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Children's concepts of the social affordances of a virtual dog and a stuffed dog

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ABSTRACT

Virtual characters are programmed to simulate relationship partners, yet little is known about how children conceptualize the social affordances of these characters, despite their growing presence in children's lives. In two studies (combined $N = 49$), we investigated the extent to which preschool children differentiate the social affordances of a virtual character that simulates social behaviors and those of a stuffed animal of the sort that children often use in pretend play. Children guessed whether a child in a video was referring to a stuffed dog or a virtual dog in a series of statements. The stuffed dog was associated with items rated by adults as relevant to friendship, whereas the virtual dog was associated with items rated as relevant to entertainment. These results suggest that despite their sophisticated programming, virtual characters might not be superior to simple stuffed animals as relationship partners.

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1. Introduction

Young children's lives are filled with a wide range of relationship partners, including parents, siblings, caretakers, and peers. This diverse social network provides experiences that help children appreciate the special social affordances of friendship (Gleason & Hoffman, 2006). Children as young as 20 months engage in reciprocal patterns of behavior found in friendships (Ross, Conant, Cheyne, &

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Alevizos, 1992), and by age 4, they conceptualize friendships in terms of shared activities, affection, and physical closeness (Furman & Bierman, 1983).

According to Gleason (2013), discussions of the social networks of both children and adults should include relationships with a wide range of imaginary others including imaginary companions, diary friends, celebrities, deceased loved ones, and fictional characters in novels, in addition to relationships with real people. Further, advances in artificial intelligence are providing new opportunities for children to develop imaginary relationships with robots and with virtual characters portrayed on technological devices. There is a growing literature on children's relationships with social robots (Kahn, Gary, & Shen, 2013), but little is known about their relationships with the virtual entities encountered on websites and in computer games. Our research provides preliminary information by exploring children's intuitions about the social affordances of a virtual character in a Nintendogs® game.

1.1. Social robots vs. stuffed animals as social partners

According to Turkle (2011), the goals for smart toys have shifted from building knowledge or helping children practice skills to providing companionship. "For decades computers have asked us to *think* with them; these days, computers and robots, deemed sociable, affective and relational, ask us to *feel* for and with them" (p. 39). Social robots are programmed to express needs and solicit caregiving, with updated versions providing increasingly realistic cues to mimic intentionality, personality, and emotion, as well as greater capacity for voice, facial, and emotional recognition (Kahn et al., 2013; Minato, Shimada, Ishiguro, & Itakura, 2004). Research suggests that although children recognize that robots are not alive (Jipson & Gelman, 2007), they nevertheless believe that friendships are possible and attempt to engage robots in social interaction (Kahn, Friedman, Pérez-Granados, & Freier, 2006).

Kahn and colleagues have conducted much of the work in this area, focusing on how children think about and interact with a sophisticated robotic dog named AIBO (Friedman, Kahn, & Hagman, 2003). In one study, 3–6-year-olds' answers to yes/no questions about animacy, biological properties, mental states, moral standing, and social rapport were very similar for AIBO and a stuffed dog (Kahn et al., 2006). However, children's behavior with AIBO over an interactive play session (about 35 minutes) reflected an expectation of reciprocity, whereas their behavior with the stuffed dog included more animations (e.g., making it move). Children recognized that the robot dog generated behaviors, but that they controlled the behaviors of the stuffed dog.

Given AIBO's impressive ability to initiate interaction and respond to children's behavior, it might seem surprising that children did not clearly differentiate AIBO from a stuffed dog when asked about the possibility of friendship. However, children often conceptualize relationships with personified objects as they would actual friendships (Gleason, 2002), and their descriptions often include Parker and Asher's (1993) hallmarks of high quality friendships (e.g., shared activities, caring, and intimate exchange). In addition, children often describe these toys as autonomous agents capable of thinking, feeling, and acting – for example, a stuffed dog that likes to ride in cars and go camping, but is afraid of the dark (Taylor, Sachet, Maring, & Mannering, 2013). Moreover, interaction with stuffed animals can contribute to children's real-world resilience. In two experiments conducted after the 2006 Israeli-Lebanon war, 3–6-year-olds given a stuffed dog to care for were rated by parents as having fewer stress-related symptoms at a two month follow-up than children in a control condition (Sadeh, Hen-Gal, & Tikotzky, 2008).

Children's capacity to form attachments to stuffed animals – and the potential of these imagined relationships to provide real world comfort – should not be underestimated. Instead of expecting that social robots might be even more readily adopted as social partners, one might ask whether the programmed behaviors of a social robot might reduce children's control over interactions, ultimately making the social robot a less attractive partner for the exchange and affection that characterize friendship.

1.2. Virtual characters vs. stuffed animals as social partners

Research on anthropomorphism – the attribution of human-like traits to non-human animals and inanimate objects – suggests that preschool children readily endow inanimate objects with

intentionality, emotions, and personalities, even without all the cues provided by advanced social robots (Piaget, 1929). However, anthropomorphism research also reveals how important the characteristics of movement (e.g., whether movement is autonomous) are to the attribution of intentionality and animacy (Epley, Waytz, & Cacioppo, 2007). Social robots' body movements and facial expressiveness improve with every upgrade, but the realism and subtlety of movement and expression possible on a screen are currently far beyond what any social robot can achieve. Even simple two-dimensional geometric shapes moving around a screen can communicate complex social interactions. By age 5, children provide anthropomorphic interpretations of Heider and Simmel's (1944) animated film of geometric shapes, describing, for example, a "mean" large triangle scaring a small triangle that is "afraid" (Springer, Meier, & Berry, 1996).

Strong anthropomorphic cues make screen-based characters an interesting focus for research on children's conceptions of imaginary relationships. An equally important motivation for this research are technological advances that permit children's increasing interaction with virtual entities; while social robots like AIBO are expensive (about $2000) and do not yet pervade children's lives, children engage increasingly frequently with virtual characters in apps, websites and videogames. American children between ages 5 and 8 spend an average of 29 minutes per day playing video and computer games (Rideout, 2013).

Intangible virtual characters have particularly compelling movement cues to intentionality, and, like social robots, many come equipped with programmed responses intended to simulate the reciprocal patterns of behavior found in human and human/animal relationships. For example, in Nintendogs®, virtual dogs appear tired and dirty when they need to be fed and bathed, and lick the screen to elicit "physical" affection. Children respond to these cues for caretaking, but do they confide in a virtual character or tell it stories? The programming elicits reciprocity that might make the potential for friendship salient to young children. On the other hand, limitations in the range of programmed behaviors might constrain the nature of children's interactions with the character. In the case of stuffed animals, children have creative control over the interactions, but reciprocity – which is fundamental to friendship – is entirely imagined.

In two exploratory studies, we investigated how children differentiate the social affordances of a virtual screen-based dog and a stuffed dog. To avoid the response biases that can characterize children's responses to a long series of yes/no questions, we used a guessing game in which children indicated whether another child might be talking about a virtual dog or a stuffed dog. A forced choice procedure, used in the second study, also allowed for a more sensitive measure of possible differences in children's intuitions. For example, children might consider both dogs to be potential friends (and thus answer "yes" in response to yes/no questions about friendship), but consider friendship to be a stronger possibility for the stuffed dog (and thus choose the stuffed dog when given a forced choice).

2. Study 1

2.1. Method

2.1.1. Participants

Participants were 16 European-American children and their mothers ($n = 15$), including one pair of siblings, recruited from a database of children in a middle class community (8 girls; mean age 66.56 months, range 48–83 months). One additional child was dropped because she performed below chance on distracter items designed to determine if children understood the social affordances task.

2.1.2. Materials

A stuffed dog wearing a red collar and a virtual dog wearing a yellow collar (both fawn-colored pugs with black faces) were used in the experiment. The virtual dog appears in the videogame Nintendogs® displayed on a Nintendo 3DS® game console. During the introductory phase of the experiment, real and virtual brushes, as well as feeding props (a real dog bone and bowl, virtual dog treats) were used. The virtual props were accessible in a side bar menu in the Nintendogs® game. Items used in the social affordances task were presented in a video featuring a child approximately the same age as the participant. Eight videos were used, four with a boy (shown to male participants) and four with a girl
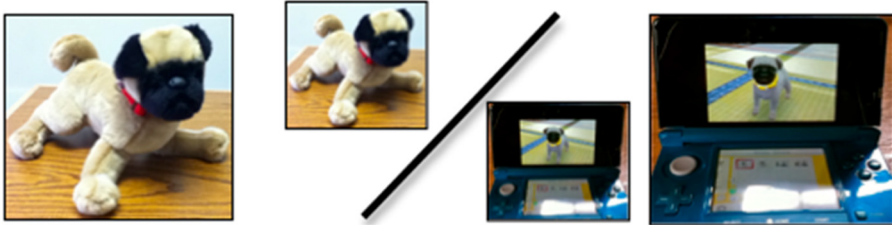
Fig. 1. Picture stimuli corresponding to the response options.

(shown to female participants), with the introduction order of the two dogs and the location of the two dogs on the table counterbalanced within each set of four videos. The video was played on a 13″ laptop computer. Three 3.5″ × 4.5″ pictures (Fig. 1) representing the response options were used for the social affordances task (i.e., pictures of the stuffed dog, the virtual dog, and both dogs separated by a backslash symbol).

2.1.3. Procedure

After obtaining informed consent, experimenters escorted the children and their parents to separate rooms. Parents were asked demographic questions and questions about their children's familiarity with the Nintendo 3DS® console, the Nintendogs® game, and other virtual pet games/apps. The children were introduced to a stuffed dog ("Stuffy") and a virtual dog ("iPuppy"), with the order counterbalanced across participants. The experimenter modeled petting, feeding, and brushing both dogs using the props and asked participants to repeat these actions.

In the social affordances task, children were asked whether each of a series of 34 statements referred to the stuffed dog or the virtual dog, or could refer to either dog. Twenty-eight statements concerned a range of social affordances. These items were inspired by research on dimensions of friendship quality (Parker & Asher, 1993), relationships with imaginary companions (Gleason, 2002; Taylor, 1999), and claims about education and entertainment in materials used to promote the Nintendogs® game. Three of these items were dropped from analyses because children's interpretations were unclear.[1] In addition, there were six distracters, including two unambiguous descriptions of the stuffed dog, two unambiguous descriptions of the virtual dog, and two ambiguous descriptions that could refer to either dog. The 25 social affordance items (excluding the three omitted items) are listed in Table 1 as they appeared in the video, along with the six distracters.

The experimenter introduced the video, saying, "Now I'm going to show you a video of a little boy/girl named Noah/Sarah. Noah/Sarah has both dogs at home. Let me show you what I mean by that." The experimenter played the first part of the video in which Noah or Sarah introduced the stuffed dog and virtual dog. Then the experimenter told participants that the child would tell them about his/her dogs. "Sometimes Noah/Sarah will be talking about Stuffy, sometimes Noah/Sarah will be talking about iPuppy, and sometimes you just can't tell – he/she could be talking about *either* Stuffy or iPuppy." As the experimenter stated these possibilities, the pictures representing the response options were placed on the table in the same location as the stuffed dog and virtual dog in the video. The picture representing the "either one" response was placed between the pictures of the stuffed and virtual dog. After the child in the video made each statement, participants indicated which dog he or she was talking about.

The task began with three practice statements. The child in the video made an unambiguous statement about the stuffed dog ("S/He has a red collar"), then an unambiguous statement about the virtual

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[1] The item "S/He's just a toy" was dropped because children's spontaneous comments indicated that some children interpreted the item as referring to whether or not the object was animate, whereas other children interpreted the item as meaning that the object was not more special than a regular toy (our intended meaning). The items "I'd like to trade him/her in for a new one" and "Even when s/he gets old, I don't want a new one; I just want him/her" were dropped because although their meanings are the opposite of each other, many children gave the same response to both questions. This pattern suggested that children were interpreting the meaning differently than we intended or they were misunderstanding these items.

Table 1
Study 1: Children's endorsements for the different response options.

	Stuffy	iPuppy	Either
Social affordance items			
S/He entertains me.	1	7	8
I like to figure out what s/he can do.	5	3	8
I know I can trust him/her.	6	2	8
I always feel like checking to see what s/he is doing.	4	4	8
S/He always does what I want him/her to do.	5	6	5
I'm proud of him/her.	3	4	9
S/He needs me to take care of him/her.	7	2	7
Sometimes I think s/he's boring.	6	5	5
S/He helps me feel better when I am sad.	4	5	7
I like to find ways to teach him/her new tricks.	6	6	4
Hugging him/her makes me feel safe.	13	1	2
I play with him/her every chance I get.	4	7	5
S/He can sometimes surprise me.	6	6	4
S/He protects me.	8	2	6
S/He always wants to play, even when I'm busy.	7	5	4
I tell him/her my secrets.	3	6	7
I love him/her.	6	2	8
S/He teaches me how to be a good dog owner.	4	3	9
I play with him/her when there's nothing else to do	5	5	6
S/He's a really good friend.	4	2	10
S/He's annoying sometimes.	3	3	10
S/He keeps me company when I am lonely.	5	3	8
S/He makes me laugh.	2	6	8
I like to sleep with him/her at night.	16	0	0
I teach him/her how to behave.	7	6	3
Distracter items			
I can feel his/her fur with my hand.	15	1	0
S/He's a stuffed animal.	16	0	0
When I'm done playing with him/her, I have to turn him/her off.	1	13	2
S/He's on a screen that I hold in my hands.	1	14	1
S/He's got two ears.	3	0	13
S/He's got four legs.	2	3	11

dog ("S/He has a yellow collar), followed by a statement that could be about either dog ("S/He has a collar"). After each statement, the video was paused and the experimenter asked, "Which dog do you think s/he's talking about? Point to the picture of the dog you think s/he's talking about." All the children responded correctly to the three practice statements.

Then the experimenter said, "Okay, now we're ready to play the game. Noah/Sarah is going to tell you some things about his/her dogs and your job is to guess which one s/he is talking about. If you think s/he's talking about Stuffy, point to the picture of Stuffy, like this. If you think s/he's talking about iPuppy, point to the picture of iPuppy, like this. And if it's hard to tell – if you think s/he could be talking about either Stuffy *or* iPuppy – point to this picture here (the either option), like this." For the first three items, the video was paused and the experimenter prompted children to respond (i.e., "Which dog do you think s/he's talking about?"). For the rest of the items, unless the child showed signs of hesitation, the experimenter played each item and paused the video to allow children to select a response. The children were not given feedback and items were presented in a randomized order. We compared children's responses for the first and second half of the items and found that endorsements for Stuffy, iPuppy, and "either" did not vary between the halves, suggesting that fatigue or practice did not affect results.

To assess children's interest in the two dogs, we asked children to choose one for a three-minute free-play session. Next, the children participated in another research project for about 15 minutes. Finally, children were asked which dog they liked better and why, and whether they had a stuffed dog, a real dog, or any other pets at home. The session lasted about one hour and children were given $10 for participating.

2.2. Results and discussion

Table 1 shows the number of children who selected the stuffed dog, the virtual dog, or the "either one" option. All but one child (excluded from analyses) were accurate for the six distracters ($M_{correct}$ = 4.94, SD = 1.18), indicating that they were attending to the task. However, children did not differentiate between the stuffed dog and virtual dog for the social affordance items, frequently responding that the items could refer to either dog (three of 16 chose "either one" for 90% or more of the items). When children did endorse a preference, binomial tests revealed that children's responses were equally split between Stuffy and iPuppy, ps > .05, except for the two contact comfort items, which were attributed to the stuffed dog, ps < .05. However, some children might have interpreted these questions as contrasting the stuffed dog vs. the virtual dog on the screen of the game console (which is impossible to hold) instead of the stuffed dog vs. the physical game console (which can be held). Nevertheless, the clear preference for Stuffy for these items indicates that the task can potentially show differences in children's intuitions about the two dogs when those differences exist.

When asked which dog they liked best, 12 of 16 children chose iPuppy and all 16 children chose iPuppy as the toy they wanted to play with. Eleven children had stuffed dogs at home, whereas none owned a Nintendo 3DS® game console and at least 15 children had never played the Nintendogs® game (one parent did not respond to this question). However, despite their interest in the Nintendogs® game, children did not assume that the child in the video was talking about the virtual dog. Even for items such as "I play with him/her every chance I get," children were equally likely to report that the child in the video could be referring to the stuffed dog or the virtual dog. Additionally, children did not differentiate between the two dogs for items that suggested independent agency (e.g., "S/He can sometimes surprise me"), even though Stuffy is an inert toy, whereas iPuppy moves almost continuously (e.g., wagging its tail). This suggests that the imagined agency of stuffed toys is vivid enough to compare with the observed agency of virtual characters.

In summary, results for the distracters and contact comfort items indicate that the social affordance task has the potential to elicit children's judgments about differences between a stuffed dog and a virtual one. Nevertheless, our results also suggest that children did not clearly differentiate between the relationships and interactions possible with the two types of toys. For the social affordance items, children frequently reported that a given item could refer to either dog, and when children did indicate a preference, these responses were equally split between Stuffy and iPuppy. However, having the "either one" response option might have led to results underestimating the differentiation of the two toys. Children might have selected "either one" because they believed an item could pertain to either dog or because they were not sure about their answer. Another problem was that many children pointed directly to the stuffed dog or the virtual dog in the "either one" picture, which might have reflected a choice between the two dogs rather than an "either one" response. In Study 2, we eliminated the "either one" option. In addition, we collected ratings from adults about the extent to which items were relevant to friendship, agency, entertainment, and education.

3. Study 2

In Study 2, we examined the extent to which children would differentiate the social affordances of a virtual dog and a stuffed dog when forced to choose between the two, without the option of reporting that the items could be about either. In addition, we collected ratings from adults for the 25 social affordance items to refine our interpretation of children's response patterns. We were particularly interested in children's intuitions about the possibility of having a relationship with a virtual character; we therefore asked adults to rate the items for relevance to friendship and agency. We expected that children might tend to pick the stuffed dog for items that adults rated highly on friendship, but our prediction about children's choices for agency was less clear. The reciprocity that is fundamental to friendship depends upon agency (either real or imagined), and thus children who think of stuffed dogs in terms of friendship might pick the stuffed dog for agency items as well. However, the nearly continuous autonomous movement of a virtual dog makes its agency a salient feature. Thus, children might expect that items describing agency refer to the virtual dog. Adults also rated the items for relevance to education and entertainment because these goals are often associated with virtual

games. We expected that children might pick the virtual dog for items rated highly for education and entertainment.

3.1. Method

3.1.1. Participants

Participants were 33 children (15 girls; mean age 66.39 months, range 59–80 months) and their parents (32 mothers and one father), recruited from a database of children born in a local, middle class community. Six children were of mixed ethnicity; 27 were European-American. Seven additional children were excluded because they scored below chance on distracters (four children) or repeatedly selected responses before statements were played (three children).

For the ratings, participants were 16 undergraduate students (14 females; mean age 19.94 years, range 18–29 years; 11 European American, two Asian, two Hawaiian/Pacific Islander, one unidentified) who received course credit. Three additional participants were excluded because their responses did not correlate with the rest of the sample, $ps > .05$. Their responses also did not correlate with each other, $ps > .05$, indicating a random pattern of responses.

3.1.2. Materials for the social affordances task

Two changes were made to the materials used in Study 1: (1) the picture representing the "either one" response was removed, and (2) the two distracter items that could pertain to either the stuffed or virtual dog were removed, leaving four distracter items and 25 social affordance items. Therefore, there were 29 total items; the three additional social affordance items that were dropped in Study 1 were not used in Study 2.

3.1.3. Procedure

3.1.3.1. Child tasks. The procedure was very similar to Study 1. All 33 children responded correctly to the first two practice statements. After the third practice statement, the experimenter paused the video and said:

> "S/He said, 'S/He has a collar.' Well, Stuffy has a collar and iPuppy has a collar, too. So it's really hard to tell which one s/he's talking about, right? When that happens, it's okay to just guess. You just guess the dog that *you* think s/he's talking about. Which dog do you think Noah/Sarah is talking about?"

After participants made a selection, the experimenter introduced the task.

3.1.3.2. Adult ratings of social affordance items. Ratings were collected as part of a general survey generated by psychology researchers and administered online using Qualtrics software, version 37,892 (Qualtrics Research Suite©, 2013). Participants were told they would read statements that children had made about their toys and were then asked to rate each statement for its relevance to four types of experiences: (1) agency ("whether or not the child experiences the toy as able to think/feel or act for itself"), (2) friendship ("whether or not the child has an interpersonal relationship with the toy"), (3) education ("whether or not child learns from the toy"), and (4) entertainment ("whether or not the child uses the toy for fun"). Participants used a 1–7 Likert scale, from "not at all relevant" to "highly relevant." Agreement for the 16 raters was high, Cronbach's Alpha = .93.

3.2. Results and discussion

3.2.1. Children's responses on the social affordances task

Children were accurate in their responses to the four distracters ($M_{correct}$ = 3.70, SD = 0.53). Although children in Study 1 frequently chose "either one," children in this study did not have difficulty choosing between the dogs. Just .01% of the data (nine of 825 trials) was coded as missing because children could not choose. Binomial tests were conducted to identify items for which children exhibited a preference for either dog. Table 2 shows the 25 social affordance items ordered from those that were mostly

Table 2
Study 2: Children's endorsements of the stuffed and virtual dog, with adult mean ratings on 1–7 scale for item category(ies).

	Stuffy	iPuppy	p	Adult ratings			
				Agency	Friendship	Education	Entertainment
Preference for stuffy							
Hugging him/her makes me feel safe.	27	6	<.001	4.50	6.50*	2.06	2.94
I like to sleep with him/her at night.[a]	27	5	<.001	3.69	6.19*	2.06	2.69
S/He protects me.	25	8	.005	6.25*	6.25*	2.06	2.56
I love him/her.	24	9	.01	5.00	6.44*	1.88	2.63
S/He keeps me company when I am lonely.	23	10	.04	5.06	6.44*	1.88	3.63
No preference							
I like to figure out what s/he can do.	19	14	.49	5.06	3.94	4.31	5.00
I always feel like checking to see what s/he is doing.	18	15	.73	6.06*	5.63*	2.13	3.25
S/He helps me feel better when I am sad.	18	15	.73	5.31	6.25*	2.38	3.63
Sometimes I think s/he's boring.[a]	18	14	.60	4.81	3.88	2.13	4.38
I tell him/her my secrets.[b]	18	13	.47	4.50	6.50*	2.06	2.81
I teach him/her how to behave.	17	16	1.00	6.25*	4.88	4.25	3.38
I play with him/her when there's nothing else to do.[b]	16	15	1.00	3.38	4.31	2.19	5.75*
S/He teaches me how to be a good dog owner.	15	18	.73	5.00	4.38	6.63*	3.00
S/He's a really good friend.[a]	15	17	.86	5.56*	6.81*	2.44	3.88
S/He needs me to take care of him/her.	14	19	.49	5.75*	6.25*	2.88	3.00
S/He can sometimes surprise me.	13	20	.30	6.50*	5.19	3.50	4.25
S/He's annoying sometimes.	13	20	.30	6.19*	5.69*	1.88	2.50
S/He always does what I want him/her to do.	12	21	.16	5.75*	4.88	2.63	3.88
I like to find ways to teach him/her new tricks.	12	21	.16	5.56*	5.19	4.25	5.31
I know I can trust him/her.	12	21	.16	6.25*	6.19*	2.56	3.13
I'm proud of him/her.	12	21	.16	5.88*	6.13*	2.81	3.81
Preference for iPuppy							
I play with him/her every chance I get.[a]	9	23	.02	4.38	5.63*	2.88	5.63*
S/He entertains me.	9	24	.01	5.00	4.50	2.00	6.50*
S/He makes me laugh.[a]	8	24	.007	5.50*	5.88*	1.81	6.31*
S/He always wants to play, even when I'm busy.	7	26	.001	6.25*	5.25	2.06	5.13
Distracter items							
I can feel his/her fur with my hand.	30	3	–	–	–	–	–
S/He's a stuffed animal.	33	0	–	–	–	–	–
S/He's on a screen that I hold in my hands.	4	29	–	–	–	–	–
When I'm done playing with him/her, I have to turn him/her off.	3	30	–	–	–	–	–

[a] N = 32 one child would not choose.

[b] N = 31 two children would not choose.

* Significantly higher than 4 (one tailed), p < .01.

attributed to the stuffed animal, followed by items that did not elicit a clear pattern, and ending with items that were mostly attributed to the virtual dog.

3.2.2. Adult ratings of social affordance items

Table 2 also displays the adult ratings. One-tailed t-tests were conducted to identify items that had mean ratings significantly higher ($p < .01$) than the mid-point score of 4. Twenty-three items were rated as highly relevant to one or more of the four types of experiences. Fourteen items were rated as primarily relevant to one type: friendship (six items), agency (five items), entertainment (two items), and education (one item); eight were rated as highly relevant to two types: agency and friendship (seven items), friendship and entertainment (one item); and one item was rated as highly relevant to three types: agency, friendship, and entertainment.

The adult raters did not view many of the items as relevant to education or entertainment. This might be due to how education and entertainment were defined in the instructions, but it is also possible that these items did not reflect the experiences we intended to convey. We had greater success identifying items relevant to friendship and agency: six items were rated as mostly concerning friendship, five as mostly concerning agency, and eight were rated highly for both friendship and agency, with one of these also rated highly for entertainment. Adults might have viewed the overlapping items as addressing reciprocal aspects of friendship, thus requiring that the toys have agency (provided or imagined).

3.2.3. Patterns in children's differentiation of the virtual dog and stuffed dog

The five items that children tended to attribute to the stuffed dog were all rated highly for friendship by adults, including one item that was also rated highly for agency. The pattern of endorsement for the virtual dog was more relevant to entertainment. Although two of the four items that revealed a preference for the virtual dog had high friendship ratings, these items were equally or more highly rated for entertainment. The preference for the virtual dog on the entertainment items is consistent with children's interest in playing with the virtual dog and the goals of the videogame genre. Indeed, some children spontaneously commented on the virtual dog as being a part of videogame experiences (e.g., "S/He's on a DS®.")

Given that virtual pet games are marketed to parents as educational tools, we expected that children might endorse the virtual dog for items related to education. However, only one item was rated as relevant to education and children were equally likely to attribute it to the stuffed dog or virtual dog. In future research, it might be useful to generate items that more successfully capture the affordance of education; however, children might not think of a virtual dog as a vehicle for learning.

Although there was some evidence that the stuffed dog was viewed more in terms of friendship, whereas the virtual dog was viewed more as a source of entertainment, many items did not elicit a clear preference. For example, although the items endorsed for the stuffed dog concerned friendship, the item that was most explicitly about friendship ("S/He's a really good friend") did not show any preference. In addition, four of the items rated as relevant to agency were equally likely to be attributed to either dog. Thus, although the movements of the virtual dog create a powerful perception of autonomous agency, this might not necessarily trump the imagined agency of a stuffed toy. Note that the imagined agency of the stuffed dog might have been enhanced by the experimenter's animation of the toy during the introductory procedure.

The Nintendogs® game was relatively novel (one child had played the Nintendogs® game on one occasion) and attractive to the children. Twenty-five of the 33 children asked to play with the virtual dog and 23 children said they liked the virtual dog better. However, 13 children were familiar with the Nintendo DS® console and/or had experience playing with a virtual pet. To examine how familiarity with virtual characters might influence responses, we compared (1) the mean number of endorsements (out of 25) for the virtual dog for children with previous experience ($M = 12.38, SD = 2.99$, $n = 13$) and children without such experience ($M = 12.75, SD = 3.06, n = 20$) and (2) the mean number of endorsements for the virtual dog for the 15 items rated as highly relevant to friendship for the experienced children ($M = 6.69, SD = 2.39, n = 13$) and children without experience ($M = 6.95, SD = 2.06$, n = 20). Neither of these tests was significant, $t(31) = 0.34, p = .74$, and $t(31) = 0.33, p = .74$, respectively.

4. General discussion

This research was designed to provide preliminary data regarding children's intuitions about possibilities for relationships with screen-based entities. In two studies, we investigated the extent to which preschool children differentiate the social affordances of a virtual dog portrayed on a screen and those of a stuffed dog. Perhaps the most striking result was the similarity in social affordances attributed to the two types of toys, despite their obvious differences. For example, although the virtual dog moved continuously on the screen and the stuffed dog had no independent movement, children did not differentiate between the two dogs across many items that reflected some type of agency. Moreover, although the virtual dog was more novel and engaging to these children, they did not endorse the virtual dog significantly more overall and were equally likely to choose the stuffed dog for some items that concerned enjoyment of the toy. In Study 1, the lack of differentiation was evident in children's frequent response that the social affordance items could be referring to either dog. However, even when children did not have the option of attributing items to either/both dogs (Study 2), many items did not elicit a strong preference for one dog over the other.

Differentiation that did occur was consistent with the prediction that the virtual dog might be viewed as a source of entertainment, whereas the stuffed dog might be viewed in terms of friendship. However, results for the individual items warrant caution. For example, although items associated with the stuffed dog were rated highly for friendship, not all friendship items showed this pattern. Additionally, some of these items might suggest a hierarchical relationship in which the object provides comfort and care as much as friendship. Items associated with the virtual dog tended to be relevant to entertainment; however, children were equally likely to endorse the stuffed dog for one of the entertainment items.

Our prediction regarding agency was less clear. Children did not differentiate between the two dogs for many of the agency items, underscoring the extent to which they might imagine an inert stuffed dog as having its own agenda. For example, children in Study 2 were equally likely to pick the stuffed dog as the virtual dog for many items that suggested the dog was capable of doing things on its own. The imagined agency of stuffed animals might be related to children's experience with stuffed animals and the tendency of American parents to encourage emotional attachment to such toys and refer to them as animate.

Previous experience with the Nintendo 3DS®, the Nintendogs® game, and/or other virtual pet games was not associated with children's concepts of the virtual dog, possibly because of the lack of extensive exposure to virtual characters in our sample. Children's level of exposure to new technologies and the amount of time they spend engaged with digital devices increases with age (Rideout, Foehr, & Roberts, 2010); thus, children's concepts of virtual characters might change as they become more immersed in technology. Still, it was surprising that they did not pick the virtual dog more often overall in the guessing game, given its novelty. Perhaps children did not equate their own personal thoughts about the two dogs with those of the child in the video.

Note that the results of research using robotic dogs and virtual dogs should not be generalized to the broad category of artifacts designed to stimulate social relationships. We selected our target stimuli because children are familiar with dogs, dogs have been used in past work, and it was possible to acquire a virtual dog and stuffed dog that were nearly identical. However, the virtual characters in apps, games, and websites are diverse, and many have characteristics very different from our virtual pug. For example, the virtual dog, iPuppy, like the robotic dog, AIBO, was programmed to act like a real dog and thus did not use verbal language. However, many virtual characters and social robots act like people and are capable of speech. The lack of verbal language is just one of many ways that the virtual dog, iPuppy, might differ from other virtual characters.

Our preliminary findings suggest several directions for future research. It would be interesting to collect children's intuitions about items that describe different types of social relationships (e.g., hierarchical vs. vertical) and unpack the concept of "friendship" more systematically. However, care should be taken to avoid asking many questions in a single session. Eight children of the 57 who participated in Studies 1 and 2 were eliminated because they started to either respond randomly or answer before they had heard the items stated in full. Given this issue, along with our relatively small

sample size and narrow age range, our findings are preliminary and should be examined within a larger study.

It would also be informative to determine if the guessing game task would elicit differentiated responses for virtual characters and social robots. Qualitative studies have shown that young children, adults, and the elderly form attachments with social robots and interact with them in ways akin to human or human/animal relationships (Turkle, 2011). Although Kahn et al.'s (2006) research indicates that children do not consider a social robot to be more strongly associated with the possibility of friendship than a stuffed dog, children might differentiate the social affordances of an intangible virtual character and a tangible social robot, perhaps based on differences in embodiment.

Another consideration for future research is how a history of shared experiences and interactions with a favorite toy provides context for a child's relationship with it, as well as how it affects the child's intuitions about social affordances. The children in our studies were encountering iPuppy and Stuffy for the first time, but imaginary relationships, like real ones, take time to develop. Many types of objects can acquire personal significance over time (Hood, 2009), but stuffed animals might be particularly conducive to the extended involvement that promotes imaginary relationships. Indeed, children's endorsements for the stuffed dog on the item "I love him/her" suggests that children recognize the emotional investment in these types of toys. Does a virtual character or social robot have the potential for relationship longevity?

Creative control is another consideration in thinking about children's relationships with animate and inanimate toys. There are minimal constraints on the imaginary relationships possible with stuffed animals, but a virtual character often comes with a set of behaviors, commands that it responds to, and specified ways of interacting. Does programming get in the way of developing a personal relationship? Are children more likely to love a toy when they create a relationship based purely on imagination?

Our intuition is that adult efforts to increase the realism and autonomous behaviors of smart toys might not increase the scope of children's interactions with them or make these toys preferred companions. Generations of parents have watched their children push aside a fancy toy to play with the box it arrived in, but we still often underestimate children's interest in exploring the open-ended possibilities of simple objects. There is a growing market of sophisticated artifacts designed to simulate love, comfort and protection, but for many children a stuffed animal might suffice.

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