we predicted that increasing factors related to effectance motivation would increase the tendency to anthropomorphize nonhuman agents, and in a final experiment (Study 6), we tested whether anthropomorphism is capable of satisfying this motivation.

Study 1: Unpredictable Computers

Anyone whose computer hard drive has crashed can recall an immediate feeling of frustration followed by the sense that one's computer has a mind of its own and needs to be coaxed into behaving properly. Indeed, a majority of people verbally scold (79%) and curse (73%) their computer when it fails to comply with their intentions (Luczak, Roetting, & Schmidt, 2003). Study 1 examined the relationship between technology malfunction and anthropomorphism, to assess whether people perceive computers that behave unexpectedly as humanlike. Because expectancy-violating behavior of this type should elicit effectance motivation, increases in expectancy violation should increase anthropomorphism.

Participants in two samples rated how frequently they experienced problems with their computers or software and the extent to which they perceived their computers to have minds of their own or their own beliefs and desires. We predicted that the more frequently participants' computers malfunctioned, the more they should perceive their computers to possess minds of their own, beliefs, and desires. Although correlational in nature, this is the first study we know of to directly assess within a single population the relationship between stimuli that should evoke a need for control and understanding and specifically anthropomorphic attributions.

Method

Participants. Sample A included 49 undergraduate students (25 women) who volunteered to complete a brief survey. Sample B included 63 undergraduate students (36 women) who completed a brief survey in exchange for a candy bar.

Procedure. After describing the computer they used most often and how many hours a week they used the computer, participants in Sample A rated the extent to which their computer appeared to "have a mind of its own" by drawing an X through a 112-mm continuous line marked with endpoints *Does not appear to have a mind of its own* and *Definitely appears to have a mind of its own.* Participants in Sample B rated the extent to which their computer appeared "to behave as if it has its own beliefs and desires" by drawing an X through a 112-mm continuous line marked with endpoints *Does not at all appear to behave as if it has its own beliefs and desires* and *Definitely appears to behave as if it has its own beliefs and desires.* Participants in both samples rated how often they had problems with the computer or its software on a scale of identical length, marked with endpoints *Never/Very infrequently* (0) and *Very frequently* (112). Question order was counterbalanced.

Results

As predicted, the more frequently participants' computers malfunctioned, the more likely participants in Sample A were to report their computers to appear to have minds of their own, $r(47) = .52$, $p < .001$,[3] and the more likely participants in Sample B were to report that their computers behaved as if they had their own beliefs and desires, $r(61) = .34$, $p = .007$. Interestingly, female participants in Sample A were more likely to perceive their computer to have a mind of its own ($M = 47.3$, $SD = 33.7$) than were male participants ($M = 21.3$, $SD = 22.6$), $F(1, 47) = 10.03$, $p = .003$, $\eta^2 = .18$. Because this gender difference was unexpected and is not replicated in any other study reported in this article, we do not discuss it further. No other effects were significant.

Discussion

Participants in two samples were more likely to perceive their computers to have minds, beliefs, and desires when their computers frequently malfunctioned. Most people expect their computers to function properly, and thus, malfunctions are unexpected. These findings therefore suggest that the more individuals experienced their technological possessions operating unpredictably, the more they anthropomorphized them. Although consistent with our hypotheses, computer malfunctioning is likely correlated with other factors that could have created the correlation with the anthropomorphic items, such as negativity of the behavior, length of ownership, or expertise with one's computer. To avoid the alternative interpretations inherent in such correlational designs, we manipulated the determinants of effectance motivation in Studies 2–5 while holding the stimulus being evaluated constant.

Study 2: Unpredictable Gadgets

Study 2 sought to demonstrate a causal relationship between effectance motivation and anthropomorphism by asking people to evaluate unfamiliar technological gadgets. Half of these gadgets were described as behaving predictably, the other half as behaving unpredictably. Participants then rated the gadgets on anthropomorphic and positive nonanthropomorphic measures. Previous studies have linked liking to mental state attribution (Koda & Maes, 1996; Kozak, Marsh, & Wegner, 2006; Leyens et al., 2003). Including both types of measures allowed us to dissociate anthropomorphism from dispositional attribution and positive evaluation more generally. Because unpredictable and unexpected behavior activates the motivation to understand and explain the behavior (Weiner, 1985), we predicted that participants would anthropomorphize gadgets described as unpredictable more than gadgets described as predictable.

Method

Participants. Thirty-two people (15 women, $M_{\text{age}} = 20.69$ years, $SD = 2.93$) drawn from a university population participated in exchange for $6.

Procedure. Participants rated 30 robotic gadgets in one of two conditions (randomly assigned). The name of each gadget appeared alongside a brief description and a rule as to how it operated. The rules were designed to make the gadget appear either predictable or unpredictable. Order was held constant across conditions. Gadget predictability was counterbalanced: Participants in one condition ("replicate A") read descriptions and rules suggesting that all of the odd-numbered gadgets (1, 3, 5, . . . , 29) operated in an unpredictable manner. Participants in the other condition ("replicate B") read descriptions and rules suggesting that all of the even-numbered gadgets (2, 4, 6, . . . , 30) operated in an unpredictable manner.

Upon entering the laboratory for an experiment about "evaluating gadgets," participants sat in individual cubicles to complete a computerized questionnaire that began with the following instructions:

> Today we would like you to evaluate a variety of technological devices. Prototypes of these robotic devices currently exist in robotics laboratories around the country and although they are not yet ready for mass production, most of these devices will be available for nationwide consumer purchase by holiday season in 2007. Currently, developers are looking for consumer feedback, and your responses to these devices will be valuable.
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> For now, we would like you to read a very brief description of how each device works. More specifically, each product operates by a "rule" and you will be given a brief description of what this "rule" is. Some of these rules are straightforward, and some are not. After reading about each device's rule, you will be asked to rate the device on a variety of measures. The measures on which you rate these devices should be taken literally not figuratively.

Instructions to take the measures literally were intended to test a stronger form of anthropomorphism as opposed to a metaphoric or figurative version. Participants viewed each gadget one at a time. All gadgets resembled existing products or products in development. For example, "Clocky—Clocky is an alarm clock that looks like a furry animal, and operates in a way that makes it difficult to repeatedly press snooze in the morning."

Following this short description, information depicted the product as operating within a user's control (i.e., predictably), such as "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 operating outside the user's control (i.e., unpredictably), such as "When you press snooze, Clocky either runs away from you, or it jumps on top of you" (for descriptions of all stimuli, see Appendix A).

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[3] Controlling for gender, $r(46) = .49$, $p < .001$.

Following the presentation of each gadget, participants reported the extent to which they could control that device on a 7-point scale, 1 (*Not at all*) to 7 (*Very much*). This measure served both as a manipulation check and as a measure of perceived control over each gadget. To assess anthropomorphism, participants then reported the extent to which they believed the gadget appeared to have "a mind of its own," have "intentions, free will, consciousness," and appeared to experience emotions on the same scale. Finally, participants rated each gadget on a number of positive nonanthropomorphic measures, including the extent to which they considered it attractive, efficient, and strong, on the same scale. The experimenter then thanked, debriefed, and paid participants.

Results

We first computed mean item ratings for all unpredictable gadgets and for all predictable gadgets by averaging across each set of gadgets. We then averaged these mean item ratings to attain an overall anthropomorphism composite rating for both unpredictable and predictable gadgets (α = .93 and .94, respectively). We used the same procedure for the nonanthropomorphic items to create an overall composite (for unpredictable and predictable gadgets, α = .70 and .75, respectively). Because we did not design the nonanthropomorphic items to measure any single coherent construct and because of their lower reliability as a composite measure, we also analyzed these items individually.

The manipulation of gadget predictability appeared to be effective. Participants indicated that they would be less able to control the gadgets when they were described as unpredictable ($M = 2.85$, $SD = 1.02$) than when they were described as predictable ($M = 5.11$, $SD = 1.98$), paired $t(31) = 9.33$, $p < .0001$, $d = 1.56$.[4]

As expected, participants anthropomorphized the unpredictable gadgets ($M = 2.02$, $SD = 1.15$) more than the predictable gadgets ($M = 1.69$, $SD = 0.86$), paired $t(31) = 3.47$, $p = .002$, $d = 1.03$. Treating the nonanthropomorphic items as a composite revealed a significant effect in the opposite direction, such that participants rated the unpredictable gadgets more negatively on the nonanthropomorphic items ($M = 2.87$, $SD = 0.95$) than the predictable gadgets ($M = 3.33$, $SD = 1.06$), paired $t(31) = 4.30$, $p < .001$, $d = 1.08$. A 2 (replicate: A or B) × 2 (description: predictable vs. unpredictable) × 2 (rating: anthropomorphic vs. nonanthropomorphic) mixed-model analysis of variance (ANOVA) yielded a significant main effect for rating, qualified by a Description × Rating interaction, $F(1, 30) = 31.09$, $p < .0001$, $\eta^2 = .51$. A closer inspection of the individual nonanthropomorphic items revealed that participants rated unpredictable gadgets to be less attractive ($M = 2.77$, $SD = 1.11$) than predictable gadgets ($M = 3.44$, $SD = 1.41$), paired $t(31) = 4.36$, $p < .0001$, $d = 1.15$, and they rated unpredictable gadgets to be less efficient ($M = 3.34$, $SD = 1.09$) than predictable gadgets ($M = 4.11$, $SD = 1.36$), paired $t(31) = 4.99$, $p < .0001$, $d = 1.31$. Ratings of strength between predictable and unpredictable gadgets did not differ significantly ($p = .63$).

Discussion

These findings suggest that increased anthropomorphism for the unpredictable gadgets did not result simply from increased positivity or a general increase in dispositional attribution toward unpredictable gadgets but instead increased the tendency, as Hume (1757/1957) would have suggested, to "ascribe to them thought and reason and passion" (p. xix). Because this experiment manipulated stimulus predictability independent of the stimulus itself, the results also demonstrate that unpredictability alone (rather than some other correlated feature of the stimulus) can stimulate anthropomorphism.

One alternative interpretation, however, is that people may think of other humans as inherently unpredictable, and the findings of Study 2 could therefore result from semantic priming rather than effectance motivation. If humans are thought of as being inherently unpredictable, then describing a nonhuman as unpredictable could activate thoughts about human attributes or characteristics. To examine whether this association between human and unpredictability exists, we conducted a posttest with 39 participants drawn from the same university population as Study 2. These participants answered two questions—(a) "Which type of movement is more typical of a human: predictable movement or unpredictable movement (movement that could occur in one of two ways at random)?" and (b) "If a technological device were to behave in an unpredictable fashion or in a predictable fashion, which movement would remind you most of a human?"—with the response options *predictable, unpredictable,* or *neither*. Twenty-four people (62%) responded predictable to the first question, significantly more than what would have been expected by chance, $\chi^2(2, N = 39) = 15.85$, $p < .0001$. Fifteen people responded predictable, 17 responded unpredictable, and seven responded neither to the second question, revealing no significant difference between these options, $\chi^2(2, N = 39) = 4.31$, $p = .12$. This result suggests that an alternative interpretation based on simple associative priming is unlikely. Humans are no doubt capable of spontaneous and unpredictable behavior, but there was no evidence for an association between humanness and the type of unpredictability manipulated in Study 2. Studies 4 and 5 addressed this alternative explanation directly. Before turning to these studies, we first examined the effect of unpredictability on a more implicit measure of anthropomorphism—neural activation—in Study 3.

Study 3: Neuroimaging Anthropomorphism

The first two studies demonstrated that the unpredictability of a stimulus increases anthropomorphism. However, the self-report nature of the dependent variables did not distinguish between whether participants were actually attributing humanlike minds to nonhuman agents or simply using mind as a metaphoric description of their behavior. Study 3 extended this research using functional magnetic resonance imaging (fMRI) to investigate the nature of the information processing operations that may be triggered using procedures virtually identical to Study 2. If people engage in a strong form of anthropomorphism (i.e., truly attributing human mental states to nonhuman agents; Epley et al., 2007), then mentalizing nonhuman agents should correspond to increased activation in a network of brain regions involved in mentalizing other human agents. If, however, people are instead responding to stim-

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[4] An initial analysis that included gadget (the particular gadget being evaluated) as a factor revealed no meaningful effect for this factor. Therefore, the analyses reported involve collapsing over all predictable gadgets and collapsing over all unpredictable gadgets.

uli in a metaphoric sense and are instead responding, for instance, by thinking about the predictability or unpredictability of the stimuli, then a different network of brain regions should be involved. Using neuroimaging should also help to determine the neural correlates of anthropomorphism that existing research has yet to identify definitively.

Existing research has suggested that tasks roughly related to anthropomorphism activate brain regions involved in social cognition, but these regions have varied widely across studies. This is largely because of the lack of systematic attention to this topic and because existing research has not employed tasks that constitute a clear test of anthropomorphism itself. For instance, one study demonstrated that motor areas of the brain hypothesized to be the mirror neuron system (a system theoretically implicated in the simulation of action) were equally active both when individuals observed a robot's actions and when they observed humans performing those same actions (Gazzola, Rizzolatti, Wicker, & Keysers, 2007). Simulating action, however, does not involve mental state inference and may or may not be directly related to anthropomorphism. Another study investigated anthropomorphism by assessing the neural correlates of dispositional attributions toward objects (Harris & Fiske, 2008). Dispositional attributions are necessary but insufficient for anthropomorphism because they do not automatically imply uniquely human attributes, such as mental states. Aggressiveness, for instance, is a dispositional trait that is not perceived to be uniquely human. Nor are the amygdala and superior temporal sulcus (STS), the neural regions examined in that study of attribution, regions essential to the process of mentalizing that operationally defines anthropomorphism. Instead, these regions may index the processing of animate or living agents rather than purely anthropomorphized agents (Blakemore et al., 2003; Wheatley, Milleville, & Martin, 2007).

Other studies have demonstrated that the STS, an area that reliably responds to biological motion versus nonbiological motion (Allison, Puce, & McCarthy, 2000), and areas involved in theory of mind (e.g., the temporoparietal junction and the medial prefrontal cortex [MPFC]) and processing emotions (the amygdala) are more active when people observe animated shapes and characters engaged in social or intentional motion compared to nonsocial, random, or mechanical motion (Castelli, Happé, Frith, & Frith, 2000; Martin & Weisberg, 2003; Pelphrey, Morris, & McCarthy, 2004; see also Heberlein & Adolphs, 2004). Another study demonstrated that merely imagining a set of moving shapes to be animate revealed increased activation of these regions commonly involved in social cognition (Wheatley et al., 2007). This research provides information about the perception of nonhuman stimuli, but it constitutes a relatively insufficient test of anthropomorphism's neural correlates because animacy and motion—even biological or social motion—are not uniquely human features. Attributing humanlike mental states to nonhuman agents is the essence of anthropomorphism, and neural activity should show evidence of that basic mentalizing process. We designed the present experiment to refine and extend existing contributions and to provide further understanding of anthropomorphism's neural correlates.

The region that appears most centrally involved in mentalizing is the MPFC. Over the past 15 years, one of cognitive neuroscience's most consistent findings has been that tasks that explicitly involve considering the mind of another person rely on a small set of brain regions that includes the MPFC (Amodio & Frith, 2006; C. D. Frith & Frith, 1999; U. Frith & Frith, 2003; Gallagher et al., 2000; Gallagher, Jack, Roepstorff, & Frith, 2002). Research has also implicated this region in reasoning about people versus objects (J. P. Mitchell, Heatherton, & Macrae, 2002) and assessing an agent's mental characteristics versus its physical characteristics (J. P. Mitchell, Banaji, & Macrae, 2005). One study, in fact, demonstrated the MPFC as preferentially active when participants played a competitive game against a person compared to when they played against a computer (Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004). Given existing findings on the role of the MPFC, we hypothesize that if unpredictability increases anthropomorphism via mentalizing, then evaluating unpredictable gadgets should produce greater activation in the MPFC.

One alternative hypothesis is that unpredictability merely increases perceived biological and social motion. That is, unpredictable gadgets may increase animism rather than anthropomorphism via mental state attribution. If this hypothesis is correct, then the STS should be preferentially active when participants evaluate unpredictable versus predictable gadgets because prior research has implicated this region in the processing of biological and social motion (Allison et al., 2000; Grèzes et al., 2001).

A second alternative hypothesis is that unpredictable gadgets simply increase thinking about the unpredictability of the stimulus. Cognitive neuroscience research has operationalized unpredictability in a multitude of ways ranging from expectancy violation to temporal unpredictability of sound to infrequency of events and has therefore identified a variety of regions implicated in processing unpredictability. These regions include the amygdala (Herry et al., 2007), the inferior parietal lobule (G. McCarthy, Luby, Gore, & Goldman-Rakic, 1997), and the intraparietal sulcus (Dreher & Grafman, 2003). If evaluating unpredictable gadgets simply increases attentiveness to unpredictability rather than anthropomorphism, then only these regions that process unpredictability should be preferentially active when evaluating predictable versus unpredictable gadgets. We used fMRI to test these hypotheses, conducting a whole-brain contrast for unpredictable $>$ predictable trials, a consequent connectivity analysis, and a weighted analysis in which we assessed correspondence between neural activation and behavioral measures of anthropomorphism.

Method

Participants. Twenty-three healthy right-handed volunteers (13 women, $M_{\text{age}} = 23.39$ years, $SD = 7.09$) participated in the experiment in exchange for \$15 to \$25 per hour of participation.

Procedure. Just before entering the scanner, participants read about the 30 gadgets used in Study 2 as well as two additional gadgets (an animatronic punching bag and a specialized drinking straw), 32 gadgets in total. Gadgets always appeared in the same order, and approximately half of the participants received unpredictable descriptions of Gadgets 1–8 and 17–24 and predictable descriptions of Gadgets 9–16 and 25–32, whereas the remaining participants received descriptions in the opposite order. Gadgets of each type, predictable or unpredictable, appeared on a corresponding color background, either yellow or green (also counterbalanced approximately equally). Participants studied the gadgets and then completed a quiz in which they indicated whether each gadget was described as predictable or unpredictable. Participants proceeded to the next portion of the experiment only once they scored 100% correct on the quiz.

Participants then completed an abridged practice run of the primary experimental task on a computer outside the scanner. In this task, participants viewed two blocks of slides, one pertaining to the unpredictable gadgets and one pertaining to the predictable gadgets. Each slide contained the question "To what extent does [the gadget] have a mind of its own?", and participants responded using the keyboard number keys corresponding to a 5-point scale, *Not at all* (1) to *Very much* (5). After this practice run, participants began the fMRI portion of the experiment, from which we collected data.

In the scanner, each session consisted of eight blocks with four baseline blocks— each showing a static cross (48 s)—preceding four rating blocks pertaining to unpredictable or predictable gadgets. These blocks corresponded to the order of gadget descriptions from the prescanning task. Each rating block contained eight slides (each slide = 6 s) and prior to each rating block, the word *ready* appeared on the appropriately colored background to indicate the subsequent block type (see Figure 1). As in the practice run, each slide contained a question asking participants the extent to which a particular gadget has a mind. Participants had 6 s per gadget to answer this question using the same 5-point scale and selecting a number on a five-button response box. If participants did not answer within the 6-s time frame, their rating was not recorded (occurring in only 1.77% of all trials).

Participants viewed stimuli while being scanned in a 3T GE Signa Scanner. The scanner recorded high-resolution anatomical T1-weighted spoiled gradient-recalled images for each participant in 124 1.5-mm sagittal slices with 6° flip angle and a 24-cm field of view (FOV). We acquired functional images using a gradient-echo spiral-in/out pulse sequence (Glover & Law, 2001) with 40 contiguous 4.2-mm coronal slices separated by 0.5-mm gaps, with slices collected in an interleaved order spanning the whole brain (repetition time = 3 s, echo time = 28 ms, flip angle = 84°, FOV = 24 cm; 64 × 64 matrix size, fat suppressed). The total time for each functional scan was 6.6 min (see Figure 1) that yielded 64 data points for resting state and 32 data points each for unpredictable and predictable gadgets, respectively.

We performed image processing using AFNI software. Preprocessing included motion correction, temporal smoothing using a 3-point Hamming window, spatial smoothing using a 5-mm full width at half maximum (FWHM) Gaussian filter, and spatial normalization to isometric 3-mm^3 voxels in the UCLA ICBM 452 T1 template provided by AFNI software. We estimated BOLD responses using the general linear model and the AFNI program 3dDeconvolve (Ward, 2001). We modeled the expected hemodynamic response by convolving a gamma-variate waveform with stimulus-timing information for unpredictable and predictable items and performed a within-participants regression against time-series data to yield beta coefficients for each condition. We entered voxelwise beta contrasts (unpredictable > predictable) into a one-sample t test between participants (df = 22). A cluster analysis followed using a voxelwise threshold of $p < .025$, $t(22) = 2.67$; a voxel connection radius of 5.2 mm; and a volume of 1,539 μL (57 voxels), resulting in a corrected whole-brain alpha of .05. Values are based on a representative median value chosen from all voxels in the cluster, and cluster parameters were determined using a Monte Carlo simulation (10,000 iterations, FWHM = 5 mm).

We also performed a functional connectivity analysis to determine regions of the brain showing correlated patterns of activity. Functional connectivity refers to an undirected association between multiple fMRI time series (Wager, Hernandez, Jonides, & Lindquist, 2007) and can supplement contrast analyses of fMRI data to determine connections between brain regions. Functional connectivity can be applied at different levels, from regions of interest to clusters of voxels (Wager et al., 2007). The present analysis involved functional connectivity at the voxelwise level, using the cluster result from the whole-brain voxelwise t test as a seed and correlating each participant's mean preprocessed time series for the seed with each voxel's time series as specified by Wager et al. (2007). Because voxelwise connectivity can generate false positives in identifying regions of association, we set thresholds and cluster sizes based on Monte Carlo simulations to provide a whole-brain alpha criterion of $p < .05$. An interaction regressor was constructed by calculating the pairwise product of the seed time series and a contrast matrix coding unpredictable and predictable stimuli as 1 and −1, respectively. A whole-brain voxelwise regression modeled three parameters: the correlation with the seed region, the unpredictable–predictable contrast, and the interaction between the seed region and the contrast determined by the product of the first two regressors (Heekeren, Marrett, Bandettini, & Ungerleider, 2004). We converted R values to Z' using Fisher's transformation, entered Z' values into a one-sample t test across

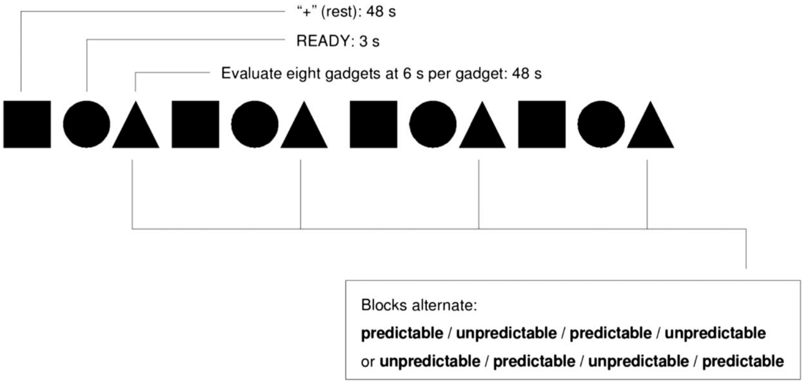

Figure 1. Schematic representation of the experimental design from Study 3.

participants ($df = 22$), and performed a cluster analysis as described above, voxelwise, $p < .00001$, $t(22) = 6.690$, cluster size 243 μL, corrected $\alpha < .001$. The results of this cluster analysis revealed functional associations with the seed that were neuroanatomically interpretable and neurobiologically meaningful. Specifically, prior research that we address in our discussion has associated these anatomical regions with sociocognitive processes related to mentalizing (Buckner & Carroll, 2007; Legrand & Ruby, 2009; Schilbach, Eickhoff, Rotarska-Jagiela, Fink, & Vogeley, 2008; but see Smith et al., 2009, for an alternative view).

Results

Behavioral data. Anthropomorphism—operationalized as ratings of the extent to which a gadget had a mind of its own—did not vary as a function of block (for either unpredictable blocks or predictable blocks; *p*s > .25) Therefore, we created composite indexes by averaging participants' anthropomorphism ratings for all gadgets described as unpredictable and for all gadgets described as predictable. Consistent with the findings of Study 2, participants anthropomorphized the gadgets significantly more when they were described as unpredictable ($M = 2.73$, $SD = 1.35$) than when they were described as predictable ($M = 1.58$, $SD = 0.64$), paired $t(22) = 4.20$, $p < .0001$, $d = 1.36$.

fMRI data. A whole-brain contrast on the imaging results comparing unpredictable gadgets to predictable gadgets yielded a statistically significant cluster 2,646 μL in size. This cluster falls within the ventromedial prefrontal cortex (vMPFC) and anterior cingulate cortex (ACC), spanning the medial frontal gyrus (MFG) and the orbitofrontal cortex, with a center of mass at Talairach Coordinates 3, 40, −1 (Talairach & Tournoux, 1988), and a mean $t = 3.79$ across voxels in the cluster (see Figure 2). The vMPFC, a region involved in inferring others' mental states, is the only significant region of activation that this contrast identified. This finding supports our hypothesis that differences in stimulus predictability—holding all other properties of the stimulus constant—are sufficient to produce differences in anthropomorphism.

It is possible that differences in activation reflect differences in difficulty between evaluating both types of gadgets—all descriptions of unpredictable gadgets include the term *unpredictable*—may facilitate relatively easier and less effortful heuristic responding to the measure of anthropomorphism. This account is unlikely, however, given that research has identified the anterior dorsolateral prefrontal cortex activation as associated with working memory (as an index of cognitive effort; D'Esposito et al., 1995) and the anterior cingulate as indicative of task difficulty (e.g., Barch et al., 1997), neither of which showed increased activation for evaluations of predictable gadgets in the current study (even at a more liberal threshold, $p < .05$, uncorrected). Furthermore, the absence of increased activation at this threshold in the visual cortex suggests that manipulating predictability did not meaningfully influence visual processing toward these gadgets.

If the identified cluster indexes anthropomorphism, then it should correlate with other brain regions involved in mentalizing. To identify correlated brain regions, we conducted a functional connectivity analysis. This analysis, based on the vMPFC cluster seed, yielded significant correlated activity for the simple correlation parameter as well as the interaction parameter (as specified above) in the following regions: the vMPFC and anterior cingulate regions extending superior to the MFG, the medial cingulate gyrus and posterior cingulate, medial and bilateral precuneus, bilateral middle and superior temporal gyri extending to the inferior parietal lobules in the region of the temporoparietal junction, bilateral parahippocampal gyri, and bilateral middle occipital gyri (see Figure 2 for regions and center of mass for each cluster in the connectivity analysis; see Table 1 for a summary of these results). This network of regions resembles a circuit strongly implicated in the corresponding processes of self-projection (Buckner & Carroll, 2007), mentalizing (Legrand & Ruby, 2009; Spreng, Mar, & Kim, 2009), and social cognition more generally (Schilbach et al., 2008), as would be expected if participants were anthropomorphizing unpredictable gadgets.

Weighted analysis. Finally, we examined the relationship between the behavioral ratings and the neuroimaging results by performing an analysis that incorporated self-report anthropomorphism ratings into the fMRI model. We first standardized self-reported anthropomorphism ratings within participants. Four par-

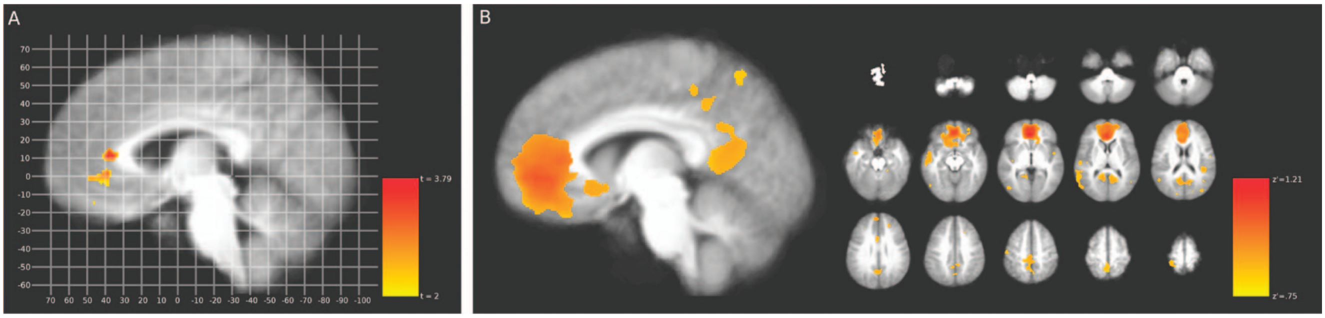

Figure 2. Results from the whole-brain voxelwise *t* test and correlation analysis from Study 3. A: Results from the whole-brain voxelwise *t* test comparing the unpredictable–predictable contrast values to zero across participants ($p < .025$, corrected), showing the sole significant cluster in medial prefrontal cortex (MPFC). Results are shown in the Talairach Atlas grid. The peak *t* value for the cluster was 3.79. B: Results of a correlation analysis using A as a seed. Functional magnetic resonance imaging time-series data were averaged across the MPFC cluster and correlated voxelwise within participants. Pearson *R* values were converted to Z' using Fisher's *Z* transformation, then compared to zero using a one-sample *t* test ($p < .0000001$, corrected).

Table 1
Results of Connectivity Analysis

Region	Brodmann's areas	Voxels	X	Y	Z	Median *d*	Median *Z*′
L/R medial prefrontal cortex	9, 10, 11, 32	2,003	2	42	2	1.77	.61
L/R posterior cingulate	7, 18, 19, 30, 31	686	2	−53	28	1.52	.43
L/R precuneus							
L/R cuneus							
L/R lingual gyrus							
L/R calcarine gyrus							
R superior temporal gyrus	19, 21, 22, 37, 39	208	55	−57	8	1.50	.39
R middle temporal gyrus	21	72	55	−13	−9	1.53	.45
L postcentral gyrus	1, 3	44	26	−42	69	1.47	.36
L middle temporal gyrus	19, 22, 37, 39	37	42	36	16	1.46	.38
L superior temporal gyrus							
L superior temporal gyrus	13, 41	37	42	36	16	1.53	.43
L Rolandic operculum							
R medial temporal pole	21	23	48	1	−22	1.51	.40
R Postcentral Gyrus	1, 2, 3	22	51	−17	51	1.47	.35
R superior temporal gyrus	41	19	57	−20	9	1.51	.39
L middle occipital gyrus	19	17	−38	−79	21	1.50	.39
R Heschl's gyrus	13	15	41	−18	15	1.45	.43
R insula							
R Rolandic operculum							
L superior temporal gyrus	22	12	−48	0	1	1.50	.37
L temporal pole							
L middle frontal gyrus	9	12	−22	39	31	1.44	.48

Note. Regions resulting from the correlation analysis using the functionally determined medial prefrontal cortex cluster as a seed, including nearest Brodmann's areas, cluster size, Talairach coordinates for each cluster's center of mass, and the mean Z' value averaged across all voxels in the cluster. Clusters were determined by calculating correlations to the seed within participants, performing Fisher's R to Z transform, and comparing Z' values to zero across participants with a voxelwise threshold of $p < .0000001$. L = left; R = right.

ticipants showed no variance in their anthropomorphism ratings (all items were rated as 1) and were thus excluded from the analysis. We then recreated the block-design time series using these z scores, providing an expected neural response function that represented the ratings for each stimulus item. If the ratings did not covary with the fMRI data from the scanner, the model would fit poorly the fMRI data and the weighted model. However, this analysis revealed significant activity for the unpredictable > predictable contrast in MPFC $p < .01$, volume = 432 µl, threshold $t(18) = 2.88$. The strongest activity was in the same region of the MPFC found in the primary analysis.

Discussion

As predicted, participants were more likely to attribute mind to gadgets described as unpredictable than to gadgets described as predictable. More important, the neuroimaging results reveal that evaluating the mental capacity of unpredictable gadgets is associated with relative increases in fMRI activity in an area centered in the vMPFC and ACC. A weighted analysis demonstrated a correspondence between this area of the MPFC and participants' explicit anthropomorphism ratings. These findings suggest that perceiving an agent as having a mind of its own may not be mere metaphor.

The region identified raises the possibility that perceiving the unpredictable gadgets involves thinking about these agents as legitimately humanlike or selflike. Although the region of the MPFC we identified is involved in a variety of processes, this region has been previously shown to be critically involved a variety of sociocognitive processes (Amodio & Frith, 2006), including egocentric mentalizing about similar others (Jenkins, Macrae, & Mitchell, 2008; J. P. Mitchell, Macrae, & Banaji, 2006). The present study's findings allow for the possibility that individuals are engaging in egocentric mentalizing when anthropomorphizing these technological agents, whereas our results are inconsistent with alternative hypotheses—specifically, that the experimental manipulations simply increases neural activity associated with perceiving animacy and biological motion or with perceiving unpredictability. The areas we detected have been observed in prior studies of mentalizing, whereas research on processing biological motion has identified the STS (Allison et al., 2000) and research on processing unpredictability has identified multiple regions including the amygdala (Herry et al., 2007), the inferior parietal lobule (G. McCarthy et al., 1997), and the intraparietal sulcus (Dreher & Grafman, 2003). None of these areas were observed in the current experiment, even at a liberal threshold ($p < .05$, uncorrected). Moreover, no study to our knowledge has yet implicated the vMPFC region we identified to be activated by processing differences in predictability per se, whereas a broad literature points to this region as involved in social cognition processes such as mentalizing (see Amodio & Frith, 2006; U. Frith & Frith, 2003; J. P. Mitchell, 2009).

Because the vMPFC is implicated in various other functions ranging from prediction error to reward processing to outcome monitoring, the results of the connectivity analysis provided a stronger test of the anthropomorphism hypothesis. If participants were especially likely to think about the mental states of the gadgets when they were described as unpredictable, then, based on prior research, we hypothesized not only that the vMPFC would be activated but that this activation would be functionally connected to activation in the precuneus and posterior cingulate. If participants were more likely to think about the animism or unpredictability of the gadgets when they were described as unpredictable, this network of activation should not be observed. Our results permitted us to reject the hypotheses that our manipulation merely influenced animism or processing unpredictability. The pattern of activation from the seed region extends from the prefrontal cortex to the parietal lobe, encompassing areas including the bilateral precuneus and posterior cingulate. This circuit resembles a set of regions termed the *default network* of the brain (Raichle et al., 2001), identified as the network active when the brain is at a baseline or resting state. This network appears associated with self-projection involved in egocentric perspective taking (Buckner & Carroll, 2007), and other work has noted this network's specific involvement in mentalizing or theory of mind (Legrand & Ruby, 2009; Spreng et al., 2009). One recent meta-analysis of research on this network "demonstrates a remarkable overlap between the brain regions typically involved in social cognitive processes and the 'default system'" (Schilbach et al., 2008, p. 457). The convergence of these findings suggests the possibility that the network of regions identified in the connectivity analysis reflects preferential mentalizing toward the unpredictable gadgets, supporting our broader hypothesis that unpredictability increases anthropomorphism.

Study 4: An Unpredictable Robot

Study 4 provided an alternate manipulation of unpredictability to examine the effects of predictability at encoding on anthropomorphism. Participants interacted with a computerized robot that behaved predictably or unpredictably. Specifically, participants asked a robot 10 yes-or-no questions through a computer interface. The robot responded in either a relatively predictable fashion or an unpredictable fashion. Participants then evaluated the robot on anthropomorphic and nonanthropomorphic traits and reported how predictable the robot seemed, how much they understood it, and how much they liked it. We expected participants would anthropomorphize the robot more when it behaved unpredictably (i.e., responding yes 50% of the time and no 50% of the time) than when it behaved more predictably (i.e., responding yes or responding no 80% of the time).

Method

Participants. Fifty-five visitors to the Museum of Science and Industry in Chicago, IL (24 women, $M_{\text{age}} = 34.89$ years, $SD = 12.32$), received their choice of a small gift in exchange for participating.

Procedure. Participants in each condition sat at a computer where they interacted with the "operating system of the Asimo robot" by asking Asimo 10 yes-or-no questions about anything they wanted to know. Unbeknownst to participants, Asimo randomly responded yes or no to their questions in one of three specified proportions. In the unpredictable condition, Asimo responded yes to five of the questions and no to five of the questions in a random fashion. In the predictable-yes condition, Asimo responded yes to eight of the questions and no to two of the questions. In the predictable-no condition, Asimo responded yes to two of the questions and no to eight of the questions. Participants asked each question one at a time, and Asimo appeared on the screen after each question with an answer.

When finished asking questions, participants evaluated Asimo. Participants first completed a manipulation check by reporting the extent to which they thought Asimo was predictable, on a 5-point scale, *Not at all* (1) to *Extremely* (5). To assess anthropomorphism, participants reported the extent to which they thought Asimo appeared to have a mind of its own, intentions, free will, consciousness, desires, beliefs, and the ability to experience emotions on the same 5-point scale. As in Study 2, participants also reported the extent to which Asimo appeared to possess positive nonanthropomorphic traits, namely, attractiveness, efficiency, and strength, on identical 5-point scales. Participants also reported the extent to which they felt like they could understand Asimo's thought process and the extent to which they liked Asimo on the same 5-point scales. Upon completing the experiment, participants were thanked, debriefed, and compensated.

Results

We computed composite scores for both anthropomorphic items ($\alpha = .82$) and nonanthropomorphic items ($\alpha = .30$). Because the intercorrelation between the nonanthropomorphic items was insufficient to justify a composite, we only analyzed these items individually. It is unclear whether the lower intercorrelation of these nonanthropomorphic items reveals something systematic about this participant sample or procedure or whether it stemmed from the generally lower intercorrelation between this set of items observed in all of the experiments reported in this article. These nonanthropomorphic items, after all, were chosen because they were unrelated to anthropomorphism, not because they were related to each other.

As hypothesized, planned orthogonal contrasts showed that participants in the unpredictable (2) condition perceived Asimo as more predictable than did participants in the predictable-yes (-1) and predictable-no (-1) conditions, $t(52) = 2.87$, $p < .01$, $r = .37$ (for all means in this experiment, see Table 2). Interestingly and unexpectedly, post hoc tests (Tukey's honestly significant difference [HSD]) revealed that participants in the predictable-no condition perceived Asimo to be more predictable than participants in the predictable-yes condition ($p < .05$). Although we can only speculate, this difference may have resulted from the different questions asked between the conditions and the appropriateness of Asimo's responses to these questions (i.e., the no responses may have been more correct to participants' questions in the predictable-no condition).

More important, a one-way ANOVA measuring the extent to which participants attributed anthropomorphic qualities to Asimo also revealed significant differences between conditions, $F(2, 52) = 4.50$, $p = .02$, $\eta^2 = .15$. Planned orthogonal contrasts revealed that participants in the unpredictable condition (2) were more likely to attribute anthropomorphic qualities to Asimo than were participants in the predictable-yes (-1) and predictable-no (-1) conditions, $t(52) = 2.57$, $p < .015$, $r = .34$. Anthropomorphism did not differ significantly between the two predictable conditions (Tukey's HSD, $p = .31$) but varied with the predictability ratings as our theory would suggest, with participants in the predictable-yes condition directionally anthropomorphizing more than those in the predictable-no condition. Consistent with the pattern of the predictability findings, post hoc tests (Tukey's HSD) indicated that anthropomorphic attributions differed significantly

Table 2
Average Responses by Robot Condition (Study 4)

	Robot condition					
	Predictable-yes		Predictable-no		Unpredictable	
Dependent measures	*M*	*SD*	*M*	*SD*	*M*	*SD*
Predictability (manipulation check)	2.88	1.41	3.79	1.08	2.42	0.84
Anthropomorphism	1.57	0.65	1.26	0.33	1.87	0.80
Attractiveness	1.88	1.17	2.95	1.68	2.53	1.22
Efficiency	3.29	1.45	2.84	1.38	2.89	1.10
Strength	2.76	1.25	3.11	1.59	2.63	0.96

between the unpredictable and predictable-no conditions ($p < .015$). The unpredictable and predictable-yes conditions did not differ significantly ($p = .33$).

We next performed ANOVAs on attributions of nonanthropomorphic traits, for which we had no predictions. No significant differences between conditions emerged on attributions of efficiency and strength (Fs < 1.00), but a marginally significant difference of attractiveness emerged, $F(2, 52) = 2.68$, $p = .08$, $\eta^2 = .09$. Post hoc tests (Tukey's HSD) revealed that participants found Asimo marginally less attractive in the predictable-yes condition compared to the predictable-no condition ($p = .064$). There were no other significant differences between conditions. These findings again suggest that stimulus unpredictability increases anthropomorphism specifically rather than altering the attribution of dispositional attributes more generally.

The findings from this study also make it clear that anthropomorphism and liking of an object may be relatively independent and depend on the object being evaluated. No significant between-condition differences emerged for liking of Asimo ($F < 1.00$), suggesting that manipulating predictability uniquely affected anthropomorphism independent of positivity toward Asimo. Somewhat unexpectedly, there were also no significant between-condition differences in understanding of Asimo ($F < 1.00$). Understanding was negligibly correlated with predictability, $r(53) = .038$, $p > .78$, suggesting that participants either did not construe this question as expected (perhaps construing it as a measure of whether they understood the programming of the computer software itself) or that understanding in this context is simply distinct from predictability.

Discussion

Unpredictability increased anthropomorphism in Study 4, as it did in Studies 1–3. Participants were more likely to perceive a robot to be a thinking, desiring, intentional, emotional agent when it responded in a relatively unpredictable manner. These results extend those of Studies 1–3 by demonstrating a causal link between stimulus unpredictability and anthropomorphism. Although the first three studies were consistent with our predictions that effectance motivation increases anthropomorphism, none of them conclusively demonstrated that the results stemmed from effectance motivation per se, rather than stemming from some purely cognitive process or a simple association. One hallmark of motivation is that it is guided by one's current goals and the incentive for rewards versus punishments. We therefore manipulated effectance motivation directly in Study 5 by increasing participants' incentives for being an effective and competent social agent and then measuring the extent to which participants anthropomorphized nonhuman agents.

Study 5: Motivating Predictability

In this study, participants watched videos of an unfamiliar robot. We increased effectance motivation for some participants by asking them to predict what the robot would do next and paying them for each correct answer. Other participants were not as motivated because they were not asked predict the robot's behavior nor were they paid to do so. This manipulation should have increased directly participants' motivation for understanding, explaining, and predicting an agent, the hallmarks of effectance motivation. We therefore predicted that participants incentivized to predict the robot's behavior would be more likely to anthropomorphize it than participants who had no incentive and were not asked to predict the robot's behavior.

Method

Participants. Sixty-three people from a university population (28 women, $M_{\text{age}} = 20.83$ years, $SD = 2.30$) received $4 to $10 for participating based on their condition and the accuracy of their predictions.

Procedure. Participants evaluated a robot, R1, displayed on a computer. Participants first familiarized themselves with R1 and watched six brief videos of R1 edited to stop before its action concluded (i.e., putting dishes away, attempting to turn on a broken vacuum cleaner, picking up blocks, taking a beer from the refrigerator, clearing dishes from a table, and being struck by a person). After the first portion of each video, a statement of the two possible outcomes of R1's action appeared (e.g., "R1 will EITHER put the dishes in the drawers OR it will put the dishes on the counter," "R1 will EITHER strike back OR it will retract," etc.). Participants randomly assigned to the control condition simply saw each statement. Participants randomly assigned to the motivated condition predicted which of the two actions R1 would perform at the end of each video and were told beforehand that they would receive $1 for each correct prediction. The experimental condition involved both prediction and a monetary incentive for accuracy to ensure that this manipulation would motivate rather than merely instruct participants to predict the robot's behavior.

All participants then evaluated R1. To assess anthropomorphism, participants reported the extent to which they believed R1 had a mind of its own, intentions, desires; was conscious; and could experience emotions on 7-point scales, *Not at all* (1) to *Very much* (7). Interspersed within these items were nonanthropomorphic measures, including the extent to which they considered R1 good-looking, useful, durable, efficient, and strong, rated on identical scales. As a manipulation check, participants reported how much they "care about predicting what R1 will do in these videos" on an identical scale. Finally, participants saw the second portion of each video, including its outcome. They were then thanked, debriefed, and paid $4 (plus $1 for every correct prediction in the motivated condition).

Results

To analyze participants' responses, we first averaged ratings of the five anthropomorphism items to attain an overall anthropomorphism composite ($\alpha = .82$). We used the same procedure for the nonanthropomorphic items to create an overall composite ($\alpha = .66$). Because this nonanthropomorphic composite was once again of only moderate reliability, rendering the composite variable more difficult to interpret, we also analyzed each of these items individually, as in Studies 2 and 4.

The motivation manipulation appeared to be effective. Participants in the motivated condition indicated that they cared more about predicting R1's actions ($M = 4.96$, $SD = 1.48$) than did participants in the control condition ($M = 4.22$, $SD = 1.49$), $t(61) = 1.96$, $p = .055$, $d = .50$. Also as predicted, participants in the motivated condition anthropomorphized R1 ($M = 2.20$, $SD = 1.28$) more than did participants in the control condition ($M = 1.65$, $SD = 0.72$), $t(61) = 2.18$, $p < .035$, $d = .56$.

Treating the nonanthropomorphic items as a composite revealed no significant difference in ratings between the motivated condition ($M = 4.49$, $SD = 0.80$) and the control condition ($M = 4.15$, $SD = 0.93$), $t(61) = 1.51$, $p = .14$, $d = .39$. A 2 (condition: motivated vs. control) × 2 (composite: anthropomorphic vs. nonanthropomorphic) mixed-model ANOVA on these composite measures revealed two significant main effects, but no significant interaction. Participants produced higher ratings on the nonanthropomorphism composite ($M = 4.29$, $SD = 0.89$) than on the anthropomorphism composite ($M = 1.88$, $SD = 1.02$), $F(1, 61) = 25.74$, $p < .0001$, $\eta^2 = .81$, and participants in the motivated condition ($M = 3.35$, $SD = 0.86$) evaluated R1 higher on both composites than those in the control condition ($M = 2.90$, $SD = 0.63$), $F(1, 61) = 5.69$, $p = .02$, $\eta^2 = .082$. A closer inspection of the individual nonanthropomorphic items revealed that R1 was rated as marginally more efficient by participants in the motivated condition ($M = 5.00$, $SD = 1.39$) than participants in the control condition ($M = 4.38$, $SD = 1.16$), $t(61) = 1.93$, $p = .058$, $d = .49$. No significant differences emerged between conditions in how good-looking ($p = .31$), durable ($p = .17$), useful ($p = .70$), or strong ($p = .70$) participants rated R1 to be.

Discussion

As predicted, participants who were motivated to predict a nonhuman agent's behavior anthropomorphized it more than participants who were not explicitly motivated to do so. Participants' motivational state did not significantly affect overall ratings on nonanthropomorphic traits, although no significant interaction emerged. This pattern in the nonanthropomorphic ratings was driven primarily by participants' ratings of R1's efficiency, a finding we did not observe in the preceding two studies and one we are therefore reluctant to speculate about in detail. There was no meaningful effect of how good-looking R1 was rated to be, unlike Studies 2 and 4, in which ratings of attractiveness were influenced in opposite or orthogonal directions by our experimental manipulation of effectance motivation. These results build on the preceding experiments by manipulating effectance motivation in participants directly while holding the behavior of the agent constant. Not only is a stimulus that activates effectance motivation especially likely to be anthropomorphized but so too is a person who is especially motivated to understand and predict a nonhuman agent especially likely to anthropomorphize that agent.

Study 6: Anthropomorphizing Enhances Effectance

Anthropomorphism appears to arise, in part, from effectance motivation. If this is the case, then not only should increasing the factors central to effectance motivation increase anthropomorphism (as demonstrated by Studies 1–5) but also anthropomorphism should satisfy effectance motivation. Just as eating food satisfies hunger, anthropomorphism should satiate this motivation for mastery and make an agent seem more predictable and understandable. Although theoretical speculation has suggested that anthropomorphism is functionally adaptive in providing this sense of efficacy (Dennett, 1987; Epley et al., 2007; Humphrey, 1983; Mithen, 1996), no experiment to our knowledge has examined this hypothesis directly. We therefore designed Study 6 to do so.

Participants in Study 6 wrote brief essays about four different stimuli—a small dog, a humanlike robot, a mobile alarm clock that contains some humanlike features, and basic geometric shapes. Each participant received instructions to anthropomorphize two of the target stimuli and to treat the other two target stimuli objectively. After each essay, participants rated the extent to which they understood the agent and felt they could predict its future behavior. We predicted that participants would rate the agents they were asked to anthropomorphize as more understandable and predictable than the agents they were asked to describe objectively.

Method

Participants. Forty-two[5] people from a university population (18 women, 3 unidentified, $M_{\text{age}} = 21.71$ years, $SD = 6.47$) received $4 for their participation.

Procedure. Participants evaluated four stimuli in one of two conditions. The four stimuli appeared in the same order in both conditions (dog, robot, alarm clock, shapes). Participants randomly assigned to replicate A were asked to anthropomorphize the dog and alarm clock but to describe the robot and the shapes objectively. Participants randomly assigned to replicate B were asked to describe the dog and alarm clock objectively but to anthropomorphize the robot and the shapes.

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[5] Data from three participants were excluded because of a computer error that failed to record their responses in full.

Each participant watched videos of the four stimuli, wrote a brief essay about each stimulus, and evaluated each stimulus on a laboratory computer in a private cubicle. The first stimulus evaluated was a small spotted puppy that played with a larger dog (instructions informed participants to focus on the small puppy only). The second stimulus evaluated was Kismet, a robot designed to facilitate interactions between robots and humans. The video showed Kismet generating affective responses toward an experimenter. The third stimulus evaluated was Clocky, a mobile alarm clock with wheels and a simple facelike appearance that runs away when the alarm sounds. The video showed Clocky beeping loudly, spinning, and rolling across a floor surface. The final stimulus evaluated was an animated set of shapes similar to those presented in Heider and Simmel's (1944) classic study of spontaneous attribution toward the behavior of objects. Each video was under 1 min in duration ($M = 30.09$ s, $SD = 11.40$).

Participants watched the video of each stimulus three times and received instructions either to anthropomorphize or to treat the stimulus objectively as a behaviorist would (see Appendix B for all instructions). Participants received reminders of these instructions before the onset of each video and directly before evaluating each stimulus on two measures to assess perceived efficacy: the extent to which participants felt they understood the stimulus and the extent to which they felt capable of predicting its future behavior because understanding and predictability are hallmarks of effectance (White, 1959). Participants made evaluations on 11-point scales, *Not at all* (0) to *Very much* (10). After making these evaluations, participants were debriefed, compensated, and dismissed.

Results

Compared to the prior studies, this study included a much wider variety of nonhuman agents, including biological agents (a dog), technological agents (a robot and an alarm clock), and animated geometric shapes. A multivariate ANOVA demonstrated that this variety produced significant variability in the average ratings of perceived understanding and predictability, $F(3, 39) = 7.02$, $p = .001$, $\eta^2 = .35$, with some agents rated as easier to understand and predict (the shapes and dog) than others (the robot and clock; $M_{\text{dog}} = 5.20$, $SD_{\text{dog}} = 1.97$; $M_{\text{robot}} = 4.61$, $SD_{\text{robot}} = 2.09$; $M_{\text{clock}} = 3.67$, $SD_{\text{clock}} = 2.68$; $M_{\text{shapes}} = 5.44$, $SD_{\text{shapes}} = 2.53$). We therefore standardized participants' responses for each agent and averaged ratings of perceived understanding and predictability for each agent ($r_{\text{dog}} = .72$, $r_{\text{robot}} = .41$, $r_{\text{clock}} = .60$, $r_{\text{shapes}} = .71$, all ps $< .01$) to create a composite effectance score for each one. We then averaged these scores for the two agents participants were instructed to anthropomorphize and the two they were instructed to treat objectively.

A 2 (instructions: anthropomorphic vs. objective) × 2 (replicate: A vs. B) repeated-measures ANOVA revealed only a significant main effect for instructions, $F(1, 40) = 4.46$, $p < .05$, $\eta^2 = .10$. Participants perceived greater efficacy with the agents they were instructed to describe anthropomorphically ($M = 0.13$, $SD = 0.70$) than with the agents they were instructed to describe objectively ($M = -0.13$, $SD = 0.79$). There was no significant main effect of replicate or interaction (Fs < 2.30, ps $> .14$), suggesting that the effect of instructions did not depend on the specific agents participants were describing.

Discussion

Studies 1–5 suggest that people anthropomorphize at least partly to satisfy their basic motivation for understanding and efficacy. The results of Study 6 suggest that anthropomorphism may indeed satisfy effectance motivation. Although we did not measure effectance motivation directly, participants reported greater understanding and predictability for stimuli they were told to anthropomorphize compared to those they were told to treat objectively. Consistent with existing suggestions and theoretical predictions (Dennett, 1987; Epley et al., 2007; Hebb, 1946; Heider, 1958/1964), transforming these stimuli into humanlike entities provided more understanding and predictability than construing the stimuli as what they actually were: nonhuman biological, robotic, mechanical, and animated entities.

General Discussion

The concept of anthropomorphism first arose in a philosopher's critique of religion. Centuries later, it remains a central topic of discussion across an increasingly diverse range of scholars (Atran & Norenzayan, 2004; Barrett, 2000; Cohen, Hill, Shariff, & Rozin, 2008; Feuerbach, 1873/2004; Freud, 1930/1989; Guthrie, 1993; Kirkpatrick, 1998; Serpell, 2003; D. S. Wilson, 2002). The tendency to perceive humanlike agency in the environment is not, however, limited to supernatural agents and can extend to targets spanning the alphabetical spectrum from alarm clocks (Epley, Akalis, et al., 2008) to zebras (Sapolsky, 1994). Understanding anthropomorphism is not simply an attempt to understand how people understand this diversity of agents in their everyday lives but is also an attempt to understand the psychological processes that enable people to attribute humanlike capacities to other agents.

This research examined whether effectance motivation—the basic motivation to be an effective social agent that entails maintaining a sense of predictability, control, and understanding over one's environment—serves as one possible determinant of anthropomorphism. We recognize that effectance motivation stimulates a variety of strategies for explanation, prediction, and sense making, and the current research demonstrates that anthropomorphism is one of the strategies employed when attempting to maintain mastery with nonhuman stimuli. The first four studies demonstrated that unpredictability (either through naturally occurring variability or through experimental manipulation) and the motivation for predictability increase the tendency to anthropomorphize nonhuman agents. Study 1 demonstrated that everyday instances of unpredictability in a nonhuman agent, namely, one's computer, are associated with anthropomorphic inferences about that agent. Study 2 demonstrated the causal link between unpredictability and anthropomorphism by demonstrating that people were more likely anthropomorphize gadgets described as unpredictable than the same gadgets described as predictable. This pattern of results was specific to anthropomorphic attribution and not to general dispositional attribution. Study 3 suggests that the neural bases of anthropomorphism triggered by effectance motivation are similar to those involved in simulating the minds of other humans. These findings provide additional support for our hypotheses using a measure that does not rely solely on self-report and also provides insight into the underlying neural correlates of anthropomorphism. Study 4 demonstrated that people are more likely to anthropomorphize nonhuman stimuli that behave relatively unpredictably in an interaction.

Studies 2 and 4 also demonstrated that liking a stimulus is not a necessary condition for anthropomorphizing it. This point is important because prior research has demonstrated a positive correlation between liking of an agent and attribution of mind to that agent (Kozak et al., 2006; McPherson-Frantz & Janoff-Bulman, 2000). Other studies have demonstrated that people enjoy interacting more with anthropomorphic technology compared to more mechanomorphic technology (Burgoon et al., 2000; Koda & Maes, 1996). It is interesting that the present studies did not replicate this pattern. In fact, Study 2 demonstrated precisely the opposite pattern such that participants anthropomorphized the unpredictable gadgets more than the predictable gadgets but liked them less. We think these findings highlight the importance of an agent's functionality in determining the relationship between mind perception and liking. For example, when interacting with a tool or object with specific functionality (such as the gadgets in Study 2), individuals may dislike an agent that operates with a humanlike mind of its own. When interacting with agents that lack a singular or particular functionality, such as with one's pets or one's friend, liking and mind perception may be positively correlated. Existing research has not definitively explained the relationship between mind perception, liking, and functionality, and this topic bears further investigation.

Study 5 demonstrated that manipulating the motivation to predict the behavior of a stimulus increases anthropomorphism. Incentivizing participants to make accurate predictions about a robot's behavior increased anthropomorphism of the robot, even though the robot's behavior was held constant across conditions. Study 5 thus rules out the possibility that unpredictability increases anthropomorphism only by cuing or priming humanness. It does not, of course, rule out the possibility that these associations play some role in the process of anthropomorphism.

Finally, Study 6 demonstrated that anthropomorphizing an unpredictable agent actually satisfies effectance motivation. In this study, stimuli that participants were led to anthropomorphize were rated as being more understandable and predictable than objects they were instructed not to anthropomorphize. Not only do factors that increase effectance motivation increase anthropomorphism but anthropomorphizing seems to satisfy this motivation as well.

We believe these studies have interesting implications for at least six areas of future research, three more broadly concerned with effectance motivation and three more specific to the phenomenon of anthropomorphism. The following sections describe these topics.

A Unifying Concept of Effectance Motivation

The present studies operationalize effectance as the motivation to attain control, predictability, and understanding, and to reduce uncertainty, unpredictability, and randomness. We believe that this broad conceptualization usefully ties together a number of related factors that researchers have traditionally considered in isolation. Research on the need for meaning, uncertainty reduction, and sense making, as well as that on individual differences in causal uncertainty (Weary & Edwards, 1996), need for closure (Webster & Kruglanski, 1994), desire for control (Burger & Cooper, 1979), locus of control (Rotter, 1966), and tolerance for ambiguity (Norton, 1975), suggests a common motivation to be an effective agent in one's environment.

Our conceptualization of effectance motivation unites these related tendencies and, we believe, contributes to a growing psychological literature on how people make sense of the world and attain a sense of competence. Our research demonstrates that anthropomorphizing a nonhuman agent is one way of satisfying effectance motivation, but it is certainly not the only way. Recent research has demonstrated that experiencing a loss of control or a violation of one's expectancies increases the tendency to see meaningful patterns in random information (Whitson & Galinsky, 2008), seek external sources of control such as God (Kay, Gaucher, Napier, Callan, & Laurin, 2008), and affirm one's moral beliefs to reattain meaning (Proulx & Heine, 2008). We believe that considering the commonalities across these seemingly distinct research findings may create a more coherent picture of human judgment and experience and that it is a critical and interesting mission for future research to determine whether the factors that contribute to understanding and competence are distinct or substitutable for one another.

Effectance Motivation and the Primacy of Mental State Attribution

Our research is consistent with existing research on person perception suggesting that effectance motivation increases attributional processing of others' behavior (see Pittman, 1998, for review). Explanations of others' behavior typically focus on personal causality (Gilbert & Malone, 1995) because these dispositional factors are seen as more stable, more predictable, and easier to control (Pittman & Pittman, 1980; Wortman, 1976). Our research suggests that others' mental states may be one particularly important element of attributions of personal causality that effectance motivation increases. Heider (1958/1964) described attributions of personal causality as explaining behavior in terms of one's underlying intentions, compared to "impersonal causality" that explains behavior "involving persons but not intentions" (p. 101). Because this important intentional–unintentional distinction became subsumed almost immediately by the person–situation distinction in attribution research (see Malle, 1999), only a few experiments have investigated or demonstrated a preferential focus on intentionality in explaining behavior (Malle & Knobe, 1997; Morewedge, 2009; Rosset, 2008). Other factors that evoke effectance motivation, such as deprivation of control or the expectation of interaction with an agent, may likewise increase mental state attribution and anthropomorphism.

Anthropomorphism and Efficacy in Human–Technology Interaction

In 2008, the United States Patent and Trademark Office granted 157,772 patents for technological inventions, a 7% increase from 10 years previous (U. S. Patent and Trademark Office, 2009). As technology advances while the population continues to age, people may find it difficult to interact effectively with the numerous gadgets and machines they must use in their work and everyday lives. Anthropomorphism may be one way to cope with this increasingly technological environment, and the findings of Study 6 demonstrate that anthropomorphism can provide a sense of efficacy in interactions with technology. Although this study measured perceived efficacy rather than actual efficacy, a series of other findings suggests that anthropomorphism increases engagement with technology that can enable more effective interactions. For instance, anthropomorphic computer interfaces are more engaging for users (Koda & Maes, 1996; Wexelblat, 1998), elicit greater attention from users (Nass, Moon, Fogg, Reeves, & Dryer, 1995), and appear more credible in decision-making tasks (Burgoon et al., 2000). Anthropomorphizing a computer may also reduce anxiety about interacting with technical agents (Luczak et al., 2003). These findings suggest that stimulating individuals to anthropomorphize technology can facilitate effective interaction and provide real efficacy.

Anthropomorphism and Moral Consideration

Perhaps the most fundamental consequence of anthropomorphism is its implication for moral agency. Kant (1785/2005) explicated this intuition most clearly when he argued that "every rational being exists as an end in himself and not merely as a means to be arbitrarily used by this or that will. . . . rational beings are called persons inasmuch as their nature already marks them out as ends in themselves" (quoted in Farah & Heberlein, 2007, p. 37). Consistent with this argument, people report that it is less acceptable to harm nonhuman entities that they perceive to have minds (Gray et al., 2007). Individuals chronically high in the tendency to anthropomorphize also judge harm committed toward a computer, a motorcycle, or even a bed of flowers to be more morally reprehensible (Waytz, Cacioppo, & Epley, 2010). Endangered animal species that individuals care most about protecting also are those that have familiar attributes and demonstrate high similarity to humans (Kellert, 1996). Anthropomorphism grants an entity the capacity for feeling pain and pleasure, thus creating moral concern. So too does anthropomorphism grant nonhuman agents responsibility for their actions, responsibility that may then justify the delegation of punishment or credit to the agent (Ashman & Winstanley, 2007; Gray et al., 2007; Hinds, Roberts, & Jones, 2004). Understanding the basic mechanisms that enable or disable the attribution of humanlike states to other agents is critical, we believe, for understanding when nonhumans are treated as moral agents and when they are not.

Anthropomorphism and Well-Being

Just as anthropomorphizing provides benefit to the target stimulus in granting it moral status, anthropomorphizing may benefit the perceiver of the stimulus. If anthropomorphism enhances efficacy, then it may also contribute to individuals' physical and mental health. Experiencing a loss of mastery and control over one's environment can lead to depression (Benassi, Sweeney, & Dufour, 1988), anxiety (Molinari & Khanna, 1981), and an overall pattern of learned helplessness (Petersen, Maier, & Seligmann, 1995). Anthropomorphism may help counteract these consequences by providing a sense of understanding, predictability, and control.

Dehumanization

One final implication of this research is that understanding the causes and consequences of humanizing a nonhuman may provide insight into the inverse process of dehumanizing other people. Psychological discussion on this topic has typically depicted the function of dehumanization as licensing aggression and immoral behavior toward the dehumanized target (Bandura, 2002; Bandura et al., 1975). Dehumanization may operate passively as well, in that individuals may simply fail to see others as essentially humanlike. Just as the present research demonstrates entities that prompt a desire for understanding and explanation as eliciting humanization, entities that fail to engage a desire for understanding or effective interaction may also diminish the attribution of mind.

People may perceive individuals who behave in a rote, predictable, or seemingly inert manner as mindless automatons (Haslam, 2006; Loughnan & Haslam, 2007). Targets with whom one is unlikely to interact, such as outgroup members (Harris & Fiske, 2006; Leyens et al., 2003), minority group members (Marcu & Chryssochoou, 2005), refugees (Esses, Veenvliet, Hodson, & Mihic, 2008), or individuals on the verge of death (Osofsky, Bandura, & Zimbardo, 2005; Schulman-Green, 2003), are more likely targets of dehumanization as well. Because interaction is unlikely with these individuals, they engage little need for understanding, predictability, and control, and hence, they fail to engage mental state attributions. Just as the present research establishes preconditions for the moral consideration of nonhuman entities, these findings may also inform research on the denial of human qualities to others and consequent wrongdoing toward these individuals. Understanding when people see other agents as humanlike may ultimately provide insight into when people are likely to behave at their compassionate best toward others and also at their dispassionate worst.

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(*Appendices follow*)

Appendix A

Gadget Descriptions and Rules (Study 2)

Clocky

Clocky is an alarm clock that looks like a furry animal, and operates in a way that makes it difficult to repeatedly press snooze in the morning.

A. 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.

B. When you press snooze, Clocky either runs away from you, or it jumps on top of you. Its response to pressing snooze is unpredictable in this way.

Moodpod

Moodpod is an MP3 player that plays songs in different moods based on your bodily state (measured through galvanic skin response).

A. You can program Moodpod so that when your body expresses a sad mood, Moodpod will play sad songs (congruent with that mood), or you can program it so that when your body expresses a sad mood, Moodpod will play happy songs (to make your mood more positive).

B. When Moodpod detects your body expressing a sad mood, it either plays sad songs (congruent with that mood), or it plays happy songs (to make your mood more positive). The affective valence of the music it plays in response to detecting a sad mood is unpredictable.

Emotoboard

Emotoboard is a computer keyboard used primarily for individuals writing e-mails at work. It assesses—through sensors on each key—the impact of one's keystrokes, the speed with which one is typing, and physiological arousal. Emotoboard then conveys to a typist when his or her typing style might be conveying a message that is too hostile or aggressive.

A. You can program Emotoboard such that it will automatically change words and sentence structure to convey a more pleasant tone when it perceives your typing style as hostile; or you can program it to simply flash a warning message on the screen to indicate that your typing style is too hostile.

B. When Emotoboard senses your typing style is hostile, it will either automatically change words and sentence structures in order to convey a more pleasant tone; or it will simply flash a warning message on the screen to indicate that your typing style is too hostile. It responds to hostility in an unpredictable manner.

Attention Goggles

Attention Goggles are glasses that detect where your visual attention is directed, and report feedback about the environment into attached headphones.

A. You can program Attention Goggles such that they will provide feedback about the most potentially dangerous (avoidable) aspects in the field where one's attention is directed; or you can program them such that they will provide feedback about the most potentially pleasurable (approachable) aspects in the field where one's attention is directed.

B. When Attention Goggles are triggered, they will either provide feedback about the most potentially dangerous (avoidable) aspects in the field where one's attention is directed or they will provide feedback about the most potentially pleasurable (approachable) aspects in the field where one's attention is directed. Which type of environmental stimuli they provide feedback about is unpredictable.

RestVest

RestVest is a vest that you wear to release muscle tension. It can detect muscle tightness in your back and works to relieve those particular areas.

A. You can program RestVest so that when it senses tension it massages that particular area, or you can program it to remain stationary and heat the particular area.

B. When RestVest senses tension in a particular area it either massages that area, or it remains stationary and heats the particular area. Its response to sensing tension is unpredictable.

Breathalyzer Phone

Breathalyzer Phone is a cell phone that can detect through a breath test when you are intoxicated.

A. You can program Breathalyzer Phone so that when it detects a high blood alcohol level (BAL), it alerts you on the screen, or you can program it so when it detects a high BAL, it locks up your phone so that you do not call others while intoxicated.

B. When Breathalyzer Phone detects a high blood alcohol level (BAL) it either alerts you on the screen or it locks up your phone so that you do not call others while intoxicated. Its response to detecting a high BAL is not always predictable.

(*Appendices continue*)

WeatherToaster

WeatherToaster is a toaster that also prints out the current weather outside onto your toast.

A. You can program WeatherToaster so that when the weather is cloudy, it prints out the word “CLOUDY” on the toast, or you can program it so that it prints out the shape of a cloud on the toast.

B. When you make toast, and the weather is cloudy, WeatherToaster either prints out the word “CLOUDY” on the toast or it prints out the shape of a cloud on the toast. Which printout it displays, the word or the image, is not predictable.

Snowsneakers

Snowsneakers are tennis shoes that help people walk through snow using sensors on the bottom of each shoe.

A. You can program Snowsneakers so that when they sense snow, they heat up to melt the snow, or you can program them so that they shoot out tiny claws to help provide traction on the snow.

B. When Snowsneakers sense snow, they either heat up to melt the snow or they shoot out tiny claws to help provide traction on the snow. Which function they perform when detecting snow is not predictable.

Voicetype

Voicetype is a device attached to a computer that you speak into. Voicetype simultaneously converts speech into type in a word processing program.

A. You can program Voicetype so that when it notices a grammatical mistake, it provides a suggestion; or you can program it so that when it notices a grammatical mistake, it stops typing until you verbally make a correction.

B. When Voicetype notices a grammatical mistake, it either provides a suggestion or it stops typing until you verbally make a correction. Its response to grammatical mistakes is not predictable.

EnFocus Camera

EnFocus is a camera that virtually eliminates blurriness in photography.

A. You can program EnFocus so that when it detects blurriness in an image, it readjusts the aperture automatically to take a clear photo or you can program it so that when it detects blurriness, it closes its lens and will not take a photo until manually readjusted.

B. When EnFocus detects blurriness in an image, it either readjusts the aperture automatically to take a clear photos or it closes its lens and will not take a photo until manually readjusted. Its response to blurriness is unpredictable.

DangerMouse

DangerMouse is a computer mouse (that looks like a real mouse) for children that prevents them from accessing dangerous or explicit material on a computer or on the Internet.

A. You can program DangerMouse so that when the cursor is placed on a potentially dangerous element (piece of e-mail, software download, hyperlink, etc.) it freezes up (does not allow the cursor to click), or you can program it to “run away” and automatically move the cursor to the corner of the computer screen.

B. When the cursor is placed on a potentially dangerous element (piece of e-mail, software download, hyperlink, etc.) DangerMouse either freezes up (does not allow the cursor to click), or it “runs away” and automatically moves the cursor to the corner of the computer screen. Which of these functions is performed when a dangerous element is approached is not predictable.

Sound Princess

The Sound Princess is a device that can be attached to a toilet to eliminate potentially embarrassing “toilet noises” so that, in public restrooms, surrounding patrons do not hear these noises.

A. You can program the Sound Princess to mask toilet noises by producing white noise, or you can program it to reduce toilet noises by simulating the sound of repeated toilet flushes.

B. When triggered, the Sound Princess masks toilet noises either by producing white noise, or by simulating the sound of repeated toilet flushes. The sound produced by this device is unpredictable.

Heart-Healthy Watch

The Heart-Healthy Watch is a normal time-telling watch that also alerts you to indicators of heart disease.

A. You can program the Heart-Healthy Watch to indicate when your blood pressure reaches a dangerously high level, or you can program it to indicate when your pulse reaches a dangerously high level.

B. When the Heart-Healthy Watch is triggered it either indicates when your blood pressure reaches a dangerously high level, or it indicates when your pulse reaches a dangerously high level. Which process it indexes and provides feedback on is unpredictable.

Sensorazor

Sensorazor is an electric face razor that can detect and adjust to changes in someone’s facial architecture.

A. You can program Sensorazor to stop shaving (turn off) when it detects an area of sensitive skin, or you can program it to employ softer blades when it detects an area of sensitive skin.

(*Appendices continue*)

B. When Sensorazor detects an area of sensitive skin, it either stops shaving (turns off) or it employs softer blades. Which operation occurs when Sensorazor detects sensitive skin is unpredictable.

Pillow Mate

Pillow Mate is a robotic pillow shaped like the torso of a human.

A. You can program Pillow Mate so that when you squeeze it, it hugs you or you can program it so that when you squeeze it, it curls into a ball.

B. When Pillow Mate is squeezed, it either hugs you or it curls into a ball. It is unpredictable in this way.

Childsafe DVD Player

The Childsafe DVD Player is a DVD player that censors explicit or R-rated portions of particular movies or programs.

A. You can program the Childsafe DVD Player to blur out images in particularly explicit scenes or you can program it to omit particularly explicit scenes altogether.

B. When explicit scenes are identified, the Childsafe DVD Player either blurs out images in these scenes or it omits the scenes altogether. Which of these operations occurs is not predictable.

Sportalert Monitor

Sportalert is a monitor attached to your television that notifies you when a sports contest on another channel has reached a critical point (e.g., when a football team is closing in on a touchdown).

A. You can program Sportalert so that when it identifies a critical point in a sports contest, it flashes a message on the channel that you are currently watching, or starts playing that sports contest (on a miniature screen) within the screen one is currently watching.

B. When Sportalert identifies a critical point in a sports contest, it either flashes a message on the channel that you are currently watching or it starts playing that sports contest (on a miniature screen) within the screen one is currently watching. Which of these functions occurs when a critical point in a sports contest is identified is unpredictable.

Reminder Ring

Reminder Ring is a ring that reminds you of daily appointments (e.g., meetings, times to take a medication, etc.).

A. You can program Reminder Ring to display a message on its small LCD screen when an appointment comes up, or you can program it to flash a light when an appointment comes up.

B. When an appointment comes up, Reminder Ring either displays a message on its small LCD screen or it flashes a light when an appointment comes up. Which notification occurs when an appointment comes up is not predictable.

CleverCharger

CleverCharger is a battery charger used in order to prevent overcharging batteries.

A. You can program CleverCharger so that when it is done charging a battery, it will beep loudly (and keep charging), or you can program it to automatically stop charging when it is done charging a battery.

B. When CleverCharger is done charging a battery it either beeps loudly (and keeps charging) or it automatically stops charging. It is unpredictable as to which of these operations occur when CleverCharger is done charging.

Street Mutt

Street Mutt is a robotic dog.

A. You can program Street Mutt to whimper when it is approached by humans, or you can program it to bark loudly when it is approached by humans.

B. When Street Mutt is approached by humans, it either whimpers or it barks loudly. Its response to being approached is unpredictable.

Ecopod

Ecopod is a functional recyclable bin for cans and plastic bottles.

A. You can program Ecopod so that it sorts and stores cans/bottles in a compact manner, or you can program it to immediately crush cans/bottles when they are deposited.

B. When cans and bottles are deposited into Ecopod, it either sorts and stores them or it immediately crushes cans/bottles. How it handles deposits is unpredictable.

CogMask

CogMask is a mask worn to bed that subliminally flashes information before your eyes to promote memory consolidation and learning during sleep.

A. You can program CogMask to flash vocabulary words and definitions or you can program CogMask to flash historical facts.

B. When CogMask is activated it either flashes vocabulary words and definitions, or it flashes historical facts. Which type of information it displays is unpredictable.

(*Appendices continue*)

No-Harm Scissors

No-Harm Scissors are scissors made to reduce the harm in carrying scissors upward.

A. You can program No-Harm Scissors so the blade automatically softens when being carried upside down, or you can program No-Harm scissors so that the blade automatically retracts when being carried upside down.

B. When No-Harm Scissors are carried upside down, either the blade automatically softens or the blade automatically retracts. How the scissors respond to being carried upside down is not predictable.

Detector Headset

Detector Headset is a combination glasses and headphones that indicate when a conversation partner is lying while speaking.

A. You can program the Detector Headset so that when it identifies a lie, it reinterprets the partner's untruthful statements into the headphones, or you can program it to send an alert signal to the headphones.

B. When the Detector Headset identifies a lie, it either reinterprets the partner's untruthful statements into the headphones, or it sends an alert signal to the headphones. Which of these operations the headset performs when detecting a lie is not predictable.

Ultimo Headphones

Ultimo Headphones are the latest in noise-reduction headphones.

A. You can program Ultimo Headphones so that when you enter noisier environments, they reduce surrounding ambient noise, or you can program them so that when you enter noisier environments they will increase the volume of the audio in the headphones.

B. When you enter noisier environments, Ultimo Headphones either reduce surrounding ambient noise, or they increase the volume of the audio in the headphones. Which of these functions they perform when encountering a noisy environment is unpredictable.

Supershade

Supershade is an innovative parasol for sunbathing.

A. You can program Supershade to convert sunlight into the ideal spectral band for tanning your skin, or you can program it to convert sunlight into energy to power personal electronic devices.

B. When sunlight contacts Supershade it either converts sunlight into the ideal spectral band for tanning your skin, or it converts sunlight into energy to power your personal electronic devices. Which of these responses is triggered when sunlight contacts Supershade is unpredictable.

Pure Air

Pure Air is an air purifier that has particular settings (e.g., humid air or dry air) for people with specific allergies and respiratory problems.

A. You can program Pure Air so that when it detects unhealthy air, it humidifies the room, or you can program it so that when it detects unhealthy air, it provides dry air throughout the room.

B. When unhealthy air is detected, Pure Air either humidifies or it provides dry air throughout the room. Which of these functions it performs after detecting unhealthy air is not easily predictable.

Handletek

Handletek is a basketball with various functions that allows basketball players to work on dribbling techniques and handling the ball.

A. You can program Handletek so when it is activated, it becomes bouncier than a normal basketball (more difficult to corral), or you can program it so that when it is activated, it becomes stickier to the palm of the dribbler (easier to grip).

B. When Handletek is on, it either becomes bouncier than a normal basketball (more difficult to corral) or it becomes sticky to the palm of the dribbler (easier to grip). What the ball does when activated is unpredictable.

Auto Detective Pen

The Auto Detective Pen is a pen that scans your surroundings to detect unknown wireless signals.

A. You can program the Auto Detective pen to alert you by flashing a light when it detects a wireless signal, or you can program it to magnetically point toward a wireless signal when it is detected.

B. When it detects a wireless signal, the Auto Detective pen either alerts you by flashing a light or it magnetically points toward the signal. Which of these functions it performs when detecting a wireless signal is not predictable.

IonKids System

IonKids System is a PDA device with a separate wristwatch. Strap the watch to the kid's wrist (or more appropriately, ankle) and it will send an alert when your kids get too far away from you.

A. You can program IonKids to alert your kids when they are too far away from you, or you can program IonKids to alert you when they are too far away from you.

B. When your kids get too far away from you, IonKids either alerts your kids or IonKids alerts you. This device is unpredictable with regard to the person it alerts.

(*Appendices continue*)

Appendix B

Anthropomorphic and Behaviorist Instructions (Study 6)

Gizmo

Anthropomorphic Description

You will now watch a video of two dogs. We would like you to focus on the little dog with black spots, named Gizmo. When watching Gizmo, we want you try to get inside of its mind and think about it in the same way you would think about other people. We want you to anthropomorphize Gizmo to see it as humanlike, and to treat it as if it had humanlike traits, emotions, and intentions. Watch its behavior closely and try to think about it as if it was a person interacting with another person. When you are done watching the video three times, we will have you write a story about what Gizmo was doing in these videos, again trying to describe the dog's behavior as if it was a human.

Behaviorist Description

You will now watch a video of two dogs. We would like you to focus on the little dog with black spots, named Gizmo. When watching Gizmo, we want you to remain detached and think only about the observable behaviors this dog is performing and think about it as you might think about any other unfamiliar animal. We want you to focus on the dog's observable behavior and think about it only in terms of the specific behaviors and actions you can actually see. Treat it as an animal interacting with another animal. Watch its behavior closely and try to remain objective. When you are done watching the video three times, we will have you write a story about what the dog was doing in these videos, again trying to describe the dog's behavior as objectively as you can.

Kismet

Anthropomorphic Description

You will now watch a video of Kismet, a robot developed at MIT. When watching Kismet, we want you try to get inside of its mind and think about it in the same way you would think about other people. We want you to anthropomorphize Kismet to see it as humanlike, and to treat it as if it had humanlike traits, emotions, and intentions. Watch its behavior closely and try to think about it as if it was a person. When you are done watching the video three times, we will have you write a story about what Kismet was doing in these videos, again trying to describe the robot's behavior as if it was a human.

Behaviorist Description

You will now watch a video of Kismet, a robot developed at MIT. When watching Kismet, we want you to remain detached and think only about the observable behaviors this robot is performing and think about it as you might think about any other unfamiliar machine. We want you to focus on the robot's observable behavior and think about it only in terms of the specific behaviors and actions you can actually see. Treat it as a machine. Watch its behavior closely and try to remain objective. When you are done watching the video three times, we will have you write a story about what Kismet was doing in these videos, again trying to describe the robot's behavior as objectively as you can.

Clocky

Anthropomorphic Description

You will now watch a video of Clocky, a moving alarm clock. When watching Clocky, we want you try to get inside of its mind and think about it in the same way you would think about other people. We want you to anthropomorphize Clocky to see it as humanlike, and to treat it as if it had humanlike traits, emotions, and intentions. Watch its behavior closely and try to think about it as if it was a person. When you are done watching the video three times, we will have you write a story about what Clocky was doing in these videos, again trying to describe the gadget's behavior as if it was a human.

Behaviorist Description

You will now watch a video of Clocky, a moving alarm clock. When watching Clocky, we want you to remain detached and think only about the observable behaviors it is performing and think about it as you might think about any other unfamiliar gadget. We want you to focus on the gadget's observable behavior and think about it only in terms of the specific behaviors and actions you can actually see. Treat it as a gadget. Watch its behavior closely and try to remain objective. When you are done watching the video three times, we will have you write a story about what Clocky was doing in these videos, again trying to describe the gadget's behavior as objectively as you can.

Shapes

Anthropomorphic Description

You will now watch a video of shapes. When watching these shapes, we want you try to get inside of their minds and think about them in the same way you would think about other people. We want you to anthropomorphize these shapes to see them as humanlike, and to treat them as if they had humanlike traits, emotions, and intentions. Watch their behavior closely and try to think about them as if they were people. When you are done watching the video three times, we will have you write a story about what these shapes were doing in these videos, again trying to describe the shapes' behavior as if they were humans.

(*Appendices continue*)

Behaviorist Description

You will now watch a video of shapes. When watching these shapes, we want you to remain detached and think only about the observable behaviors they are performing and think about them as you might think about any other unfamiliar objects. We want you to focus on the shapes' observable behavior and think about them only in terms of the specific behaviors and actions you can actually see. Treat them as objects. Watch their behavior closely and try to remain objective. When you are done watching the video three times, we will have you write a story about what these shapes were doing in these videos, again trying to describe the shapes' behavior as objectively as you can.

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New APA Editors Appointed, 2012–2017

The Publications and Communications Board of the American Psychological Association announces the appointment of 9 new editors for 6-year terms beginning in 2012. As of January 1, 2011, manuscripts should be directed as follows:

- *Emotion* (http://www.apa.org/pubs/journals/emo), **David DeSteno, PhD,** Department of Psychology, Northeastern University, Boston, MA 02115
- *Experimental and Clinical Psychopharmacology* (http://www.apa.org/pubs/journals/pha), **Suzette M. Evans, PhD**, Columbia University and the New York State Psychiatric Institute, New York, NY 10032
- *Journal of Abnormal Psychology* (http://www.apa.org/pubs/journals/abn), **Sherryl H. Goodman, PhD**, Department of Psychology, Emory University, Atlanta, GA 30322
- *Journal of Comparative Psychology* (http://www.apa.org/pubs/journals/com), **Josep Call, PhD,** Max Planck Institute for Evolutionary Biology, Leipzig, Germany
- *Journal of Counseling Psychology* (http://www.apa.org/pubs/journals/cou), **Terence J. G. Tracey, PhD,** Counseling and Counseling Psychology Programs, Arizona State University, Tempe, AZ 85823
- *Journal of Personality and Social Psychology: Attitudes and Social Cognition* (http://www.apa.org/pubs/journals/psp), **Eliot R. Smith, PhD,** Department of Psychological and Brain Sciences, Indiana University, Bloomington, IN 47405
- *Journal of Experimental Psychology: General (*http://www.apa.org/pubs/journals/xge), **Isabel Gauthier, PhD,** Department of Psychology, Vanderbilt University, Nashville, TN 37240
- *Journal of Experimental Psychology: Human Perception and Performance* (http://www.apa.org/pubs/journals/xhp), **James T. Enns, PhD**, Department of Psychology, University of British Columbia, Vancouver, BC V6T 1Z4
- *Rehabilitation Psychology* (http://www.apa.org/pubs/journals/rep), **Stephen T. Wegener, PhD, ABPP,** School of Medicine Department of Physical Medicine and Rehabilitation, Johns Hopkins University, Baltimore, MD 21287

Electronic manuscript submission: As of January 1, 2011, manuscripts should be submitted electronically to the new editors via the journal's Manuscript Submission Portal (see the website listed above with each journal title).

Manuscript submission patterns make the precise date of completion of the 2011 volumes uncertain. Current editors, Elizabeth A. Phelps, PhD, Nancy K. Mello, PhD, David Watson, PhD, Gordon M. Burghardt, PhD, Brent S. Mallinckrodt, PhD, Charles M. Judd, PhD, Fernanda Ferreira, PhD, Glyn W. Humphreys, PhD, and Timothy R. Elliott, PhD will receive and consider new manuscripts through December 31, 2010. Should 2011 volumes be completed before that date, manuscripts will be redirected to the new editors for consideration in 2012 volumes.