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Kids See Human Too: Adapting an Individual Differences Measure of Anthropomorphism for a Child Sample

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The study of anthropomorphism in adults has received considerable interest with the development of the Individual Differences in Anthropomorphism Questionnaire (IDAQ; Waytz, Cacioppo, & Epley, 2010). Anthropomorphism in children—its development, correlates, and consequences—is also of significant interest, yet a comparable measure does not exist. To fill this gap, we developed the IDAQ-Child Form (IDAQ-CF) and report on 2 studies. In Study 1A, adults (N = 304) were administered the IDAQ and IDAQ-CF to directly assess comparability between the measures. In Study 1B, an additional 350 adults were administered the IDAQ-CF to confirm that the new measure had the same underlying structure as the original IDAQ when the measures were not administered together. In Study 2, children (N = 90) in 3 age groups—5, 7, and 9 years old—were administered the IDAQ-CF and an Attribution Interview, which probed their conceptions of a robot and puppet. Results indicated the IDAQ-CF a) is comparable to the original IDAQ in adult (Studies 1A and 1B) and child (Study 2) samples, and b) predicts children's tendency to attribute animate characteristics to inanimate entities (Study 2). This research provides strong evidence that the IDAQ-CF is an effective adaptation of the original IDAQ for use with children.

Meet "Bertha," a 57.5-foot (17.5. meters), 7,000-ton (7,000,000 kg) "tunneling specialist" who likes "dirt, small boulders, perfectly formed concrete rings" and dislikes "sunlight" (Washington State Department of Transportation, 2013, left sidebar). Bertha, as named by local school children, is the world's largest-diameter tunneling machine responsible for carving a 2-mile (3.22 km) tunnel beneath downtown Seattle, WA. Bertha has a Twitter feed (@BerthaDigsSR99) with regular updates on her progress ("My cutterhead is spinning again. It feels great to be on the move."), delays ("I'm not digging right now, but there's still a lot of work happening."), and occasional comments on issues surrounding the project ("Update: I've finished reading *War and Peace*. Seems appropriate to spend my idle time exploring the nature of conflict.").

The act of anthropomorphizing—the tendency to attribute human-like characteristics, particularly internal states and capabilities, to nonhuman entities—is not new or even surprising.

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In the often-cited study by Heider and Simmel (1944), adult participants described simple moving shapes (triangles and circles) as if they had intentions and emotions. More recent work has shown that infants will interpret animated shapes as agents worthy of social evaluation (Hamlin, Wynn, & Bloom, 2007) and representative of social attachment (Johnson, Dweck, & Chen, 2007). There are, however, limits on the tendency to view objects as agentive. For example, infants who interpret a person's actions as goal-directed do not interpret the same actions as goal-directed when performed by a mechanical arm (Woodward, 1998). Yet these limits can be overcome with minimal social cues. Infants viewed a robot as a social agent (as measured by gaze following), but only when it previously engaged in a socially contingent manner with a human model (Meltzoff, Brooks, Shon, & Rao, 2010). Even the act of naming, as illustrated in the example of Bertha, can be a salient cue leading to anthropomorphic attributions (Eyssel & Kuchenbrandt, 2012).

The inclination to anthropomorphize, from pixels to pets, is evident from infancy to adulthood. Yet there is individual variability as well. Along these lines, dispositional anthropomorphism has received considerable interest following the development of the Individual Differences in Anthropomorphism Questionnaire (IDAQ; Waytz, Cacioppo, & Epley, 2010). The IDAQ was developed as an efficient measure of individual differences in anthropomorphism in adults. It involves a 15-item questionnaire that assesses anthropomorphism (e.g., attributions of consciousness, intentions, emotions) of technologies, inanimate nature, and animals. It has been found to have high internal consistency ($\alpha \geq .82$) and stability over time. Waytz et al. (2010) argued that anthropomorphism is "a far-reaching phenomenon that incorporates ideas from social psychology, cognitive psychology, developmental psychology, and the neurosciences" (p. 219). It follows that research on anthropomorphism has broad appeal within psychology. For example, studies employing the IDAQ have shown dispositional anthropomorphism is related to the perception of intentionality in financial markets (Caruso, Waytz, & Epley, 2010, Study 4), hoarding behavior (e.g., sentimental attachment to objects; Timpano & Shaw, 2013), paranormal beliefs (Willard & Norenzayan, 2013), and gray-matter volume of the temporoparietal junction (Cullen, Kanai, Bahrami, & Rees, 2013).

Unfortunately, a comparable measure of individual differences in anthropomorphism does not exist for use with children. To fill this gap—thereby allowing for investigation of the development, correlates, and consequences of anthropomorphism in children—we have developed a child version of the IDAQ, referred to as the IDAQ-Child Form (IDAQ-CF). This measure involves a 12-item questionnaire of anthropomorphism of animals, inanimate nature, and technology. We report here on two studies designed to establish the IDAQ-CF as comparable to the IDAQ and appropriate for use with child samples. In Studies 1A and 1B, we assessed the comparability between the IDAQ-CF and original IDAQ in adult samples. In Study 2, children (aged 5–9 years) were administered the IDAQ-CF and an Attribution Interview, which probed their conceptions of a robot and puppet, to assess the IDAQ-CF's predictive validity.

STUDY 1: ADULT SAMPLES

Study 1A

To assess the comparability between the IDAQ-CF and original IDAQ, we administered both measures to an adult sample.

Method

Participants. Participants included 304 undergraduate students (M_{age} = 20;4, *SD* = 46.8 months, range = 18;0–61;11; 64.8% women). Participants self-identified their race/ethnicity as White (77.3%), Asian (7.2%), Latina/o (3.0%), African American (1.6%), or Other (10.9%; including more than one race/ethnicity). Participants were recruited through the Psychology Participant Pool and received course credit for their participation.

Measures and procedure. Participants completed an online survey composed of two measures: the IDAQ and IDAQ-CF (see Table 1). The IDAQ (Waytz et al., 2010) is a 15-item questionnaire that assesses anthropomorphism of technologies, inanimate nature, and animals in terms of consciousness, free will, intentions, mindedness, and emotions (e.g., "To what extent

TABLE 1
IDAQ and IDAQ-CF Items

IDAQ	
Tech_intentions	To what extent does technology—devices and machines for manufacturing, entertainment, and productive processes (e.g., cars, computers, television sets)—have intentions?
Tech_emotions	To what extent does a television set experience emotions?
Tech_conscious	To what extent does the average robot have consciousness?
Tech_freewill	To what extent does a car have free will?
Tech_mind	To what extent does the average computer have a mind of its own?
Nat_intentions	To what extent does the wind have intentions?
Nat_emotions	To what extent does the environment experience emotions?
Nat_conscious	To what extent does the ocean have consciousness?
Nat_freewill	To what extent does the average mountain have free will?
Nat_mind	To what extent does a tree have a mind of its own?
Anim_intentions	To what extent do cows have intentions?
Anim_emotions	To what extent does a cheetah experience emotions?
Anim_conscious	To what extent does the average reptile have consciousness?
Anim_freewill	To what extent does the average fish have free will?
Anim_mind	To what extent does the average insect have a mind of its own?
IDAQ-CF[a]	
CF_Tech_intentions	Does a car do things on purpose? If yes, how much?
CF_Tech_emotions	Does a TV have feelings, like happy and sad? If yes, how much?
CF_Tech_conscious	Does a robot know what it is? If yes, how much?
CF_Tech_mind	Does a computer think for itself? If yes, how much?
CF_Nat_intentions	Does the wind do things on purpose? If yes, how much?
CF_Nat_emotions	Does a mountain have feelings, like happy and sad? If yes, how much?
CF_Nat_conscious	Does the ocean know what it is? If yes, how much?
CF_Nat_mind	Does a tree think for itself? If yes, how much?
CF_Anim_intentions	Does a turtle do things on purpose? If yes, how much?
CF_Anim_emotions	Does a cheetah have feelings, like happy and sad? If yes, how much?
CF_Anim_conscious	Does a lizard know what it is? If yes, how much?
CF_Anim_mind	Does an insect or bug think for itself? If yes, how much?

Note. IDAQ = Individual Differences in Anthropomorphism Questionnaire; IDAQ-CF = Individual Differences in Anthropomorphism Questionnaire-Child Form. [a]Study 1 questions were rephrased as "How much does . . .?" rather than the two-part question used with children.

does the average cheetah experience emotions?”). The IDAQ-CF is a 12-item questionnaire designed for use with children to similarly assess anthropomorphism of technologies, inanimate nature, and animals in terms of consciousness, intentions, mindedness, and emotions (e.g., “How much does a car do things on purpose?”). The 3 free-will questions included in the IDAQ were dropped from the IDAQ-CF due to concern with young children’s comprehension of these questions (e.g., “How much does a fish make its own choices?”) during piloting. Rather than understanding the question in a broad sense of free will, as intended, young children tended to inquire about specific instantiations of choice (e.g., “Make choices about what?”) and provided a multitude of (often-conflicting) answers to each of their spontaneously generated instances. The resulting problems posed for coding and brevity of the measure led us to drop this set of questions (for a review of children’s developing conceptions of free will, see Kushnir, 2012). In developing the IDAQ scale, Waytz et al. (2010) included 15 additional items to discriminate anthropomorphism from general dispositional attributions; however, these items are not used to compute the IDAQ score. We also included 23 additional nonanthropomorphism items (e.g., “To what extent is the average kitchen appliance useful?”) to draw attention away from the purpose of the scales. All questions (15 IDAQ items, 12 IDAQ-CF items, and 23 nonanthropomorphism items) were presented in random order, and participants responded to each question on an 11-point scale (0 = “not at all” to 10 = “very much”).

Results

IDAQ Factor Structure. Waytz et al. (2010) found that the full IDAQ scale was optimized by a two-factor, oblique structure, with one factor relating to anthropomorphic views of technology and nature and a second factor relating to anthropomorphism of animals. Questions not pertaining to anthropomorphism were scattered across the two factors with mostly weak loadings and no clear pattern. Because nonanthropomorphic items were not designed to measure the same underlying construct as the anthropomorphism items and because they are not included in the scoring of the scale, analyses in the present study were conducted only using the 15 anthropomorphic-related items.

Exploratory factor analysis (EFA) of the 15 anthropomorphic items revealed a very similar underlying structure to that observed by Waytz et al. (2010). An initial analysis using the Statistical Package for the Social Sciences with maximum likelihood extraction with an oblimin rotation (delta = 0) indicated two strong factors (Factor 1 eigenvalue = 4.86, 32.43% variance explained; Factor 2 eigenvalue = 2.62, 17.42% variance explained). A third factor had an eigenvalue of 1.24 but explained only 8.28% of the variance and did not include any items that loaded on it uniquely. No other factor had an eigenvalue greater than 1.0. Because a two-factor solution is theoretically justified and is well supported by the data, we refit the items with a two-factor, oblique solution and found that the 10 items regarding anthropomorphic views about technology and nature loaded strongly onto the first factor and 5 items regarding anthropomorphic views about animals loaded strongly onto the second factor; factors were correlated at r = .22 (see Table 2 for factor loadings). The solution was generally very clean, with the exception of the nature question, “To what extent does a tree have a mind of its own?” which loaded well on the technology/nature factor but also had a modest cross-loading on the animal factor.

TABLE 2
Study 1A (Adult Sample) IDAQ and IDAQ-CF Scale Items and Factor Loadings

	Pattern Coefficients		*Structure Coefficients*	
	Factor 1	*Factor 2*	*Factor 1*	*Factor 2*
IDAQ				
Tech_intentions	**.50**	.05	**.51**	.13
Tech_emotions	**.64**	−.18	**.61**	−.08
Tech_conscious	**.67**	−.13	**.65**	−.02
Tech_freewill	**.64**	−.14	**.61**	−.03
Tech_mind	**.65**	−.04	**.64**	.07
Nat_intentions	**.65**	.09	**.67**	.20
Nat_emotions	**.68**	.22	**.71**	.33
Nat_conscious	**.59**	.16	**.62**	.26
Nat_freewill	**.54**	.11	**.56**	.20
Nat_mind	**.48**	.31	**.53**	.39
Anim_intentions	−.03	**.67**	.08	**.67**
Anim_emotions	.10	**.69**	.21	**.71**
Anim_freewill	−.01	**.61**	.09	**.60**
Anim_conscious	.08	**.66**	.19	**.67**
Anim_mind	.14	**.67**	.25	**.70**
IDAQ-CF				
CF_Tech_intentions	**.46**	−.02	**.46**	.08
CF_Tech_emotions	**.61**	−.11	**.59**	.03
CF_Tech_conscious	.39	.13	**.42**	.22
CF_Tech_mind	**.52**	.02	**.52**	.14
CF_Nat_intentions	**.72**	.04	**.73**	.20
CF_Nat_emotions	**.74**	.01	**.74**	.18
CF_Nat_conscious	**.75**	.01	**.75**	.18
CF_Nat_mind	**.44**	.32	**.51**	.42
CF_Anim_intentions	−.13	**.64**	.01	**.61**
CF_Anim_emotions	.10	**.71**	.26	**.60**
CF_Anim_conscious	.13	**.58**	.19	**.67**
CF_Anim_mind	.02	**.74**	.19	**.75**

Note. IDAQ = Individual Differences in Anthropomorphism Questionnaire; IDAQ-CF = Individual Differences in Anthropomorphism Questionnaire-Child Form. Coefficients > .40 are in bold.

In addition, we conducted a confirmatory factor analysis (CFA) on the same data set, fitting a model with two correlated factors using structural equation modeling software (EQS) 6.2. Technology/nature items were included on the first factor and animal items were included on the second factor. Statistics were computed using the "Robust" option in EQS 6.2 to adjust for multivariate kurtosis. This model provided a moderate fit to the data, although not ideal, Satorra-Bentler $\chi^2 = 257.55$, $df = 89$, $p < .001$, comparative fit index (CFI) = .86, root mean square error of approximation (RMSEA) = .079, 90% confidence interval (CI) [.068, .090], factor correlation $r = .34$, $p < .01$.

Waytz et al. (2010) did not report fit statistics for a two-factor model including only anthropomorphic items, so we cannot directly compare the results of the present study to their report. However, they did provide correlations of all of the anthropomorphic items, which allowed us to reanalyze their data. Using correlations reported by Waytz et al. (p. 223), a model fitting two correlated factors (technology/nature and animal) indicated a fit very similar to that observed in the present study, χ^2 = 408.99,[1] *df* = 89, *p* < .001, CFI = .90, RMSEA = .077, 90% CI [.069, .084], factor correlation *r* = .51, *p* < .001. Thus, although the overall model fit in the present study is only moderate, it is reasonable to conclude that we replicated the results originally observed by Waytz et al.

Waytz et al. (2010, Study 2) also tested a model with a second-order "general anthropomorphism" factor predicting the technology/nature and animal factors and found that this model fit the data reasonably well. In the present study, the fit of the second-order factor model was virtually identical to the model with two correlated factors, Satorra-Bentler χ^2 = 257.55, *p* < .001, CFI = .86, RMSEA = .079, 90% CI [.068, .090]. The superordinate factor loaded significantly on both the technology/nature factor (standardized slope = .62, *p* < .001) and the animal factor (standardized slope = .55, *p* < .001). Thus, the data are consistent with a higher-order factor of general anthropomorphism as well as with the simpler model including two correlated factors.

Cronbach's alpha reliability for the scale, including all 15 anthropomorphism-related items, was good (α = .84). The subscale of 10 technology/nature items was also reliable (α = .85), as was the subscale of 5 animal items (α = .82). Subscale scores were created by averaging responses across the 10 technology/nature items and separately across the 5 animal items. A 2 × 2 mixed-model analysis of variance (ANOVA) with participant gender as an independent-samples factor and scale as a repeated-measures factor showed that participants had much higher endorsement of the animal items (*M* = 5.83, *SD* = 2.12) than the technology/nature items (*M* = 1.67, *SD* = 1.65), *F*(1, 302) = 906.90, *p* < .0001, η_p^2 = .75. Men and women did not differ in their overall endorsement of anthropomorphism, *F*(1, 302) = 2.90, *ns*, and the Gender × Scale interaction was also not significant, *F*(1, 302) = 0.58, *ns*, indicating that men and women do not differ in their endorsement of anthropomorphism of animals versus technology/nature.

IDAQ-CF factor structure. Responses of the adult participants to the 12-item IDAQ-CF were similarly analyzed using EFA. Initial analysis supported two strong factors (Factor 1 eigenvalue = 3.95, 32.89% variance explained; Factor 2 eigenvalue = 2.09, 17.43% variance explained); no other factor had an eigenvalue greater than 1.0. We then refit the items, forcing a two-factor solution with correlated factors. As with the adult items, the 8 technology/nature items loaded onto the first factor and the 4 animal items loaded strongly onto the second factor (see Table 2 for factor loadings). The item, "How much does a tree think for itself?" loaded primarily on the technology/nature factor but had a fairly strong loading on the animal factor as well. This item is similar to the item on the adult scale that also loaded on both factors. The item "How much does a robot know what it is?" loaded primarily on the technology/nature factor, but with a factor loading of only .39, which is weaker than other items on that factor and below the typical threshold of .40.

A CFA was next conducted on the same data set, fitting a model with two correlated factors, including technology/nature items on the first factor and animal items on the second. This model provided a moderately good fit to the data, Satorra-Bentler χ^2 = 127.01, *df* = 53, *p* < .001, CFI = .91, RMSEA = .068, 90% CI [.053, .083], factor correlation *r* = .33, *p* < .01.

[1] Robust statistics could not be computed because the input data set was a correlation matrix.

We next fitted a model with a second-order general anthropomorphism factor predicting the technology/nature and animal factors. The second-order model fit was identical to the simpler, two-factor model, Satorra-Bentler χ^2 = 127.01, *df* = 53, *p* < .001, CFI = .91, RMSEA = .068, 90% CI [.053, .083]. The superordinate factor loaded significantly on both the technology/nature factor (.48) and the animal factor (.69). Thus, as with the original IDAQ adult items, the IDAQ-CF items are consistent with a higher-order factor of general anthropomorphism, but no more so than with a simpler model with two correlated factors.

Cronbach's alpha reliability for the scale, including all 12 anthropomorphism-related items, was good (α = .80). The subscale of 8 technology/nature items was also reliable (α = .80), with the subscale of 4 animal items being slightly less reliable (α = .77). Subscale scores were created by averaging responses across the 8 technology/nature items and also across the 4 animal items. As with the adult IDAQ scale, participants showed much higher endorsement of anthropomorphism of animals (*M* = 5.80, *SD* = 2.08) than of technology and nature (*M* = 1.50, *SD* = 1.58), as indicated by a 2 × 2 mixed-model ANOVA with participant gender as an independent-samples factor and scale as a repeated-measures factor, $F(1, 302) = 1{,}076.27$, $p < .0001$, $\eta_p^2 = .78$. Men and women were not significantly different in their overall endorsement of anthropomorphism, $F(1, 302) = 2.14$, *ns*, and the Gender × Scale interaction was not significant, $F(1, 302) = 1.11$, *ns*, indicating no gender difference in endorsement of anthropomorphism of animals versus technology/nature.

Relationship between the IDAQ and IDAQ-CF. As expected, mean responses to the original IDAQ and the IDAQ-CF were very highly correlated, $r(304) = .92$, $p < .001$. The subscales were also highly correlated: Technology/Nature, $r(304) = .90$, $p < .001$, and Animal, $r(304) = .87$, $p < .001$. Mean scores on the original IDAQ (*M* = 3.06, *SD* = 1.48) were significantly higher than scores on the IDAQ-CF (*M* = 2.94, *SD* = 1.42), $t(303) = 3.58$, $p < .001$, but the effect size was very small, Cohen's $d = 0.085$ (Cohen considered an effect size of 0.20 to be "small"). The difference in overall scores was driven by responses on the Technology/Nature subscale, with responses on the original IDAQ (*M* = 1.67, *SD* = 1.65) being significantly higher than responses on the IDAQ-CF (*M* = 1.50, *SD* = 1.58), $t(303) = 4.10$, $p < .001$. This difference represents only 0.17 units on a scale from 0 to 10. On the Animal subscale, responses on the original IDAQ (*M* = 5.83, *SD* = 2.16) were virtually identical to responses on the IDAQ-CF (*M* = 5.80, *SD* = 2.08), $t(303) = 0.40$, *ns*.

Study 1B

To further validate the fit of this model, we collected additional IDAQ-CF data from a new adult sample. Because only IDAQ-CF items were administered, Study 1B also allowed us to address the concern that the strong relationship found between the IDAQ-CF and IDAQ in Study 1A was an artifact of a "bleed-over" effect. That is, participants in Study 1A may have recognized the parallel items in the IDAQ-CF and original IDAQ and reproduced their previous responses.

Method

Participants. Participants included 350 undergraduate students (M_{age} = 19;11, *SD* = 42 months, range = 17;0–47;11; 77% women). Participants self-identified their race/ethnicity as

White (75.8%), Asian (10.8%), Latina/o (3.8%), African American (0.6%), Native American (0.6%), or Other (8.5%; including more than one race/ethnicity). Participants were recruited through the Psychology Participant Pool and received course credit for their participation.

Measure and procedure. The procedure closely paralleled that used in Study 1A, except that participants only completed the IDAQ-CF (see Table 1) and 9 nonanthropomorphism (distractor) items in an online survey. All questions (12 IDAQ-CF items and 9 nonanthropomorphism items) were presented in random order, and participants responded to each question on an 11-point scale (0 = "not at all" to 10 = "very much").

Results

We used CFA to test the fit of a model with two correlated factors, including the eight technology/nature items on the first factor and the four animal items on the second. The model provided a slightly better fit to the data compared with Study 1A and a very similar fit compared with Waytz et al. (2010), Satorra-Bentler χ^2 = 117.06, df = 53, p < .001, CFI = .90, RMSEA = .06, 90% CI [.045, .074], factor correlation r = .40, p < .001. Replicating the Waytz et al. study, we also tested a higher-order model with a general anthropomorphism factor predicting the technology/nature and animal factors. Similar to Study 1A, the fit of the higher-order model was virtually identical to the two-factor model, Satorra-Bentler χ^2 = 117.06, df = 53, p < .001, CFI = .90, RMSEA = .06, 90% CI [.045, .074]. The higher-order factor loaded significantly on the technology/nature factor (standardized slope = .65, p < .001) and also the animal factor (standardized slope = .62, p < .001). Thus, as with the original IDAQ adult items, the IDAQ-CF items are consistent with a higher-order factor of general anthropomorphism, but no more so than with a simpler model with two correlated factors.

Alpha reliability for the full 12-item scale was acceptable (α = .78). The 8-item Technology/Nature subscale was also reliable (α = .78). The 4-item Animal subscale was less reliable in this sample than in Study 1A (α = .68). The lower reliability of this subscale is of concern. However, Cronbach's alpha has been shown to be negatively related to the number of items in a scale and a low alpha coefficient for a short scale such as this may not necessarily indicate lack of internal consistency (Voss, Stem, & Fotopoulos, 2000). Technology/Nature and Animal subscale scores were created by averaging responses across items within each subscale. Consistent with Study 1A, participants showed much higher endorsement of anthropomorphism of animals (M = 6.27, SD = 2.00) than of technology and nature (M = 1.64, SD = 1.65), as indicated by a main effect of scale in a 2 × 2 mixed-model ANOVA with participant gender as an independent-samples factor and scale as a repeated-measures factor, F(1, 347) = 1,181.04, p < .001, η_p^2 = .77. The main effect of gender was significant, but with a very small effect size, F(1, 347) = 4.49, p < .05, η_p^2 = .01, indicating that women had a slightly higher overall endorsement of anthropomorphism (M = 4.05) compared with men (M = 3.65). In addition, the Gender × Subscale interaction was significant, also with a very small effect size, F(1, 347) = 5.41, p < .05, η_p^2 = .02, indicating that men and women differed in their relative endorsement of anthropomorphism of technology and nature versus animals. The interaction was driven by a relatively large difference between men and women in their endorsement of anthropomorphism of technology and nature (men, M = 1.09; women, M = 1.81) and a very small gender difference in endorsement of anthropomorphism of animals (men, M = 6.22; women, M = 6.29).

Results from Study 1B provide additional support that the IDAQ-CF is comparable to the original IDAQ in an adult sample. Modest gender differences were observed in Study 1B that were not apparent in Study 1A, but the model fit in this new sample was similar to that reported by Waytz et al. (2010) and replicated the previous analyses from Study 1A, suggesting that including the IDAQ-CF items with the original IDAQ items in Study 1A did not interfere with participants' responses.

Discussion

Results from Studies 1A and 1B indicate that the IDAQ-CF measures the same underlying constructs as the original IDAQ. In an adult sample, responses on the IDAQ-CF are very similar to responses on the original IDAQ (Study 1A). Consistent with the IDAQ, the IDAQ-CF consists of two correlated factors, one assessing anthropomorphic beliefs about technology and nature and the other assessing anthropomorphic beliefs about animals (Studies 1A and 1B). On both the adult and child versions of the scale, endorsement of anthropomorphic beliefs about animals is substantially higher than beliefs about technology and nature (Studies 1A and 1B).

STUDY 2: CHILD SAMPLE

Study 2 sought to establish whether the IDAQ-CF maintained the same factor structure in a child sample as previously established in adult samples (Study 1A and 1B) and is appropriate for use with children (aged 5–9 years). In addition, we assessed the predictive validity of the IDAQ-CF in relation to children's conception of inanimate entities as animate. Waytz et al. (2010) argued that individual differences in anthropomorphism should be related to one's susceptibility to view personified technologies as humanlike. Children ascribe mental states, sociality, and moral standing to personified robots (Kahn et al., 2012), and adults "mindlessly" apply social rules when interacting with a personified computer (Nass & Moon, 2000). Although many people are compelled by personified technologies, there is considerable variability in whether and to what degree individuals understand and interact with these entities in humanlike ways. Therefore, we investigated whether the IDAQ-CF predicted children's attribution of animate characteristics to a robot and, for comparison, a puppet.

Method

Participants

Participants (*N* = 90) were equally divided among three age groups: 5 years (*M* = 5;6, *SD* = 3.36 months; 50% girls), 7 years (*M* = 7;5, *SD* = 3.84 months; 50% girls), and 9 years (*M* = 9;5, *SD* = 2.88 months; 50% girls). Parents identified their child's race/ethnicity as White (73.3%), Latina/o (3.3%), Asian (2.2%), African American (1.1%), Native American (1.1%), Other (1.1%), or more than one race/ethnicity (17.8%). Participants were recruited through announcements in school newsletters and flyers posted in the community. Each participant received $5 and a T-shirt for their participation.

Measures and Procedure

A researcher individually tested participants in a quiet lab testing room. The researcher first administered the IDAQ-CF. Participants were familiarized with the 4-point scale using 3 ordered training questions ("Do you like candy/broccoli/carrots?"). The 12 IDAQ-CF items were then presented in random order. Piloting revealed that a two-part question format was more comprehensible for younger participants. Thus, the procedure included an initial question (e.g., "Does a computer think for itself?") to which participants answered using a "thumb-up" (yes) or "thumb-down" (no) card (Figure 1). If a participant answered yes, he/she was then asked to rate how much (e.g., "How much

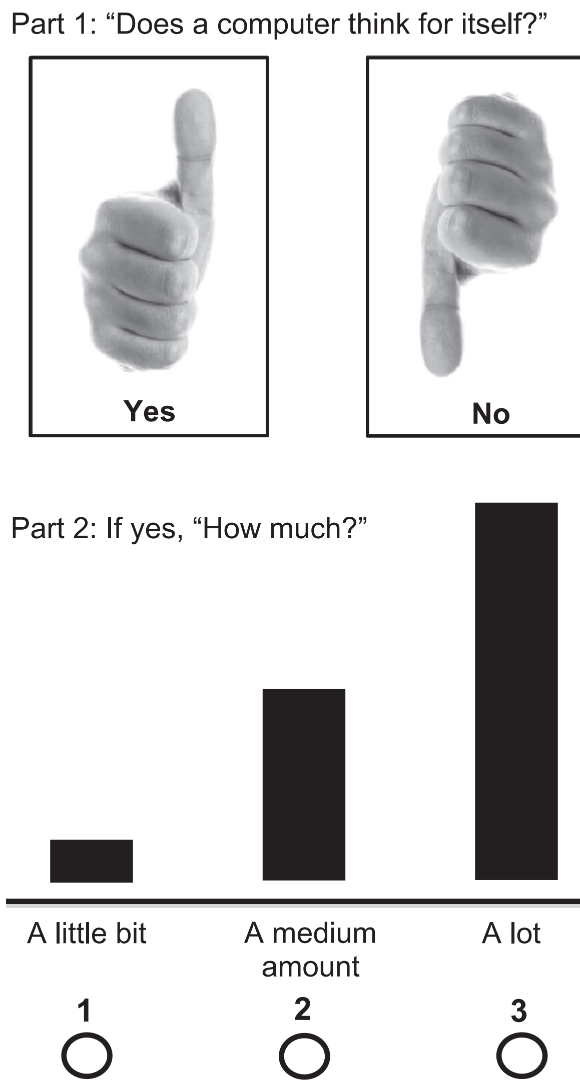

FIGURE 1 Individual Differences in Anthropomorphism Questionnaire (IDAQ)-Child Form materials and sample question format.

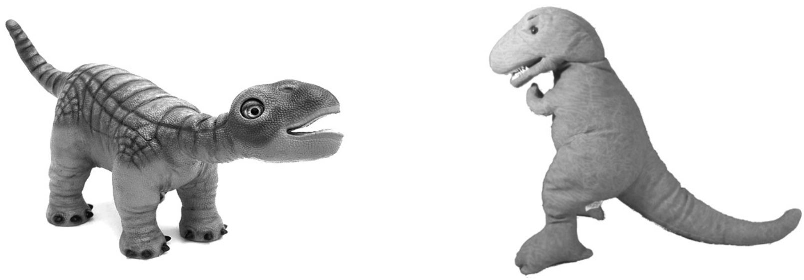

FIGURE 2 Robot “Pleo” (left) and puppet “Kasey” (right).

does a computer think for itself?”) using a scale with increasingly tall bars to indicate “a little bit,” “a medium amount,” and “a lot.” The 4-point scale was coded as “No” (0), “Yes, a little bit” (1), “Yes, medium amount” (2), and “Yes, a lot” (3).

To assess the predictive validity of the IDAQ-CF, we also administered an Attribution Interview, which assessed children’s attributions of a broad range of animate characteristics to a robot and puppet (see Figure 2). The robot used in this study was “Pleo,” which was designed to match the imagined appearance and behavior of a 1-week-old *Camarasaurus* dinosaur (http://www.pleoworld.com). Pleo has a repertoire of autonomous interactive behaviors (eats, plays tug-o-war, sits, curls up, and responds to touch); it simulates emotions and states; it vocalizes (small roars, purrs, chewing noises, and burps); it can detect objects placed in its mouth (infrared interrupter), edges and objects (color camera on its nose), and direction of sound (biaural microphones in the place of ears); and it has sensors to detect touch, orientation in space, foot falls, and being picked up. The puppet used in this study was a stuffed dinosaur puppet we called “Kasey.” The robot and puppet were approximately the same size.

During the familiarization phase, children were first presented with either the robot or puppet (counterbalanced order of presentation) and were invited to engage in five activities with the entity: feeding with a leaf, petting, scratching under chin, holding, and playing tug-o-war with a toy. The robot interacted autonomously, whereas children manipulated the puppet either internally (as with a hand puppet) or externally (as with a stuffed animal), as they preferred. Children were then allowed to play with the entity on their own for 5 min (or less if they completely disengaged from playing). The researcher then conducted the Attribution Interview, composed of 17 randomly ordered questions, to assess children’s attributions to the entity across a range of characteristics: aliveness (alive, living thing), movement (make itself move, move on its own), biological properties (grow bigger, pee/poop, die), perceptual capabilities (see, feel touch), psychological states (think, emotions), sociality (friend, spend time together, comfort), and moral standing (alright to pick up by tail, hit, put in closed box [while “on”]). Participants responded using the “thumb-up” (yes), “thumb-down” (no), and newly introduced “thumb-sideways” (sort of) cards. Responses were coded as “No” (0), “Sort of” (1), and “Yes” (2). The procedure was then repeated with the other entity.

Results

IDAQ-CF Factor Structure

Although individual survey items with five or more response categories may be reasonably analyzed using factor-analytic methods that assume continuous underlying variables, items with fewer than five categories, particularly if the distributions are skewed, are unlikely to meet this assumption, which may result in underestimation of the correlations among items (West, Finch, & Curran, 1995). Thus, survey items with a small number of response options are more appropriately analyzed as ordinal (categorical) variables (e.g., Byrne, 2006). Because questions on the IDAQ-CF included only four response options and because the responses to many questions were highly skewed, EFA was conducted using a polychoric correlation matrix, which does not require the assumptions of interval measurement scales and multivariate normality required by traditional factor analysis (Holgado-Tello, Chacón-Moscoso, Barbero-García, & Vila-Abad, 2010). An initial EFA of the 12 anthropomorphism-related items showed that the scale included two strong factors (Factor 1 eigenvalue = 4.16, 34.63% variance explained; Factor 2 eigenvalue = 2.25, 18.76% variance explained). Two additional factors had eigenvalues greater than 1.0, but they were considerably weaker and did not include any unique items. No other factor had an eigenvalue greater than 1.0. Visual examination of the scree plot further supported a two-factor solution. Thus, the items were refit with a two-factor, oblique solution. The factor correlation was found to be virtually 0, $r = .01$.[2] As shown in Table 3, 7 of the technology/nature items loaded highly on the first factor and the 4 animal items loaded highly on the second factor. One technology-related item, "Does a robot know what it is?" did not load strongly on either factor. With the exception of this item, the underlying factor structure of the IDAQ-CF in a

TABLE 3
Study 2 (Child Sample) IDAQ-CF Scale Items and Factor Loadings

	Pattern Coefficients		*Structure Coefficients*	
	Factor 1	*Factor 2*	*Factor 1*	*Factor 2*
CF_Tech_intentions	**.59**	–.02	**.59**	.05
CF_Tech_emotions	**.76**	.03	**.76**	.12
CF_Tech_conscious	.25	–.28	.21	–.25
CF_Tech_mind	**.63**	–.26	**.60**	–.18
CF_Nat_intentions	**.59**	.15	**.61**	.22
CF_Nat_emotions	**.94**	.12	**.96**	.23
CF_Nat_conscious	**.70**	–.12	**.75**	.18
CF_Nat_mind	**.73**	.03	**.74**	.12
CF_Anim_intentions	.01	**.42**	.06	**.42**
CF_Anim_emotions	–.04	**.46**	.02	**.45**
CF_Anim_conscious	–.02	**.45**	.04	**.44**
CF_Anim_mind	.04	**.99**	.16	**.99**

Note. IDAQ-CF = Individual Differences in Anthropomorphism Questionnaire-Child Form. Coefficients > .40 are in bold.

[2] Analyses on the child sample were also conducted without the polychoric correlation adjustment. The pattern of results was identical but with weaker factor loadings.

sample of children appears to be very similar to the structure identified in an adult sample. We were unable to conduct a follow-up CFA due to the considerably higher sample size requirements for CFA (Savalei & Bentler, 2006).

IDAQ-CF Subscales

Reliability for the IDAQ-CF was computed using ordinal alpha, a measure similar to Cronbach's alpha that is based on polychoric correlation and is appropriate for data measured on ordinal scales (Gadermann, Guhn, & Zumbo, 2012). Ordinal alpha reliability for the full scale including all 12 items was good (α = .79). Excluding the item, "Does a robot know what it is?" would increase the reliability of the scale slightly to .81. The subscale of 8 technology/nature items was highly reliable (α = .85). Excluding the robot item would increase the reliability of this subscale to .87. Thus, although the robot item did not load strongly on either factor, its presence in the overall scale and on the Technology/Nature subscale does not substantially reduce reliability. Similar to results with the adult sample, the 4-item Animal subscale had lower alpha reliability (α = .71), which may be due to the scale including only 4 items.

Subscale scores were created by averaging responses across the eight technology/nature items and the four animal items; average responses can range from 0 (no endorsement of anthropomorphic beliefs) to 3 (strongest endorsement of anthropomorphism). Although responses to individual items are discrete, when multiple items on a scale are averaged, they can take on many more values, and as is typical with Likert-type scales, they may be appropriately analyzed using statistics such as ANOVA, which is very robust to violations of the assumption of interval measurement (e.g., Carifio & Perla, 2007).

As with the adults in Study 1, children showed much higher endorsement of anthropomorphism of animals ($M = 1.53$, $SD = 0.80$) than of technology and nature ($M = 0.59$, $SD = 0.60$), as indicated by a significant main effect in a 2 × 3 × 2 mixed-model ANOVA with participant gender and age as independent-samples factors and subscale as a repeated-measures factor, $F(1, 84) = 96.42$, $p < .0001$, $\eta_p^2 = .53$. Boys and girls did not differ in their overall endorsement of anthropomorphism, $F(1, 84) = 2.51$, *ns*, and the Gender × Scale interaction was not significant, $F(1, 84) = 0.14$, *ns*. The main effect of age group was also not significant, $F(2, 84) = 1.99$, *ns*. However, the Age Group × Subscale interaction was significant, $F(2, 84) = 5.80$, $p < .005$, $\eta_p^2 = .12$. Post-hoc tests indicated that the age groups did not differ significantly in their endorsement of anthropomorphism of technology and nature, $F(2, 87) =$

TABLE 4
Study 2 (Child Sample) Mean Scores on IDAQ-CF by Age

	Technology/Nature		*Animal*	
Age (Years)	*M (SD)*	*95% CI*	*M (SD)*	*95% CI*
5	0.77 (0.75)	[0.55, 0.98]	1.26 (0.79)	[0.98, 1.54]
7	0.43 (0.45)	[0.21, 0.64]	1.49 (0.71)	[1.21, 1.77]
9	0.58 (0.52)	[0.36, 0.79]	1.84 (0.80)	[1.57, 2.12]

Note. IDAQ-CF = Individual Differences in Anthropomorphism Questionnaire-Child Form. Scale range = 0–3, with higher values indicating greater endorsement of anthropomorphic beliefs.

2.49, $p = .09$, but they did differ significantly in their endorsement of anthropomorphism of animals, $F(2, 87) = 4.34$, $p < .05$, specifically with 9-year-olds reporting significantly higher anthropomorphism of animals compared with 5-year-olds (see Table 4). The three-way interaction of Subscale × Age × Gender was not significant, $F(2, 84) = 0.81$, *ns*.

IDAQ-CF Predictive Validity

To investigate the predictive validity of the IDAQ-CF, we tested whether IDAQ subscales would predict children's tendency to attribute animate qualities to a robot and puppet using hierarchical multiple regression. Gender and age were entered in the first step as control variables. IDAQ-CF Technology/Nature subscale scores were entered in the second step, and IDAQ-CF Animal subscale scores were entered in the third step. Results are shown in Table 5. For the robot, the control variables (gender and age) predicted a small, nonsignificant amount of variance in lifelike attributions to the robot (4%). IDAQ-CF Technology/Nature subscale scores predicted a significant additional 18% of the variance beyond gender and age, and IDAQ-CF Animal subscale scores predicted a significant additional 10% of the variance beyond the Technology/Nature subscale scores.[3] Thus, the IDAQ-CF predicted a total of 28% of the variance in attributions to the robot. This finding is impressive, given that the questions in the Attribution Interview were not directly related to anthropomorphism, but rather asked about more general animate qualities of the robot. IDAQ-CF Technology/Nature subscale scores were positively related to animate attributions to the robot, such that children who believed that inanimate entities, such as trees and cars, have anthropomorphic qualities tended to believe that the robot had animate qualities. However, the relationship between the Animal subscale and attributions to the robot was negative, indicating that children who believed that animals have anthropomorphic qualities tended to be less likely to endorse animate qualities in the robot.

TABLE 5
Hierarchical Regression Predicting Attributions of Humanlike Qualities to a Robot and Puppet

	Robot		*Puppet*	
	ΔR^2	β	ΔR^2	β
Step 1 Control Variables	.04		.12*	
Age		–.18		–.31*
Gender		.09		.15
Step 2	.18*		.23*	
Tech/Nature subscale		.43*		.48*
Step 3	.10*		.01	
Animal subscale		–.33*		–.07

* $p < .01$.

[3] An additional regression was conducted reversing the entry order of the IDAQ-CF subscales. The pattern of results was the same, with the Animal subscale having a negative relationship with robot attributions predicting 7% of the variance beyond age and gender in Step 2 and the Technology/Nature subscale having a positive relationship predicting an additional 22% of the variance in Step 3.

Animate attributions to a puppet were similarly predicted using hierarchical multiple regression, with gender and age entered in the first step, IDAQ-CF Technology/Nature subscale scores entered in the second step, and IDAQ-CF Animal subscale scores entered in the third step. As shown in Table 5, the control variables together predicted a significant amount of variance (10%). The slope for age was significant, indicating that younger children were more likely to attribute animate qualities to the puppet. Gender was not a significant individual predictor. In Step 2, the IDAQ-CF Technology/Nature subscale predicted a significant additional 23% of the variance beyond age and gender. This is a large amount of variance explained, given the difference in the focus of the IDAQ questions, which are specifically about anthropomorphism, and the Attribution Interview questions, which are more directly about animate qualities of the puppet. The slope was positive, indicating that, when controlling for age and gender, children who endorsed human qualities for inanimate objects also tended to attribute animate qualities to the puppet. IDAQ-CF Animal subscale scores did not predict significant variance (1%) beyond Technology/Nature subscale scores.[4] Thus, children's attributions of animate qualities to a stuffed animal puppet were predicted by their tendency to believe that technologies or inanimate nature have human qualities, but not by their tendency to believe that living animals are humanlike.

Discussion

Results from Study 2 indicate that the IDAQ-CF can be used in a sample of children aged 5 to 9 years old. The child version of the scale, although not identical to the adult version (Waytz et al., 2010), appears to measure the same underlying constructs. The IDAQ-CF consists of two factors—one assessing anthropomorphic beliefs about technology and nature and the other assessing anthropomorphic beliefs about animals—which produced factor loadings comparable to those of the adult scale. The one exception was the robot item, which did not load strongly on the technology and nature factor. Nevertheless, we believe it is appropriate to retain this item as it is theoretically related to the technology factor, the scale is sufficiently reliable when it is included, and the item was not similarly problematic in the adult sample. Like adults, children endorse anthropomorphic beliefs about animals much more strongly than anthropomorphic beliefs about technology and nature.

While the focus of this article was to establish the IDAQ-CF scale, we also have evidence of developmental shifts in anthropomorphism of animals, in which 9-year-olds endorsed higher levels of anthropomorphic beliefs about animals compared with 5-year-olds. Because the current study was not designed to explore potential mechanisms for developmental differences, we can only speculate as to the cause. The most plausible explanation, in our view, is that increased anthropomorphic beliefs about animals are a product of social learning, particularly when the beliefs are socially supported. Research has shown that preschoolers' anthropomorphic beliefs about nonhuman entities are susceptible to learning. For example, Ganea and colleagues found that 3- to 5-year-olds exposed to storybooks with anthropomorphic language and illustrations of animals, compared with factual language and realistic illustrations, were more likely to anthropomorphize animals (Ganea, Canfield,

[4] As with robot attribution analysis, an additional regression was conducted reversing the entry order of the IDAQ-CF subscales. The pattern of results did not change, with the Animal subscale having a nonsignificant relationship with puppet attributions (0% variance explained) in Step 2 and the Technology/Nature subscale having a positive, significant relationship predicting an additional 23% of the variance in Step 3.

Simons-Ghafari, & Chou, 2014). Certainly, children are exposed to anthropomorphic depictions of animals in storybooks, television, and movies. Other sources of learning might also contribute to increased anthropomorphic conceptions of animals, whether through informal learning such as parental language (Gelman, Chesnick, & Waxman, 2005) or formal education such as science curricula and museum exhibits (e.g., New York Hall of Science's *Wild Minds: What Animals Really Think*; Horowitz, 2012). Future work will need to address potential mechanisms that underlie age-related increases in anthropomorphic beliefs about animals.

In terms of predictive validity, the IDAQ-CF predicted children's broader conceptions of inanimate entities as animate. The Technology/Nature subscale positively predicted children's tendency to extend more general animate characteristics to the robot and puppet. In other words, children who endorsed anthropomorphic beliefs about technology and inanimate nature were more likely to think about a robot and puppet in lifelike ways (e.g., having perceptual, psychological, social, and moral attributes)—a result that illustrates a consistent relationship in children's conceptual thinking. Interestingly, children who more readily endorsed anthropomorphic beliefs about animals were less likely to ascribe animate characteristics to the robot. However, there was no relationship between children's anthropomorphic beliefs about animals and their animate conceptions of the puppet. One possibility is that individuals who more readily endorse mental states in animals are increasingly sensitive to detecting entities that approximate and yet violate animacy. Along these lines, Wheatley and colleagues found evidence of a two-stage process for mind detection involving initial facial detection (human and doll faces) and subsequent elimination of false alarms (doll face; Wheatley, Weinberg, Looser, Moran, & Hajcak, 2011). Robots, but not stuffed animal puppets, may provide sufficient animacy cues (e.g., autonomous movement, interactive behaviors) to elicit initial conceptions of animacy, but these animacy cues may not hold up to further scrutiny, particularly from those who are more adept at reading minds in animals. Future research will need to explore whether individual differences in anthropomorphic tendencies are related to sensitivity in mind detection. In summary, as evidenced by the IDAQ-CF subscales differentially predicting children's conception of the robot, the unique predictive effects of IDAQ-CF subscales highlight that anthropomorphism is not a unified construct in children. The independence of the subscales is consistent with our finding that the two factors were not correlated in children, although they were in adults. Thus, it may be that anthropomorphic thinking undergoes a developmental transformation toward increased consistency in anthropomorphic beliefs across technologies, inanimate nature, and animals.

GENERAL DISCUSSION

The results of two studies suggest the IDAQ-CF, a new measure of individual differences in anthropomorphism in children, is comparable to the original adult measure (IDAQ; Waytz et al., 2010), is appropriate for use with children aged 5 to 9 years old, and is predictive of children's tendency to attribute animate characteristics to nonhuman entities. Consistent with the original IDAQ, the IDAQ-CF is composed of two subscales—one related to technology/nature and the other related to animals—which were evident in both the adult and child samples. Across adult and child samples, the IDAQ-CF (full scale and subscales) had good internal consistency, and both children and adults endorsed anthropomorphic beliefs about animals more strongly than anthropomorphic beliefs about technology/nature. In terms of direct tests of comparability, in the adult sample, the full scales and subscales of the IDAQ and IDAQ-CF were highly correlated (rs ≥ .87) and produced very similar model fits, suggesting the IDAQ-CF measures the same underlying construct as the original IDAQ.

This research provides compelling evidence that the IDAQ-CF is a promising new measure of anthropomorphism in children, yet it is not without limitations. Namely, the robot item ("Does a robot know what it is?") was problematic in the child sample in that it loaded on both the technology/nature and animal factors. This finding was not the case with the adult sample. Why is it that children responded differently than adults on the robot item? One explanation is grammatical. Recall the question was framed as, "Does a robot know what it is?" Rather than being self-referential, the "it" in the question might imply there is something about which the robot should know. This grammatical issue might be best solved with a revised version of this question, suggested by one of our reviewers: "Does a robot know that it is a robot?" Further research will be necessary to confirm that this wording solves the grammatical concern; however, early piloting suggests easy comprehension among children aged 4 to 9 years old. Another explanation is developmental. Trees are often conceptually challenging for young children, resulting in an underattribution of aliveness that may not be resolved until around 7 years of age (Carey, 1985). Robots may pose a similarly (or more) difficult conceptual problem that will also be resolved with development, even if not evident in 9-year-olds (our oldest age group). Another possibility is that children who grow up with increasingly sophisticated personified technologies may understand them as "sort of" alive, which is somewhere in between living and nonliving (new ontological category hypothesis; Kahn, Severson, & Ruckert, 2009; Severson & Carlson, 2010). Future research could bring evidence to bear on these possible explanations.

A more immediate issue is that the robot item may not be a psychometrically appropriate instantiation of "technology" in a child sample; another technological item may provide a better-fitting model. Future research could examine replacing the robot item with another technology that would more strongly align with the technology/nature factor, particularly when using the IDAQ-CF with a child sample. With that said, we opted not to jettison the robot item as reliability was high and not appreciably affected by the inclusion of the item. Thus, researchers should be aware that this item may be problematic, but not to the extent that precludes its use or compromises the reliability of IDAQ-CF as a measure of anthropomorphism. Researchers wishing to replace entities in the scale should be aware that doing so might shift the psychometric properties of the measure, as children may anthropomorphize entities within each category to a different degree. For example, common pets, such as cats and dogs, may be more readily anthropomorphized and inclusion of such animals could inflate the Animal subscale. At the same time, cross-cultural research may necessitate replacing an entity with one that is more culturally familiar. In a study in progress examining cultural differences in anthropomorphism between Chinese and North American children (Severson, Li, & Lillard, 2015), some IDAQ-CF animals were replaced with animals that would be more familiar to Chinese children (e.g., tiger replaced cheetah and tortoise replaced turtle). The early evidence suggests that using these different (although arguably similar) animals did not result in any change in the psychometric properties of the Animal subscale.

More generally, future research could provide further validation of the IDAQ-CF scale. For example, researchers could examine whether the scale would yield comparable results if the entities were rotated through the questions. This same recommendation could similarly apply to the original IDAQ, which to our knowledge has not rotated or replaced any entities. In addition, subsequent studies could assess whether individual differences are relatively stable across development. Finally, future work could establish whether the IDAQ-CF (a self-report measure) relates to individual differences in tasks using indirect, behavioral, or neural measures of anthropomorphism.

The IDAQ-CF can be broadly applied to investigate the development, nature, and mechanism of anthropomorphism. Our results revealed developmental differences in the child sample, with increasing anthropomorphism of animals with age. Although we developed the IDAQ-CF measure for use with children, our analyses indicate the IDAQ-CF is comparable to the IDAQ in an adult sample. The IDAQ-CF is therefore well positioned as a single measure of anthropomorphism for use with child and adult samples to investigate developmental trajectories and outcomes. Fruitful research could also follow from investigations of the nature of anthropomorphism. By its very definition, anthropomorphism is conceptually related to psychological processes involved in understanding other humans' minds. In fact, neuroimaging research suggests the same neural bases are involved in the ability to infer mental states of humans and nonhuman others (Castelli, Happé, Frith, & Frith, 2000; Dubal, Foucher, Jouvent, & Nadel, 2011; Gazzola, Rizzolatti, Wicker, & Keysers, 2007). Thus, one line of inquiry could focus on whether (and to what extent) common underlying processes are at play in social cognition and anthropomorphism. Another provocative area for research would focus on the mechanisms involved in anthropomorphism. Why is it that dispositional differences exist—why are some people more inclined to anthropomorphize nonhuman others? What is the role of experience or learning in these tendencies? Thus, future research could examine effects of direct experience and cultural learning on the tendency to anthropomorphize.

The creation of the original IDAQ (Waytz et al., 2010) opened up a wide range of investigations into individual differences in anthropomorphism in adults. With the creation of the IDAQ-CF, we have further extended the possible lines of inquiry on anthropomorphism to now include children. Our research provides strong evidence that the IDAQ-CF is an effective adaptation of the original IDAQ for use with children. We hope the IDAQ-CF will prove useful for researchers interested in the development, nature, and mechanisms of anthropomorphism, as well as the causes, correlates, and consequences of anthropomorphic cognition.

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