THE BIOLOGICAL, PSYCHOLOGICAL, AND SOCIAL PROPERTIES CHILDREN AND ADULTS ATTRIBUTE TO VIRTUAL AGENTS

by

NAOMI RUTH AGUIAR

A DISSERTATION

Presented to the Department of Psychology
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

September 2016

DISSERTATION APPROVAL PAGE

Student: Naomi Ruth Aguiar

Title: The Biological, Psychological and Social Properties Children and Adults Attribute to Virtual Agents

This dissertation has been accepted and approved in partial fulfillment of the requirements for the Doctor of Philosophy degree in the Department of Psychology by:

Marjorie Taylor	Chairperson/Advisor
Dare Baldwin	Core Member
Lou Moses	Core Member
T. Bettina Cornwell	Institutional Representative

and

Scott L. Pratt	Dean of the Graduate School

Original approval signatures are on file with the University of Oregon Graduate School.

Degree awarded September 2016

DISSERTATION ABSTRACT

Naomi Ruth Aguiar

Doctor of Philosophy

Department of Psychology

September 2016

Title: The Biological, Psychological and Social Properties Children and Adults Attribute to Virtual Agents

For children, high quality friendships are associated with adaptive social, emotional and academic functioning. There is also evidence that children experience real and imaginary friendships in similar ways, and that imagined relationships could have an impact on development. However, less is known about the relationships made possible by virtual agents in digital media. This dissertation research was designed to provide preliminary data about children's concepts of virtual agents, and the social opportunities they attribute to such entities.

In Studies 1 and 2 (combined N = 48), preschool aged children differentiated the social affordances of a stuffed dog and a virtual dog. Participants played a game in which they guessed whether a child in a video was referring to a stuffed dog or a virtual dog in a series of statements. Items designed to assess high quality friendships, such as comfort, protection and love, were attributed more to the stuffed dog than the virtual dog.

Studies 3 and 4 examined adult and child concepts of a virtual child, and how concepts of this entity might differ from a real child, a child on a video chat program (e.g., Skype™) and an inanimate doll. Adults and children attributed a range of properties to each child agent, including biological, psychological and social properties,

as well as opportunities for relationships. In Study 3 (N = 144), adults did not differentiate between the virtual child and the doll on the social property; however, they favored the doll on opportunities for unilateral relationships. In Study 4 (N = 30), five to eight-year-old children indicated an overall preference for the doll on the social property, as well as on opportunities for reciprocal relationships. Children also favored the doll on opportunities for love, companionship, and intimate disclosure.

Altogether, these findings suggest that virtual agents afford more limited social opportunities than inanimate artifacts, and they are less likely to be loved by children and adults alike. These results raise important questions about the design goals for virtual agents, and the functions they are intended to serve in our everyday lives.

This dissertation includes both previously published and co-authored material.

CURRICULUM VITAE

NAME OF AUTHOR: Naomi Ruth Aguiar

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, Eugene
New York University, New York

DEGREES AWARDED:

Doctor of Philosophy, Psychology, 2016, University of Oregon
Master of Science, Psychology, 2010, University of Oregon
Bachelor of Fine Arts, Dance, 2001, New York University

AREAS OF SPECIAL INTEREST:

Artificially Intelligent Agents
Imaginary Companions
Social Cognition

PROFESSIONAL EXPERIENCE:

Graduate Teaching Fellow, University of Oregon, 2008 - 2016

Program Assistant, The Dana Foundation, 2004 - 2007

Communications Officer, European Dana Alliance for the Brain, 2006

GRANTS, AWARDS, AND HONORS:

Beverly Fagot Dissertation Award, The Biological, Psychological and Social Properties Children and Adults Attribute to Virtual Agents, University of Oregon, 2016

Distinguished Teaching Award, University of Oregon, 2015

Passed with Distinction, Major Preliminary Examination for Advancement to Candidacy, University of Oregon, 2015

Marthe E. Smith Memorial Science Fellowship, University of Oregon, 2012

Clarence and Lucille Dunbar Scholarship, University of Oregon, 2009

Nontraditional Student Award for Leadership and Academic Achievement, University of Oregon, 2008

Tisch School of the Arts Merit Scholarship, New York University, 1998

PUBLICATIONS:

Aguiar, N. R., & Taylor, M. (2015). Children's concepts of the social affordances of virtual characters and stuffed animals, *Cognitive Development*, 34, 16-27.

Taylor, M., & Aguiar, N.R**.** (2013). How real is the imaginary? Children's capacity to gain comfort from imaginary relationships. In S. A. Gelman & M. R. Banaji (Eds.), *Navigating the social world: The early years* (pp. 113-116). New York: Oxford University Press.

Aguiar, N. R., Stoess, C. J., & Taylor, M. (2012). The development of children's ability to fill the gaps in their knowledge by consulting experts. *Child Development*, 83(*4*), 1368-1381.

ACKNOWLEDGMENTS

First and foremost, I would like to thank my adviser, Dr. Marjorie Taylor, for her years of guidance, mentorship, and investment this research. I would also like to thank the members of my Dissertation Committee, Dr. Dare Baldwin, Dr. Lou Moses, and Dr. T. Bettina Cornwell, for their invaluable counsel on research design, implementation and statistical analyses. In addition, my research assistant, Sarah Amini, was instrumental in helping me complete the final phases of data collection and data entry. Special thanks are also due to Carl Oslund and Anna Collins at Oslund Design Incorporated in Eugene, Oregon. Their expertise with Photoshop© made it possible to successfully create images of the real children, the virtual children and the dolls that were in Study 4. This research was supported in part by the Beverly Fagot Dissertation Award, which I received through the Department of Psychology at the University of Oregon. I am grateful to the Department for selecting me to receive this award. Finally, I would like to thank my family and friends, especially my generous and loving parents, Dr. James Aguiar and Dr. Randi Burke. Their steadfast support has enabled me to pursue all of my personal and professional goals. And these acknowledgements would not be complete without thanking my beloved daughter, Isabelle, who encouraged me everyday throughout this process to be my best personal and professional self.

For Dr. Marjorie Taylor, whose unwavering personal and academic support made this work possible

TABLE OF CONTENTS

Chapter Page

Chapter Page

Chapter Page

Chapter Page

Chapter Page

Chapter Page

LIST OF FIGURES

Figure Page

LIST OF TABLES

Table Page

CHAPTER I

GENERAL INTRODUCTION

Overview

Friendships play an important role in children's lives. Having high quality friendships is associated with their sense of well-being (Hartup & Sevens, 1999; Rubin, Bowker, McDonald, & Menzer, 2013) and predicts adaptive social and emotional functioning (Rubin et al., 2013). Although most research on friendship has focused on the flesh and blood variety, there is growing evidence that imaginary friendships should also be included in discussions of children's social networks. In particular, imaginary companions -- the invisible characters and personified objects that children interact with and talk about on a regular basis -- are often experienced in ways that are similar to real friendships (Gleason, 2013; Gleason, 2002; Gleason & Hohmann, 2006) and are capable of providing real-life support (Taylor, 1999). However, less is known about the relationships that have been made possible by recent technological advances in the programming of virtual agents in apps, websites and videogames. Unlike the static media characters of the past, virtual entities present children with opportunities to engage in exchanges that simulate the reciprocal patterns of behavior found in real-life relationships. Artificial agents such as virtual characters and social robots could become a stable part of children's larger social networks, and could be capable of influencing their social, emotional and moral development (Kahn et al., 2013).

This dissertation was designed to examine how children and adults conceptualize virtual agents and the social opportunities they potentially provide. In Studies 1 and 2, I investigated the extent to which preschool children differentiated the social affordances

of a virtual dog that simulated social behaviors and a stuffed animal similar to those used in pretend play (Aguiar & Taylor, 2015). These studies were published in a special issue of *Cognitive Development*, "Cognizing the Unreal", and were co-authored with Marjorie Taylor, Ph.D[1]. In Study 3, I investigated the biological, psychological, and social properties adults attribute to a humanoid agent as compared with attributions to a real person and an inanimate doll. Items that successfully captured biological, psychological and social functioning were then used in a follow-up pilot study with 5- to 8-year-old children (Study 4). In Study 4, I examined children's concepts of a child virtual agent, as compared with their concepts of a real child and an inanimate doll.

In this chapter, I review the literature on children's friendships with real-life peers and with imaginary companions, and explore how these relationships inform the study of children's relationships with virtual agents. First, the literatures on children's friendships with real peers and with imaginary companions are reviewed, discussing similarities and differences in the characteristics and significance of these relationships. Next, the literature on avatars, social robots and virtual agents is reviewed, examining how children conceptualize and interact with these agents, as well as the extent to which children view them as potential friendship partners. Finally, findings across these literatures are synthesized into key themes that motivated this dissertation research.

Children's Friendships with Real-life Peers

Rubin and his colleagues define friendship as a close, voluntary relationship between two people that is reciprocal in nature (Rubin et al., 2013; Rubin, Bukowski, &

[1] Reprinted from *Cognitive Development*, Volume 34, Naomi R. Aguiar & Marjorie Taylor, "Children's concepts of the social affordances of a virtual dog and a stuffed dog", pages 16 – 27, Copyright (2015), with permission from Elsevier.

Parker, 2006). Among pre-verbal children, friendships are generally indexed by behavioral patterns that are socially contingent and displayed by both partners, such as seeking proximity, showing mutual displays of positive affect during play and engaging in complementary play behaviors (e.g., chasing and being chased) (Howes, 1983; Howes, 1996; Rubin et al., 2013). For school-age children and adolescents, friendships are generally identified in two ways: (1) children list each other when asked to indicate their best friend on a class roster (peer nomination method), and (2) children mutually express feelings of affection and positive regard for each other in self-report questionnaires, interviews, and other sociometric measures (Furman, 1996; Rubin et al., 2013).

Approximately 91% of typically developing infant, toddler and pre-school age children meet the criteria for friendship with at least one peer (Howes, 1983) and this percentage remains high as children's friendship networks expand with age (Hartup, 2006; Rubin et al., 2013). Once friendships are formed, these social bonds vary in their duration. In general, dyadic friendships stabilize as children age (Poulin & Chan, 2010; Hartup, 2006; Rubin et al., 2013). Friendships are the least stable during early adolescence, but the termination of friendships in any given developmental window is not uncommon (Poulin & Chan, 2010; Rubin et al., 2013). Reasons for the dissolution of friendship vary, and include both attributes (e.g., aggressiveness) of the children involved in the relationship, as well as the overall quality of the friendship (Crick, Murray-Close, Marks, & Mohajeri-Nelson, 2009; Poulin & Chan, 2010). Children in high quality friendships are more likely to sustain these relationships over time (Berndt, 2004; Rubin et al., 2006).

Friendship Formation

Previous research has identified the dyadic behavioral patterns that have been observed in young children as they become friends, such as proximity seeking, coordinated and socially contingent play, as well as the display of positive affect during play (Howes, 1983; Hartup, 1992). For example, in two controlled experiments, Gottman (1983) compared the conversations between preschool age children who were friends and children who were strangers to determine the features that differentiated friends from non-friends (i.e., agreement ratios). This criterion variable was then used to predict the progress towards friendship among children randomly assigned to dyadic pairs for three audio-recorded play sessions. During the first session, children who "hit it off" communicated clearly, and were able to exchange information, resolve conflict and establish common play activities. In subsequent sessions, exploring similarities and differences and self-disclosure became increasingly important for friendship formation. Based on these findings, Gottman and Hartup (1992) describe friendship formation as a dynamic process in which children must effectively communicate, exchange, and coordinate information in order to establish common ground, resolve disagreements, explore similarities and resolve differences. Although less is know about the process in which older children become friends, Hartup (1992) cites unpublished work by Furman and Childs (1981) showing that similar processes are involved among school age children.

Friendship Quality

According to Berndt and colleagues, the overall quality of a friendship is determined by the degree to which positive and negative features are present in the

relationship (Berndt, 2002, 1996; Berndt & McCandless, 2009). They broadly define high quality friendships as dyadic peer relationships that possess more positive features or that are higher on positive features (e.g., prosocial behaviors) than negative features (e.g., conflict). However, in many studies the assessment of friendship quality focuses exclusively on the number or extent of positive features.

There are a variety of methods used to collect information about the features of children's friendships. Young children are sometimes asked to report about their general concepts of friendship (e.g., "What is a friend?") (e.g., Furman & Bierman, 1983), but most of the research is with school-age children and adolescents using a peer nomination approach, sociometric approach, or combination of both (Berndt, 1996; Furman, 1996). Typically, children are asked to rate the features of a friendship on Likert scales that indicate either how true a particular feature is of their friendship (e.g., Parker & Asher, 1993), or how often a particular type of feature occurs within that friendship (e.g., Berndt & Keefe, 1995) (see also Bukowski, Boivin, & Hoza, 1994; Furman & Adler, 1982; Furman & Burhmester, 1985).

In early childhood, children describe features of friendship that are more superficial in nature, focusing predominantly on physical proximity (e.g., "he lives next door"), concrete behaviors (e.g., "we play"), and common activities (e.g., "we do things together") (Bigelow, 1977; Bigelow & LaGaipa, 1980; Furman & Bierman, 1983; Hayes, Gershman, & Bolin, 1980). Although some features are endorsed across age groups (e.g., common activities, reciprocal liking, and "ego" reinforcement), older children increasingly describe and endorse features of friendship that are less superficial and more intimate, including psychological affordances such as self-disclosure, intimacy, trust and

acceptance (Bigelow, 1977; Furman & Bierman, 1983; Furman & Bierman, 1984). Using a cluster analysis, Bigelow proposed a cumulative, three-stage model of development in which early concepts of friendship (e.g., physical proximity and common activities) form the basis upon which subsequent concepts of friendship are developed (e.g., loyalty, commitment, intimacy).

Dimensions of friendship quality. While there is some agreement among researchers, the particular dimensions that define friendship quality vary in two ways among the established inventories. First, the number of dimensions can differ dramatically from one inventory to the next; Bigelow (1997) assessed children's friendships on 21 positive dimensions, whereas Berndt and Keefe (1995) examined only four dimensions of friendship quality. And although factor solutions generally support the number of dimensions that comprise a given inventory (see Furman for a review), Berndt (1996; 2002) argues that friendship quality consists of two overarching dimensions: positive features (e.g., prosocial behavior) and negative features (e.g., conflict). This claim is based on evidence indicating that positive and negative features of friendship are not highly correlated, and therefore represent separate dimensions (see Berndt, 2002). Second, although the defining dimensions of friendship quality overlap to some degree across measures, but there is still a great deal of disagreement about the specific dimensions that comprise friendship quality (e.g., see Furman, 1996 and Berndt and McCandless, 2009 for comparisons).

The existing variations among these measures make it difficult to decide how friendship quality should be measured in a given study. Although Furman (1996) argues that theory is an important consideration for selecting a measure of friendship quality,

few inventories are theoretically motivated. In his review, Furman cites only two measures derived from theory: (1) Furman and Burhmester's (1985) Network of Relationships Inventory (NRI), which is based on social provisions theory (Weiss, 1974), positing that the social interactions inherent in different relationships foster opportunities for specific social affordances or "provisions" and (2) Furman and Wehner's (1994) Behavioral Systems Questionnaire (BSQ), which is based on attachment systems theory, positing that friendships provide children with a secure base from which to establish the emotional intimacy necessary for adult romantic relationships (see Hartup, 2009).

In addition to theoretical motivation, the specific goals of the study also might make one measure more appropriate than another. For example, Furman and Burhmester's (1985) NRI was specifically designed for making comparisons across different types of relationship partners (e.g., siblings, parents, and peers). This inventory had also been successfully adapted to compare friendships with real peers and imaginary companions (e.g., Gleason, 2002; Gleason & Hohmann, 2006).

The developmental significance of high quality friendships. Although there is some contradictory evidence regarding the importance of friendship quality (see Berndt, 2002), high quality friendships are associated with decreased feelings of loneliness (Ladd, Kochenderfer, & Coleman, 1996; Parker & Asher, 1993) and adaptive functioning in academic settings (see Hartup, 1996 and Hartup & Stevens, 1997 for reviews). Children in high quality friendships have more positive attitudes towards school (e.g., Berndt, Hawkins, & Jiao, 1999), adapt well to transitions in school (e.g., Ladd, Kochenderfer, & Coleman, 1996), and are more involved in school activities (e.g., Berndt & Hawkins, 1991). Having a high quality friendship is also associated with increased

popularity at school (Cauce, 1986), positive attitudes towards peers (Berndt, 1989), and higher academic performance (Cauce).

High quality friendships might also mitigate the effects of peer victimization on social and emotional well-being (Hodges, Boivin, Vitaro, & Bukowski, 1999; Schmidt & Bagwell, 2007). Schmidt and Bagwell (2007) found that school age girls in high quality friendships reported lower levels of social concerns when faced with relational and overt victimization by peers (e.g., emotional threats and physical aggression). Additionally, girls in high quality friendships experienced lower levels of depression in the context of physical victimization. Specifically, dimensions of help and security served as buffers against the negative effects of peer victimization, which included items about reliability, dependability, protection, help, and conflict resolution. Similarly Hodges et al. (1999) found that school age children with teacher-reported internalizing problems were less likely to be victimized over the course of one-year if they were in high quality, protective friendships.

Summary

The literature on children's friendships with real-life peers provides a wealth of information about the prevalence, course, and significance of early friendships, the dimensions that describe friendship, and the measures that can be used to study friendship at different ages and for different goals. It is clear from this literature that reciprocity is key to understanding friendship. By definition, friendships with real-life peers are reciprocal relationships, in which children nominate each other as friends, report mutual liking, and show socially contingent, affective and synchronous play styles. Children are drawn to peers who are similar and friendship formation is based on verbal and

behavioral reciprocities to effectively establish and maintain common ground during play. These observed reciprocities form the basis of high and low quality friendships. Indeed, friendships in which positive features are mutually provided are likely to thrive, whereas friendships in which negative features are mutually reinforced are likely to dissolve.

The importance of reciprocity is particularly intriguing to consider from the point of view of research investigating imaginary relationships in which any reciprocity has to be wholly imagined. In friendships with real-life peers, two individuals contribute to the relationship and the reciprocities are observable. However, what happens when the relationship is imaginary? For example, there is only one vehicle (the child) in a relationship with an imaginary companion. To the extent that the relationship involves reciprocity, that experience has to be entirely imagined. Given the importance of reciprocity in friendships with real-life peers, is it even appropriate to describe an imaginary relationship as friendship?

In what follows, I review the literature on imaginary companions, making the case that these relationships have at least some of the characteristics of real-life friendships – including reciprocity. The topic of reciprocity continues in the final sections on relationships with virtual agents. The combination of programmed and imagined reciprocities that characterize interactions with virtual agents raise interesting questions about the perception of these entities, as well as their potential to be friendship partners.

Children's Friendships with Imaginary Companions

Gleason (2013) defines two key tenets of imaginary relationships: (1) they are based on made-up characters that are inaccessible to others and (2) the relationships are

reciprocal in nature (i.e., the child has imagined exchanges with the made up character). Thus, like friendships with real children, reciprocity is considered to be an important component of children's imaginary relationships, despite the fact that these reciprocities have one vehicle (the child) and that these exchanges are entirely imagined.

Among preschool-age children, imaginary friendships generally take the form of an "imaginary companion", originally defined by Svendsen (1934) as: "an invisible character, named and referred to in conversation with other persons or played with directly for a period of time, at least several months, having an air of reality for the child, but no objective basis" (p. 988). This definition excludes special toys that children imbue with personalities (i.e., personified objects) (Newson & Newson, 1968). However, if these toys possess human-like characteristics (e.g., personalities) that go beyond providing the child with comfort, more current research includes them in the general definition (e.g., Klausen & Passman, 2007; Singer & Singer, 1981; Taylor, 1999).

The presence of an imaginary companion is typically assessed via self-report measures (e.g., Bonne, Canetti, Bachar, De-Nour, & Shalev, 1998; Pearson et al., 2001; Schaefer, 1969; Seiffge-Krenke, 1993). However, for younger children, researchers often supplement child reports with parent interviews (see Taylor, 1999). In general, methods that rely solely on parent or on child reports can be misleading. According to Taylor (1999), child reports are necessary because parents are not always aware of their children's imaginary companions, or have limited or inaccurate information regarding the characteristics of these companions. On the other hand, parent reports are helpful because some children might make up an imaginary companion during the interview process. Methods that rely on both parent and child report are ideal because parents can

corroborate the presence and general description of the imaginary companion, and children can provide detailed information about the nature and function of their imagined friends (Taylor & Carlson, 1997).

Friendships with imaginary companions are less common than friendships with real peers, but the incidence can be quite high for children aged 7-years-old and younger. Depending on how imaginary companions are defined, frequencies can range from 23% for invisible friends (Pearson et al., 2001) to 65% for both invisible friends and for personified objects (Taylor, Carlson, Maring, Gerow & Charley, 2004). Although imaginary companions tend to disappear as children age (Pearson et al. 2001), the creation of an imaginary companion is not limited to the preschool years. Several studies have found that both school-age children (Hoff, 2005; Pearson et al., 2001; Taylor et al., 2004) and adolescents (Bonne et al., 1998; Pearson et al.; Seiffge-Krenke, 1997; Taylor, Hulette, & Dishion, 2010) maintain their childhood companions, or create new ones. Diary-based companions (Seiffge-Krenke, 1993) and imagined relationships with celebrities and other media figures (i.e., "parasocial relationships") are also found among younger and older age cohorts (Bond & Calvert, 2014; Gleason, 2013). Although parasocial relationships are based on either real people or characters made up by other people, if the relationship has features that transcend reality (e.g., relationship qualities that have no real world basis), then these relationships are included in the general definition of an imaginary relationship (Gleason, 2013).

Attributes of Imaginary Companions

In real friendships, children are friends with peers who are similar to themselves (e.g., same age, gender, and interests) (Aboud & Mendelson; Hartup, 2006; Rubin et al.,

2006). However, many imaginary companions differ substantially from their creators, both in physical attributes and personality (Taylor, 1999; Taylor & Mannering, 2006; Taylor, Shawber, & Mannering, 2009). Some children create companions that are human, and are the same sex and age as their creator, but many children create invisible friends that are animals, objects, or unique fantastical creatures. Taylor and Mannering (2006) found that in a sample of approximately 600 descriptions of imaginary companions, 40% were personified objects based on special toys and 60% were invisible friends. Of these invisible friends, 34% of imaginary companions were described as ordinary people, 16% were humans with extraordinary powers (e.g., could fly), 15% were invisible animals, 8% were superheroes, ghosts or spirits, and 7% were fantastical or made up creatures (e.g., a world traveling Cyclops).

Additionally, children vary in the extent to which they create imaginary companions with wholly positive personality traits or characteristics. Some imaginary companions are described as possessing mostly positive qualities, such as being friendly, helpful, and compliant (Taylor, 1999; Taylor & Mannering, 2006). However, it is not uncommon for imaginary companions to have negative features as well, such as being bossy, annoying or argumentative (Taylor; Taylor & Mannering). In the literature, these negative features are typically used as an index of the level of autonomy experienced by children when interacting with their imaginary companions (Gleason, 2013). Although imaginary companions who always agree and comply with the child's wishes might still be experienced as autonomous by the child, autonomy is more unambiguous when imaginary companions are described as willful, argumentative and non-compliant. Nevertheless, it is important to note that the experience of autonomy in children's

relationships with their imaginary companions is considered normative, and not indicative of problems with reality monitoring (Taylor, Carlson, & Shawber, 2007). Typically-developing children are aware that their imaginary companions are not real, and many children explicitly point out the fantasy status of their imaginary companions in interviews with researchers (Taylor, Shawber & Mannering, 2009).

Variations in autonomous behaviors are also described in terms of the social, emotional and physical "competencies" of the imaginary companion. The competence of the imaginary companion might depend partly on whether the friend is invisible or a personified object and on the creators' gender. Gleason, Sebanc, & Hartup (2000) found that 80% of mothers of children with personified objects described children's relationships with these toys as hierarchical, in which the child cared for and nurtured a less competent companion, whereas 57% of mothers of children with invisible friends described their children's relationships with these imagined characters as egalitarian (i.e. in which both the child and the imaginary companion were equally competent). Harter and Chao (1992) found that the competency of children's invisible imaginary friends might vary in relation to gender. In their sample, girls tended to create friends that were less competent (e.g., needing care), whereas boys tended to create friends that were more competent (e.g., could do things that the boys admired). However, Coetzee and Shute (2003) found that both boys and girls rated their invisible imaginary companions as less competent than themselves and other research has found that imaginary companions are typically described as competent (see Taylor & Aguiar, 2013).

Friendship Formation

To date, little is known about the processes in which relationships with imaginary companions are formed. Instead, efforts have been made to capture the reasons why children might create them. Frequently, studies indicate that children create imaginary companions: (1) for fun and companionship (2) as a means to evade loneliness or boredom (3) to avoid blame for wrongdoings and (4) to bolster self esteem (Ames & Learned, 1946; Harter & Chao, 1992; Hoff, 2005; Klausen & Passman, 2007; Nagera, 1969; Newson & Newson, 1968; Singer & Singer, 1990; Taylor, 1999). Additionally, researchers frequently suggest that children might create imaginary companions as a means of coping with a range of environmental, situational, internal or chronic problems (Bender & Vogel, 1941; Carlson, Tahiroglu, & Taylor, 2008; Hoff, 2005; Singer, 1993; Singer & Streiner, 1966; Seiffge-Krenke, 1997; Sadeh, Hen-Gal, & Tikotzky, 2008; Taylor et al., 2010). For example, Singer and Streiner found that blind children created imaginary companions who were sighted and could do things that the children themselves could not do (e.g., find hidden objects, read mail). The authors suggest that blind children might create imaginary companions to cope with or compensate for their perceptual limitations.

Friendship Quality in Imaginary Companions

In spontaneous descriptions of imaginary companions, children often include the hallmarks of high quality friendships identified in the friendship literature, such as shared activities, mutual affection, and intimate exchange (e.g., Parker & Asher, 1993). For example, school-age children frequently described their imaginary companions as providing support through companionship, help with day-to-day tasks (such as

homework), and emotional support for coping with negative emotions and difficult life experiences (Taylor & Aguiar, 2013).

According to Gleason and colleagues (Gleason, 2002; Gleason & Hohmann, 2006), children conceptualize their relationships with imaginary companions in ways that are similar to real friends. In two separate studies, children were asked to report on the dimensions of friendship quality with real friends and imaginary companions. The procedure was adapted from a version of the NRI (Furman & Burhmester, 1985), which is based on Weiss's (1974) social provisions theory. In this theory, relationships are described as affording six social provisions (attachment, guidance, nurturance, reliable alliance, reassurance of worth, social integration). Of these six provisions, one primary provision is what distinguishes one relationship from another (Cutrona & Russell, 1987). For example, nurturance might serve as the primary provision for parent child relationships, whereas reassurance of worth might serve as the primary provision for relationships with peers. Multiple provisions can be obtained from one relationship, and these provisions can vary in importance based on context and development (e.g., the need for nurturance from parents might decrease as children age).

In the first study (Gleason, 2002), 4-year-old children were asked to report on dimensions of conflict, instrumental help, power and nurturance for parents, siblings, a best friend and an imaginary companion. Children with imaginary companions were more likely to attribute nurturance to their imaginary companion compared to a best friend (driven primarily by personified objects). Additionally, children with invisible friends were more likely to attribute instrumental help to a best friend, whereas children with personified objects were equally divided between their imaginary companions and

their best friends. However, across relationship affordances, children with either invisible friends or personified objects did not significantly differentiate imaginary companions and best friends, suggesting that overall, children conceptualize these relationships in ways that are similar.

These findings were replicated in a subsequent study (Gleason & Hohmann, 2006) examining children's concepts of reciprocal friends, unilateral friends, non-friends and imaginary companions. In this study, 4- and 5-year-old children nominated three friends from a class roster, who were later identified by experimenters as reciprocal friends or unilateral friends based on how often the dyadic pairings reported playing with each other (e.g., "play with a lot/not very much"). Non-friends were identified as dyadic pairings in which children did not nominate each other as a friend, and indicated that they did not play with each other very often. Children were then interviewed about imaginary companions. In a follow-up session, children were asked to report on positive dimensions of friendship quality based on an adapted version of the NRI, including companionship, reliable alliance, affection and enhancement of worth for the four relationship types. Children with imaginary companions rated all three types of friendships (imaginary companions, reciprocal friends, and unilateral friends) as providing greater levels of these positive dimensions compared to non-friends. Additionally, these positive dimensions were attributed more to imaginary companions than unilateral friends. However, there were no statistical differences between imaginary companions and reciprocal friends across all five dimensions. As in the original study (Gleason, 2002), these findings indicate that children conceptualized their imaginary companions in ways akin to real reciprocal friendships.

The Developmental Significance of Imaginary Companions

For children's real friends, the absence of a close peer relationship is associated with risk, but for imaginary companions, it is the presence of a close relationship that has sometimes been regarded as a possible "red flag" for problematic psychological functioning- particularity in older children (Benson & Pryor, 1973; Freud, 1968; Svendsen, 1934). However, research findings with both younger and older age cohorts are not consistent with this negative view. Children might create imaginary companions when bored, lonely, or as a vehicle for coping, but they are not shy, withdrawn, or without real friends (Gleason, 2004; Mauro, 1991). Studies examining the correlates of children with imaginary companions indicate that these children tend to be less shy than their peers (Mauro; Taylor, Sachet, Mannering & Maring, 2013), are well liked at school (Gleason), and are functioning well emotionally and psychologically (Taylor, 1999). Additionally, some studies have found that children with imaginary companions have advanced social understanding skills (Lillard & Kavanaugh, 2014; Taylor & Carlson, 1997). Children with imaginary companions might also derive real benefits from these imagined friends in ways that are similar to real friendships.

The most compelling evidence for the benefits of imaginary companions comes from studies examining how imaginary companions might help children cope with a range of environmental, situational, internal or chronic problems (Bender & Vogel, 1941; Hoff, 2005; Sadeh, Hen-Gal, & Tikotzky, 2008; Seiffge-Krenke, 1997; Singer, 1993; Singer & Streiner, 1966; Taylor et al., 2010). For example, recent empirical work indicates that imaginary companions – like real friends – can be a protective buffer against chronic environmental stressors. In a longitudinal study examining the relation

between imaginary companions and coping in adolescence, 152 at-risk 12-year-olds reported instances of imaginary companions (past, current or none), and were assessed for peer acceptance, problem behaviors and coping strategies (Taylor et al., 2010). Adolescents with current imaginary companions (9% of the sample) were found to endorse positive coping strategies, but also exhibited more problem behaviors and were rejected by their peers. However, in a longitudinal follow-up after high school, adolescents who reported a current imaginary companion at age 12 showed more positive outcomes (i.e., high school diploma, no history of arrest, no record of substance abuse, and no mental health diagnoses) compared other adolescents in the sample.

Currently, one of the most compelling studies examining the role of imaginary companions in coping with adversity comes from an intervention with personified objects (Sadeh et al., 2008). In this study, 2 – 7-year-old Israeli children living in temporary war camps during the 2006 Israeli/Lebanon conflict experienced high levels of trauma-induced stress, including trouble sleeping, separation anxiety, disinterest in play and increased startle responses. To help children transition to their lives back at home when it was deemed safe, Sadeh and colleagues administered an intervention designed to ameliorate children's stress related symptoms and to activate internal coping strategies. Children were randomly assigned to a standard educational intervention group for parents or the "Huggy Puppy" group in which children were given stuffed animals that were described as being far from home, emotionally vulnerable, and in need of care. Children in the Huggy Puppy intervention group were then asked to care for the stuffed animal by playing with it, hugging it, and sleeping with it at night. After three weeks, a comparative analysis of pre- and post-test stress reaction scores showed a significant

decrease in the number and severity of stress related symptoms for children in the Huggy Puppy group. Additionally, higher levels of attachment with the stuffed animal were associated with lower scores on the stress reaction checklist. These results were later replicated on a larger sample of elementary school children who had also been adversely affected by the war.

Considered together, descriptions of imaginary companions and empirical work suggest that children might rely on imaginary companions in ways that are similar to their real friendships. As with real friends, children might turn to imaginary companions for comfort, companionship, protection and security. And like children's real friends, the benefits from relationships with these imagined friends could be not only real, but long lasting.

Summary

Although children's real and imaginary friendships diverge in a number of ways (prevalence, forms, and attributes), reciprocities are a defining feature of both types of relationships. In friendships with imaginary companions, children act as the sole vehicle of imagined reciprocities that, with some exceptions (e.g., when a child gives voice to an imaginary companion), are unobservable to others outside of the relationship. Some imaginary companions are more clearly autonomous than others, with personalities described by children as wild, bossy or unruly. However, children who create imaginary companions are not out of touch with reality; they readily recognize that these friendships are not real.

Nevertheless, children conceptualize their relationships with imaginary companions in ways that are similar to friendships with real peers. In descriptive reports,

children frequently describe features found in high quality friendships with real peers, such as affection, guidance, and intimate exchange. Additionally, statistical comparisons between real and imaginary friends have shown that children attribute similar features to both types of relationships, such as companionship, reliable alliance and enhancement of worth. Children might also derive real benefits from their imaginary companions, in ways that are similar to real friendships. Imaginary companions could provide companionship and comfort during stressful life events, and might serve as a protective factor in high-risk social environments. Additionally, imaginary companions might help children reduce internalizing symptoms by activating their own internal resources for coping with extreme environmental stressors. Together, these findings suggest that children's imaginary companions can have a real and potentially lasting impact on development.

If relationships with imaginary companions affect children's development, can the same case be made for relationships with the virtual agents encountered on apps, websites and videogames? In imaginary relationships, children create their companions and facilitate imagined interactions with them. On the other hand, programmers develop virtual agents that are capable of responding socially to children in observable ways. How might this ontological ambiguity – being not alive but able to respond in ways that appear real – affect children's concepts of these agents as potential friendship partners? In the following section, I review the extant literature on children's concepts of and interactions with virtual agents, as well as complementary research on avatars, social robots and other traditional media platforms (i.e. television). Drawing from research on children's real and imaginary friendships, I make a case for virtual characters as a

complex social entity, affording both unique and overlapping relationship qualities with children's real and imaginary friends.

Relationships with Virtual Agents

Virtual agents fall under the umbrella of personified conversational agents -- technologies designed to mimic gestural and affective behaviors, personality traits, and social scripts for the purposes of simulating real life relationships (Freier, 2008). Also referred to as embodied conversational agents (Cassell, 2000), virtual agents can take on a variety of forms, including embodied virtual agents encountered in apps, websites and videogames, as well as disembodied voice interfaces encountered in smart phones (e.g., "Siri"), automated checkouts, and voice-activated navigations systems (Freier, 2008). It is important to note that these agents are all operated by Artificial Intelligence (AI); thus, "avatars" are not considered virtual agents. Avatars, unlike virtual agents, are embodied representations of a human operator in a screen-based or fully immersive virtual environment (Fox et al., 2015). Additionally, social robots fall under the umbrella of personified conversational agents, but are also not classified as virtual agents because they are embodied in physical (rather than digitized) space. However, to fill gaps in the research on virtual agents, studies with both avatars and social robots will be discussed.

Currently, children's exposure to sophisticated virtual agents remains limited, particularly for younger age cohorts (Rideout, 2013). However, according to Blascovich and Bailenson (2011), the foray into virtual environments with increasingly sophisticated virtual agents is inevitable -- even for very young children. Indeed, the advent of touch technologies has made it possible for children under the age of one to interact with screen-based characters. The most recent study of children's media use revealed that

38% of children under the age of two have used mobile screen-based devices to access digital media (Rideout, 2013). Given that these data are now three years old, is it is likely that the number of children exposed to digital content at younger ages has continued to rise as digital media and portable devices evolve.

Attributes of Virtual Agents

The form of embodied virtual agents is constrained only by the programmer's imagination. They can be animals, humans, artifacts (e.g., Microsoft's "Clippy"), or fantastical novel creatures. In research settings, embodied forms vary widely, but in video games, agents are constrained in visual appearance (e.g., a narrow range of fantastical creatures), and in their functions (e.g., enemy combatants). Video games for younger children often have animal agents, whereas games for older children are more likely to have humanoid agents. Additionally, boys and girls cite different motivations for playing videogames (Olsen, 2010), which might lead them to interactions with different types of virtual agents. For example, in research with adults, men report preferring role-playing games where they are likely to encounter more sophisticated agents, whereas women report preferring more traditional types of games (e.g., virtual board games) that might include less sophisticated or disembodied agents (Lucas & Sherry, 2004).

Not much information has been documented about the personalities and competencies of agents currently available to children in apps, websites and games. However, context generally provides clues as to their nature and functions. In some educational studies, teaching and learning are programmed as a reciprocal exchange, where child participants and a "virtual peer" might learn from each other (e.g.,

Finkelstein et al., 2013). Thus, in this context, the agent should be perceived as equally competent, and in some cases more competent than the child player. In naturalistic settings, many video games for younger children are designed to teach them to nurture and care for a virtual pet that is less competent than the child and dependent on "affection" and instructional input from the child player. Additionally, virtual pets and other synthetic agents (such as social robots) are programmed to "learn" from human input. For example, Sony's robotic dog, AIBO, responds to tactile input, which can discourage or reinforce certain behaviors, thus shaping the robot's "personality" (Kahn et al., 2013). Therefore, children often have some creative control over these types of agents, although there are significant limitations due to the context and the level of programming sophistication.

The Formation of Relationships with Virtual Agents

Currently, there is a paucity of research examining the processes by which children might develop relationships with virtual agents. However, Blascovich and Bailenson, (2011) describe a general theory of virtual behavior that provides a useful framework for discussing ways in which children might relate to and be influenced by virtual agents. According to Blascovich and Bailenson, there are five tenets that govern behavior towards avatars and agents: (1) the degree to which the agent is perceived as sentient, (2) the "communicative realism" of the agent (in both form and social behaviors), (3) how children and adults consciously and unconsciously respond to the agent, (4) the degree to which the agent is socially relevant to the child, and (5) the context in which the interaction is taking place.

Concepts of sentience. Much of the research examining children's concepts of personified technologies has focused on social robots. Initial studies have examined the ways in which children might view robotic artifacts as possessing agency, biological properties, volition, emotions, and mental states (Jipson & Gelman, 2007; Kahn, Friedman, Pérez-Granados, & Freier, 2006). Although young children clearly recognized robotic entities as non-living, they attribute psychological characteristics, such as intentions and mental states to these artifacts (Kahn et al., 2006). This incongruence in children's concepts has been captured in the "new ontological category" hypothesis (Kahn, Gray, & Shen, 2013), which attempts to account for children's complex and multifaceted judgments about the reality status of social robots (Jipson & Gelman; Severson & Carlson, 2010). According to this view, children and adults treat new technologies that simulate both social exchanges and social relationships as a new and unique category of human artifacts -- non-biological agents that are neither "alive" nor "not alive" (Kahn et al., 2013; Severson & Carlson, 2010).

Subsequent research on human/robot interactions is consistent with the new ontological category hypothesis (Kahn et al., 2006; Kahn et al., 2013; Turkle, 2007). Both children and adults treat social robots – even those that vary in their level of sophistication – as sentient beings that are capable of thinking, feeling and experiencing discomfort or pain. For example, in an experiment conducted by Baird (as cited in Turkle, 2011), adults were willing to hold a Barbie doll upside down significantly longer than the popular robotic pet "Furby." The adults knew Furby could not actually experience discomfort and distress, but they still treated the robot as though it were

suffering. However, an alternative explanation is that the adults simply wanted to turn off Furby's wails of "discomfort" that occurred until the toy was turned upright.

In a more convincing demonstration, Kahn et al. (2012) found that school age children attributed mental states (i.e., the ability to have feelings and experience sadness) to a humanoid robot, Robovie, after an experimenter interrupted its turn during a game and made it return to its closet. Finally, in one of the first studies to examine children's concepts of virtual agents, Freier (2008) found that school-age children attributed moral standing to a female agent. In this study, an experimenter chided a virtual agent for making a mistake during a game of tic-tac-toe. In the experimental condition in which the agent expressed psychological harm (e.g., "hurt feelings"), children described the act of chiding as morally wrong.

Communicative realism. According to Blascovich and Bailenson (2011), virtual agents are more likely to have social influence on children and adults if they can successfully simulate human forms of non-verbal communication. These forms include photorealism (in which the agent looks human) and movement realism (in which the gestures, facial expressions and postures appear human).

In research with adults, the presence of a face is the most necessary feature for a sense of communicative realism (Yee, Bailenson, & Rickertsen, 2007; Blascovich & Bailenson, 2011). In a meta analysis conducted by Yee et al. (2007), the presence of a face was more influential than faceless shapes and disembodied voices; however, effect sizes did not differ as a function of photorealism, indicating that the level of photorealism was not as important for social influence in virtual environments. In fact, high levels of photorealism can be off-putting for adults in virtual reality according to the well-known

"uncanny valley" phenomenon first described by the roboticist, Masahiro Mori (1970). According to this theory, there is a tipping point in photorealism where familiarity with the agent plummets as a function of discomfort or repulsion, which is further enhanced by movement. However, research directly testing the uncanny valley has produced mixed results (e.g., Bartneck, Kanda, Ishiguro, & Hagita, 2009; Seyama & Nagayama, 2007). For example, Bartneck et al. (2009) found that adults rated a highly realistic doppelgänger robot as equally likeable compared to its human counterpart, whereas Seyama and Nagayama (2007) found that morphed virtual faces were rated by adults as significantly less pleasant when they crossed a critical threshold from unrealistic to highly realistic (i.e., when participants detected "buggy" eyes in the face of a virtual agent).

In research with children, the development of virtual agents has largely focused on both verbal and non-verbal forms of communication that can help build rapport between the child and the agent in interventions or instructional settings (e.g., Cassell, 2000; Yu, Gerritsen, Ogan, Black, & Cassell, 2013; Zhao, Papangelis, & Cassell, 2014). In these studies, computational models are built based on children's dyadic interactions with friends. These models are then used to program the socially contingent behaviors of a virtual agent (e.g., appropriate eye gaze, head movements, physical gestures and linguistic corpus). Thus, computational models are built to enable the agent to engage in the appropriate social reciprocities found in children's real friendships. However, children's beliefs about the capacity to develop relationships with these agents are not directly assessed.

Conscious and unconscious responses. Blascovich and Bailenson (2011) discuss how adults respond to agents in ways that are outside their conscious control. For example, adults flinch when thrown a virtual punch, even though they are consciously aware that a virtual punch cannot cause pain (Blascovich & Bailenson, 2011). Conscious and unconscious responses are further demonstrated in the incongruencies between adults' verbal and behavioral responses to computers (Freier, 2008; Nass & Yen, 2010). Nass, Moon, & Green (1997) provide a particularly compelling example of this incongruence in a study in which adults unconsciously treated computers as "gendered". Adults were randomly assigned to receive tutorials about love/relationships or physics from a computer with a male or female voice. In general, computers with male voices were rated as friendlier and more competent than computers with female voices. However, there was a significant interaction between tutorial subject and computer voice. Participants who heard the love/relationship tutorial from a female voice and the physics tutorial from a male voice rated the computers as more competent than computers that did not have voices matched for these stereotypically gendered subjects. When asked about the gender of the computer's voice, participants denied being influenced by the gender of the voice or harboring gendered stereotypes and did not believe that the voice represented the identity of the programmer, who they uniformly described as male.

In children, verbal and behavioral inconsistencies are common across a broad range of studies, including the fantasy reality distinction, mathematical equivalences, and concepts of personified technologies (Kahn et al., 2006; Woolley, 2006). For example, children in Kahn et al.'s study attributed the experience of pain to both a stuffed dog and a sophisticated robotic dog, but were more likely to behave aggressively towards the

stuffed dog during a free-play session. Because children are developing ontological knowledge about social agents and knowledge about social expectations, inconsistencies between verbal and behavioral measures afford the opportunity to examine how children conceptualize personified agents. Woolley (2006) cites several possible explanations for inconsistencies in verbal and behavioral responses that can help inform future research on children's concepts of virtual agents, including task difficulty, levels of uncertainty, as well as the child's goals during the task. Thus, any task examining children's concepts of virtual agents should use multiple measures, and should consider how the task difficulty and goals might influence the child's responses across measures.

Social relevance. In research examining young children's ability to learn from video, Krcmar (2010) and Lauricella, Gola, and Calvert (2011) describe social relevance as the identity of the actor or character (e.g., beloved or unknown media character), and the perception that the actor or character can respond to the child in ways that are socially contingent (e.g., looking at the child, pausing for a reply). Although there is no current research examining the effects of social relevance on children's relationships with virtual agents, there is empirical support for this idea with more traditional media platforms. Lauricella et al. found that toddlers were best able to perform a serialization task when learning from a video with a socially relevant media character (Elmo from *Sesame Street*) compared with a less relevant media character (DoDo, a puppet popular in Taiwan). Therefore, the social relevance of the virtual agent might be particularly meaningful for the development of a relationship.

Context. Finally, Blascovich and Bailenson (2011) suggest that the four other tenets of this general theory of virtual reality (i.e., perceptions of sentience,

communicative realism, conscious and unconscious responses, and social relevance) depend on context. Context can be based on the type of platform (e.g., immersive vs. non-immersive), the content or function of the virtual reality (e.g., video game vs. social networking site), and/or the type of personified technology (e.g., avatar vs. agent). For example, adults are generally more influenced by avatars than by virtual agents, but fully immersive virtual reality closes this gap in social influence (Fox et al., 2015). Given the diversity of the virtual environments available to children, future research will need to consider how the particular context might shape children's concepts of and interactions with virtual agents.

Relationship Qualities with Virtual Agents

Across studies examining child and adult interactions with personified technologies, research findings support the hypothesis that these agents are conceptualized as an emerging social category (Kahn et al., 2013), and are capable of influencing human behavior (Blascovich & Bailenson, 2011). However, there are a limited number of studies directly examining children's relationships with virtual agents. To date, much of the existing empirical and qualitative work has been conducted with social robots. In general, both children and adults conceptualize and treat these social agents as relationship partners. In a study conducted by Kahn et al. (2006), the majority of preschool age children indicted that it would be possible to have a reciprocal relationship with the sophisticated robotic dog, AIBO, based on mutual "liking" and reciprocated feelings of friendship. In addition, qualitative studies conducted by Turkle and colleagues have shown that young children, adults, and the elderly form strong attachments with social robots, and interact with them in ways akin to human or

human/animal relationships (e.g., confiding in them, communicating verbal and physical affection, and describing them as irreplaceable if broken or taken away) (see Turkle, 2011 for a review). Based on these findings, it is possible that children might conceptualize virtual agents as potential friendship partners, and form attachments to them.

However, these findings raise questions regarding the role of creative control in children's relationships with personified agents. In relationships with imaginary companions, there are minimal constraints on the forms, functions and features of these friendships, and the ways they can evolve over time. However, virtual agents are currently limited by the level of programming sophistication, and by the inputs available to the child for modifications of the agent's form and functions. Therefore, programming constraints might produce a set of tightly scripted social exchanges that cannot evolve through continued interactions. Thus, it is possible that programming might actually hinder the development of a friendship with an agent.

Developmental Significance of Relationships with Virtual Agents

To date, little is known about the extent to which virtual agents might influence children's social, emotional and moral functioning. However, recent and on-going intervention research suggests that, like children's real friendships, virtual agents could have the capacity to influence academic functioning (Cassell et al., 2009; Finkelstein et al., 2013), the development of social skills (Milne, Luerssen, Lewis, Leibbrandt, & Powers, 2010), and the development of empathy (Tsai & Kaufman, 2009). For example, Cassell and colleagues have developed "virtual peers" that are currently being used to help close educational gaps found on standardized tests scores for African-American

children (Cassell et al., 2009; Finkelstein et al., 2013; Finkelstein et al., 2012). These studies have shown that discrepancies in familiar and academic language could account for differences in scientific learning, and virtual peers are being successfully utilized to bridge this divide (Finkelstein et al., 2013). Additionally, Milne and colleagues (2010) have developed a virtual agent that helps children with Autism Spectrum Disorders gain conversational skills and cope with bullying.

Finally, a recent study Tsai and Kaufman (2009), has shown that virtual pets can be used to enhance empathy and humane attitudes towards animals. In this study, school age children with no pets at home were given the Nintendogs® virtual pet game for three weeks, and asked to care for a virtual dog by cleaning it, feeding it, taking it on walks, and providing it with affection. Ninety-two percent of the children in this study described the virtual agent as akin to a real pet because it behaved like a real dog and because it needed to be cared for. Additionally, compared to pre-test scores, both girls and boys showed improved scores on measures of empathy and humane attitudes towards animals.

Summary

Reciprocity is paramount to the study and development of virtual agents because virtual agents are being programmed to simulate human relationships. Current research on virtual agents and other personified technologies has focused on the anthropomorphic attributes and the socially contingent forms of non-verbal communication that can help establish rapport with virtual agents and facilitate social influence in virtual environments. For example, researchers like Cassell and colleagues have used computational models of dyadic interactions between friends to program these sophisticated virtual agents (Yu et al., 2013; Zhao et al., 2014).

The observable reciprocities that are part of the programming of virtual agents present an ontological dilemma: virtual agents are not embodied in the real world, but their movements are viewable, their "voices" are audible, and their "emotions" are detectable. It is likely that this ambiguity shapes children's concepts of virtual agents, and the qualities that characterize relationships with these entities. However, little is known about how children conceptualize these agents, and the extent to which they view them as friendship partners. Research with social robots indicates that children recognize that robots are not alive, but still attribute psychological and perceptual properties to these agents. Additionally, children believe friendships are possible with social robots, although the qualities that might comprise these relationships are unknown.

Goals of the Dissertation

Across relationships with peers, imaginary companions and virtual agents, two themes emerge that inform the study of children's relationships with virtual agents. First, real and imagined reciprocities are key to understanding friendships with real and imaginary others. By definition, the reciprocities inherent in children's real and imaginary friendships are fundamental features of these relationships, and differ only in the extent to which these reciprocities are within or outside a child's creative control (Gleason, 2013). It is not always straightforward to make this determination. For example, according to Gleason (2013), video game characters should be viewed as imaginary companions because their reality status falls within the continuum of companionships based on real life (e.g., an imaginary companion based on a real friend) and those based purely on fantasy (e.g., a fantastical creature made up by the child). However, this description fails to take into account the fact that some agents in video

games are capable of producing appropriate, socially contingent responses to the child player. In other words the social exchanges that occur within these virtual worlds are at least partly outside the child's creative control, and thus are more "real" than imagined. This ambiguity – being unreal but socially responsive – might influence both child and adult conceptions of these entities, and the relationship features they attribute to these entities.

Second, real and imaginary friendships have both distinct and overlapping relationship qualities or affordances. If children view virtual agents as potential friendship partners, then it is possible that relationships with these entities have both distinctive features and ones that overlap with the features of real and imaginary friendships. Given the importance of context in relationships on and offline (Blascovich & Bailenson; Weiss, 1974), it is possible the perceptions of virtual entities, as well as features of relationships with the entities, differ based on the embodied forms and the digital environment. For example, children might attribute nurturance to an agent in a virtual pet game, but not to a humanoid agent in a learning/adventure game.

Because so little is currently known about how children conceptualize virtual entities, the primary goals of this dissertation research were to investigate child concepts of virtual agents and the extent to which they are viewed as relationship partners. I examined children's concepts of these entities in two contexts: (1) with a virtual dog embedded in a virtual pet game and (2) with a novel humanoid agent described as being in a video game. Across studies, children were also asked to attribute a range of social and non-social properties to other possible relationship partners, including inanimate toys and real people. In Studies 1 and 2 (Aguiar & Taylor, 2015), we examined the ways in

which preschool-age children might differentiate the social affordances of virtual dog from a stuffed dog on features of high quality friendships, as well as opportunities for learning and entertainment. Study 3 was conducted with adults with the goal of developing items that could be used in a follow up study with children assessing concepts of a humanoid agent. I was also interested in exploring with adults the ways in which autonomy, creative control and embodiment might relate to concepts of a humanoid agent. Items that successfully captured a range of properties including biological, psychological and social functioning were then used in Study 4 with preschool and school age children.

In Chapter II, I report on Studies 1 and 2, which were conducted in collaboration with Marjorie Taylor, Ph.D. and published in 2015. Due to requirements mandated by the journal, these studies are reproduced as they originally appeared in the special issue of *Cognitive Development*.

CHAPTER II

STUDIES 1 AND 2: CHILDREN'S CONCEPTS OF THE SOCIAL AFFORDANCES OF A VIRTUAL DOG AND A STUFFED DOG

Overview of this Published Work

The studies described in this chapter were co-authored with Marjorie Taylor, Ph.D. Together, Dr. Taylor and I developed the Social Affordances Task that was used with participants in both studies, as well as individual items that were used in the task itself. I drafted the original content of this manuscript, with editing support from Dr. Taylor. The finalized version of the manuscript consists of a combination of my original work, revisions made by Dr. Taylor, and incorporated suggestions made by the experts who reviewed this manuscript, including Angeline Lillard, Ph.D. and Jacqueline Woolley, Ph.D.

These studies were published in a special issue of *Cognitive Development*, "Cognizing the Unreal" (Volume 34), in 2015. They are reproduced here with permission from Elsevier as they originally appeared in the journal.

Introduction

The social lives of young children 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 & Hohmann, 2006). Children as young as 20 months engage in the reciprocal patterns of behavior found in friendships (Ross, Conant, Cheyne, & Alevizos, 1992) and by four years of age, 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, in addition to relationships with real people. In this analysis, Gleason discusses relationships with imaginary companions, diary friends, celebrities, deceased loved ones, and the fictional characters in novels. In addition, advances in Artificial Intelligence are providing many new opportunities for imaginary relationships with robots and with virtual characters portrayed on technological devices. There is a growing literature on children's relationships with social robots (e.g., 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 some preliminary information by exploring children's intuitions about the social affordances of a virtual character in a Nintendogs® game.

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 emotions, as well as greater capacities for voice, facial, and emotional recognition (Kahn et al., 2013; Minato, Shimada, Ishiguro & Itakura, 2004). Research investigating children's concepts of robots suggests that although they recognize that robots are not alive (Jipson & Gelman, 2007), they nevertheless believe that friendships are possible, and attempt to engage them in social interactions (Kahn, Friedman, Pérez-Granados & Freier, 2006).

Kahn and his 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- to 6-year-old children's 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 were controlling the behaviors of the stuffed dog.

Given AIBO's impressive ability to initiate interactions and respond to children's behaviors, it might seem surprising that children did not clearly differentiate AIBO from a stuffed dog when they were asked about the possibility of friendship. However, children often conceptualize personified objects in ways that are similar to real 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 (e.g., a stuffed dog that likes to ride in cars and go camping, but is afraid of the dark) (Taylor, Sachet, Maring, & Mannering, 2013). Moreover, stuffed animals can contribute to real-world resilience. In two experiments conducted after the 2006 Israeli-Lebanon war, children (3- to 6 years) who were given a stuffed dog to care for were rated by their parents as having fewer stress-related symptoms at a two-month follow up than children in a control condition (Sadeh, Hen-Gal, & Tikotzky, 2008).

Clearly, it is important not to underestimate children's capacity to form attachments to stuffed animals and the potential of these imagined relationships to provide real world comforts. Instead of expecting that social robots might be even more readily adopted as social partners, one might ask if 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.

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 are to the attribution of intentionality and animacy (e.g., whether the movement is autonomous) (Epley, Waytz, & Cacioppo, 2007). The body movements and facial expressiveness of social robots are improving with every upgrade, but the realism and subtlety of movement and expression that is 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 five years of age, many children provided anthropomorphic interpretations of Heider and Simmel's (1944) animated film of geometric shapes (e.g., a "mean" large triangle scaring a small triangle that was "afraid") (Springer, Meier, & Berry, 1996).

The strong anthropomorphic cues that are possible with screen-based characters make them an interesting focus for research on children's conceptions of imaginary

relationships. But from our point of view, an equally important motivation for this research is the increasing presence of virtual entities. Social robots like AIBO are expensive (about $2000) and do not yet pervade children's lives. But recent technological advances provide many new ways for children to engage with virtual characters and children's interactions with virtual characters in apps, websites and videogames are substantial. American children between five and eight years 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).

Study 1

Method

Participants. The participants were 16 European-American children and their mothers (n = 15), including 1 pair of siblings, recruited from a database of children in a middle class community (*M* = 66.56 months, range = 48 – 83 months, 8 girls and 8 boys). One additional child was dropped because she was below chance on distracter items that were designed to determine if children understood the Social Affordances Task.

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 was part of 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 chosen because they 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 who was approximately the same age as the participant. Eight videos were used, four with a boy (shown to the male participants) and four with a girl (shown to the 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 (see Figure 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).

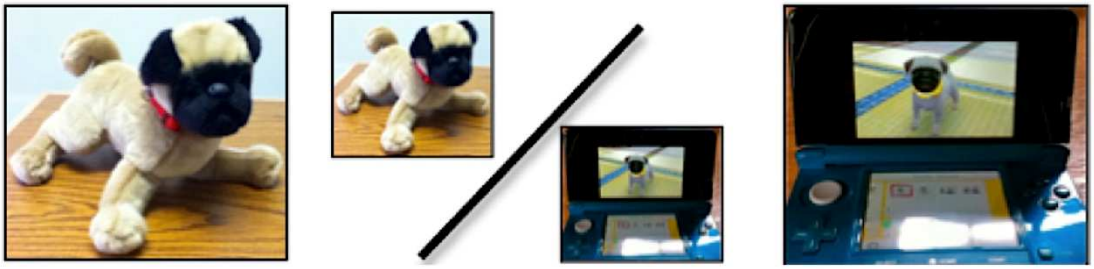


Figure 1. Picture stimuli corresponding to the response options.

Procedure. Following the informed consent procedures, 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 the claims about education and entertainment in materials used to promote the Nintendogs® game. Three of these items were dropped from the analyses because children's interpretations

were not clear.[2] 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 appeared 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.

[2] 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.

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 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. The 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 the results.)

In order to assess children's interest in the two dogs, children chose one of the dogs for a brief (three minutes) free play session. Then the children participated in

another research project (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.

Results and Discussion

Table 1 shows the number of children who selected the stuffed dog, the virtual dog, or the "either one" option. Except for one child who was dropped, the children were accurate for the six distracters ($M_{correct}$ = 4.94, SD = 1.18), indicating that they were attending to the task. However, Table 1 shows that children did not differentiate between the stuffed dog and virtual dog for the social affordance items. They frequently responded that the items could refer to either dog (3 of the 16 children 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 the best, 12 of the 16 children chose iPuppy and all 16 children chose iPuppy as the toy they wanted to play with. Eleven of the 16 children had stuffed dogs at home, whereas none owned a Nintendo 3DS® game console

and at least 15 of the 16 children had never played the Nintendogs® game (one parent did not respond to this question).

Table 1

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

Social Affordance Items	Stuffy	iPuppy	Either
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

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 result suggests that the imagined agency of stuffed toys is vivid enough to compare with the observed agency of virtual characters.

In summary, the results for the distracters and the 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, the results suggest that children did not clearly differentiate between the relationships and interactions that are 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 the items were relevant to friendship, agency, entertainment, and education.

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 they were forced to choose between the two, without the option of reporting that the items could be about either dog. In addition, we collected ratings from adults for the 25 social affordance items to help with the 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 and so adults were asked 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 the prediction about their 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 almost 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. The adults also rated the items for relevance to education and entertainment because these are goals that are often associated with virtual games. We expected that children might pick the virtual dog for items that were rated highly for education and entertainment.

Method

Participants. The participants were 33 children (M = 66.39 months, range = 59 – 80 months, 15 girls and 18 boys) and their parents (32 mothers and 1 father) who were 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 dropped because they scored below chance on distracters (4 children) or repeatedly selected responses before the statements were played (3 children).

For the ratings, participants were 16 undergraduate students (M = 19.94 years, range = 18 – 29 years, 2 males and 14 females; 11 European American, 2 Asian, 2 Hawaiian/Pacific Islander, 1 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.

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 dropped and (2) the two distracter items that could pertain to either the stuffed dog or the virtual dog were removed, leaving 4 distracter items and 25 social affordance items (29 total items; the three additional social affordance items that were dropped in Study 1 were not used in Study 2).

Procedure for 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.

Adult ratings of social affordance items. Ratings were collected as part of a General Survey generated by Psychology researchers that is administered online using Qualtrics software, version 37,892 (Qualtrics Research Suite©, 2013). Participants were told that they would read statements that children had made about their toys and were asked to rate each statement for how relevant it was 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.

Results and Discussion

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 (9 trials out of 825) were coding as missing because children could not choose. Binomial tests were conducted to identify the items for which children exhibited a preference for one dog over the other. Table 2 shows the 25 social affordance items ordered from the items that were mostly attributed to the stuffed animal, followed by the items that did not elicit a clear pattern, and ending with the items that were mostly attributed to the virtual dog.

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			
Preference for Stuffy				Agency	Friendship	Education	Entertainment
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

[a] *N = 32 one child would not choose;* [b] *N = 31 two children would not choose; * Significantly higher than 4 (one tailed), p < .01*

Adult ratings of social affordance items. In addition to the children's choices, Table 2 provides the adult ratings. One-tailed *t*-tests were conducted to identify the items that had mean ratings significantly higher ($p < .01$) than the mid-point score of 4. Twenty-three of the 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 (6 items), agency (5 items), entertainment (2 items), and education (1 item); eight were rated as highly relevant to two types: agency and friendship (7 items), friendship and entertainment (1 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 result might be due to the way in which 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 were more successful in identifying items that were 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).

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 about entertainment. Although two of the four items that showed 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 that were 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 an autonomous agent, 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 Ninendogs® game was relatively novel (one child had played the Nintedogs® 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 that were 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.

General Discussion

This research was designed to provide preliminary data regarding children's intuitions about the 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 a stuffed dog. Perhaps the most striking result was the similarity in the 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.

The 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, the results for individual items warrant caution. For example, although the items that were associated with the stuffed dog were rated highly for friendship, not all the friendship items showed this pattern. In addition, some of these items might suggest a hierarchical relationship in which the object provides comfort and care as much as friendship. In the case of the virtual dog, although items that were associated with it tended to be about entertainment, children were equally likely to endorse the stuffed dog for one of the entertainment items.

Our prediction regarding agency was less clear, and children did not did not differentiate the two dogs for many of the agency items, underscoring the extent to which children 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 Nintedogs® 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 immersed in digital devices increases with age (Rideout, Foehr, & Roberts, 2010); thus, children's concepts of virtual characters might change as they become more immersed in technologies. Still, given the novelty of the virtual dog, it was surprising that they did not pick the virtual dog more often overall in the guessing game. 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 that are 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 only one of many ways that the virtual dog, iPuppy, might differ from other virtual characters.

Our preliminary findings suggest several directions for future research. In particular, 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 from the 57 who participated in Studies 1 and 2 had to be dropped because they either started to respond randomly or to

give their answers 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 the history of shared experiences and interactions with a favorite toy provides a context for children's relationship with it, as well as how it affects their 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 that are 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.

CHAPTER III

STUDY 3: THE BIOLOGOCIAL, PSYCHOLOGICAL, AND SOCIAL PROPERTIES ADULTS ATTRIBUTE TO A VIRTUAL AGENT

Introduction

In Studies 1 and 2, preschool age children played a game in which they guessed whether a child in a video was referring to a stuffed dog or a virtual dog in a series of statements designed to assess opportunities for friendship, education and entertainment. When children differentiated between the two entities, the stuffed dog tended to be associated with items relevant to friendship, whereas the virtual dog tended to be associated with items relevant to entertainment. Overall, these results suggest that despite their sophisticated programming, virtual characters might not be superior to simple stuffed animals as relationship partners.

However, some of the preschool-age children experienced difficulty sustaining their attention to the task, perhaps due to the number of items, and the repetitive nature of the video stimuli. In addition, the forced choice procedure made it more difficult to capture variation in children's intuitions about virtual agents and inanimate artifacts. Finally, because dogs were used as the target entities, results could not be generalized to other types of virtual agents and inanimate toys.

In Studies 3 and 4, I built upon this preliminary research by examining adult and child concepts of a humanoid virtual agent, and how concepts of this entity might differ from a range of other potential relationships partners. In addition to changing the target agent from an animal to a humanoid entity, I extended the range of comparisons by adding a real child, a child on a video chat program (e.g., Skype™) and an inanimate

doll. I further refined the list of properties by dropping items that were identified by adult raters as weak in Studies 1 and 2, as well as adding items to capture the social reciprocities inherent in children's real friendships. The response options were also extended to capture greater variation in properties attributed to the virtual agent. Finally, I increased the age range in Study 4 to increase the likelihood that children would be more familiar with virtual characters, as well as to begin to explore developmental change in children's concepts.

In order to explore a wide range of properties and refine the total number of items for a child task, I first began with an online study with adult participants (Study 3). In Study 3, adult participants were introduced to the four target entities via online vignettes, and asked to attribute a range of properties to each entity using 6-point yes/no Likert scales. The select items in Study 3 that were successful in capturing a range of properties with adults were then used to investigate children's intuitions about the affordances of a humanoid virtual agent (Study 4).

Aims of Study 3

The goals of this study were threefold: (1) to generate items that tap a range of properties that could be used in a task with a child sample, including biological properties, psychological properties, and the social reciprocities inherent in real and imaginary friendships; (2) to assess the biological, psychological and social properties that adults attribute to a humanoid virtual agent as compared with the properties attributed to a real child (in person and on a video chat program, like Skype™) and an inanimate doll; and (3) to examine how individual differences in gender, fantasy

orientation, and anthropomorphic tendencies predict variance in adult concepts of a humanoid agent.

Method

Participants

Participants were 144 undergraduate students recruited primarily from Psychology 201 and 202 courses at the University of Oregon as part of their coursework requirements (mean age = 20.10 years, *SD* = 3.82, age range = 18 years – 51 years, 114 females and 30 males). Of these participants, over half identified as European-American (68.1%). The remainder of the sample identified as Asian (13.9%), Latino (6.3%), mixed race (5.6%), African-American (2.1%), Pacific Islander (1.4%), Native Alaskan, American or Hawaiian (1.4%), Asian-Indian (0.7%) and Other (0.7%). An additional eight participants were excluded from the analyses, four because they consented to participate but failed to provide any data, and four because they spent less than 15 minutes total on the study[3].

Students signed up for the Human Subjects Pool through the electronic system SONA, which is maintained by the Departments of Psychology and Linguistics at the University of Oregon. Through SONA, students had access to all ongoing studies with adults in both departments and self-selected to participate in this study. Note that

[3] Time spent on the study in minutes was used to identify cases in which participants failed to attend the tasks. I used a combination of box plots and stem and leaf plots to identify participants at the extreme upper end of the distribution (n = 17, range = 85.62 minutes – 9536.00 minutes). After excluding these participants, I obtained the mean and standard deviation for the total amount of time spent on the study (*M* = 33.43 minutes, *SD* = 15.25). Participants who fell one standard deviation below the mean (n = 4) were excluded. Examination of their individual responses revealed that these participants provided identical values for each item on the properties task and on some of the individual differences inventories. These values were the preset midpoints of the scale for each of the scaled items.

minimal information was given to potential participants during the self-selection process. The study name listed on SONA did not reveal any information about the study, and potential participants only had access to information about the type of study (i.e., laboratory experiment or online study), time commitment, and the amount of credit awarded. Participants received one course credit for participation.

Properties Task

The Properties Task assessed adult concepts of a real child, a child on a video chat program (e.g., Skype™), a virtual child, and a doll. Participants were first introduced to each type of child with vignettes presented in a randomized order:

> "Sarah/Noah is a little girl/boy who lives next door. You interact with Sarah/Noah after school and on weekends at your home."
>
> "Beth/Ben is a little girl/boy who lives in another state. You interact with Beth/Ben on a computer with a video chat program, like Skype™."
>
> "Sam is an artificially intelligent girl/boy that exists in a sophisticated virtual world. You interact with Sam when you enter the virtual world."
>
> "Pat is a doll that resembles a girl/boy. You interact with Pat after school and on weekends at your home."

Next, participants were presented with a series of questions about the child (see Appendix A) and asked to respond to each question using a 6 point yes/no Likert scale where "0" indicated "definitely not", "1 – 2" indicated "probably not", "3" indicated "maybe", "4 – 5" indicated "probably yes", and "6" indicated "definitely yes". Participants provided responses to questions about each type of child separately. The questions for each type of child were presented to participants in unique randomized orders.

Items in the Adult Properties Task

Items developed for the Adult Properties Task (n = 39) were designed to tap a range of concepts, including: (1) autonomy (e.g., "Can X do things when you are not around?"); (2) biology (e.g., "Is X alive?"); (3) creative control (e.g., "Do you control what X is doing to do?"); (4) embodiment (e.g., "Could you give X a hug?"; (5) psychology (e.g., "Can X think?"); and (6) the social reciprocities inherent in children's real friendships, (e.g., "Could X keep you company?") (see Appendix A). Because these items were designed to be used in Study 4 with children, items were generated based on young children's concepts of living and non-living kinds (e.g., Jipson & Gelman, 2007; Margett & Witherington, 2011), children's reasoning about real, imaginary, and robotic entities (e.g., Jipson & Gelman; Kahn et al., 2006; Sharon & Woolley, 2004), and children's concepts of real and imaginary friendships (Gleason, 2002; Gleason & Hohmann, 2006). In the instructions to the Properties Task with adults, participants were informed that their responses would be used to select items for a task with children (see Appendix B); however, they were instructed to respond to each item based on their own intuitions.

Measures

Because little is known about how adults conceptualize virtual entities, I included several individual difference measures that might predict variation in responses. These measures were selected based on supporting evidence from other relevant literatures (i.e., anthropomorphism, imagination, virtual reality, and robotics) indicating their potential importance in predicting individual differences in adult concepts of a humanoid agent (e.g., Blascovich & Bailenson, 2011; Epley, Waytz, & Cacioppo, 2007; Taylor et al.,

2002). Note that one participant did not complete the majority of the individual differences measures. Therefore, results from the individual differences measures are based on a sample of N = 143 participants, unless otherwise specified.

Interpersonal Reactivity Index (IRI) (Davis, 1983). The IRI (Davis) is a self-report measure designed to assess four different features of empathy: perspective taking (M = 3.56, SD = 0.56), empathic concern (M = 3.84, SD = 0.60), personal distress (M = 2.82, SD = 0.65), and fantasy (M = 3.52, SD = 0.68). The inventory consists of 28 items, with seven items each per subscale (see Appendix C). Participants were presented with a series of descriptive statements and then asked to rate the extent to which each item described them on a 5-point Likert scale, from 1 ("does not describe me at all") to 5 ("describes me very well"). Three of the four subscales (fantasy, perspective taking and personal distress) showed good internal consistencies, αs $\geq$ .78. The internal consistency for the perspective taking subscale was acceptable, α = .75. For this study, I focused specifically on the fantasy subscale as an individual difference predictor because it measures absorption in fictional experiences.

Individual Differences in Anthropomorphism Questionnaire (IDAQ) (Waytz, Cacioppo, et al., 2010). The IDAQ (Waytz et al., 2010) is a 30 item self-report measure designed to assess individual differences in anthropomorphism for a range of different entities, including five items about natural environments (e.g., the ocean) (M = 3.29, SD = 1.25), five items about animals (M = 6.19, SD = 1.82), and five items about technological artifacts (e.g., cars, computers, robots) (M = 1.59, SD = 1.60) (see Appendix D). Fifteen additional items serve as controls (M = 5.63, SD = 1.05). Participants were asked a series of questions (e.g., "To what extent does a car have free

will?") and asked to respond using a 10 point Likert scale, from 0 ("not at all") to 10 ("very much"). Internal consistencies for the three subscales ranged from acceptable, αs = .72 (technology and animals) to good, α = .80 (nature). For all of the items designed to assess anthropomorphic tendencies, internal consistency was acceptable, α = .77. For the technology and nature subscales, the distribution of scores was positively skewed. However, average scores across all of the anthropomorphism items were normally distributed. Therefore, these composite scores were used as an individual difference predictor for variance in attribution scores on the Properties Task.

Imaginary Companions Questionnaire (Taylor et al., 2002). Participants were asked about current and past imaginary companions, using a method adapted from a study conducted by Taylor et al. (2003)) with adult fiction writers (see Appendix E). Participants read the following description of imaginary companions:

"An imaginary companion is someone who is make-believe; an imaginary person or animal that you talk to or think about a lot. Sometimes an imaginary companion is completely invisible and sometimes it is an object, like a very special stuffed animal or doll."

Participants were then asked to report whether or not they had a current imaginary companion, and if so, to indicate whether it was invisible or based on a personified object (such as a toy stuffed animal, or doll) and to provide a brief description. Participants who reported having a personified object were also asked to describe how it differed from other personal artifacts. Participants who indicated that they did not have a current imaginary companion were asked whether or not they had one in the past. If they responded positively, they were asked to provide the same descriptive information.

Two independent coders who were not involved in data collection coded participants as having a past or current imaginary companion if they responded positively. Participant were categorized as not having an imaginary companion if (a) they reported not having an imaginary companion, (b) they reported having an imaginary companion but they described generic fantasies (e.g., thinking about what a future wife might look like), (c) they described an imaginary companion based on a stuffed animal or doll, but the description did not go beyond physical characteristics (i.e., the toy appeared to function more as a comfort object than as a friend), or (d) their descriptions were unintelligible. The agreement for the two coders was 90%; disagreements were resolved by discussion.

Forty-seven participants (32.6%; 8 of 30 males and 39 of 113 females) met the criteria for having an imaginary companion. Of these companions, 6 (12.8%; 1 male and 5 females) were described as current companions and 41 (87.2%; 7 males and 34 females) were described as past companions. These included 22 invisible friends (46.8%; 4 males and 18 females), 24 personified objects (51.1%; 3 males and 21 females), and one virtual character (.02%; male). Having an imaginary companion was not related to gender, χ^2 (1, n = 144) = 0.62, p = .43. Because of the low number of current imaginary companions, I collapsed across past/current status in subsequent analyses.

Digital Technologies Questionnaire. Although digital devices are now a pervasive presence in American culture, attitudes towards new technologies might vary widely, particularly for technologies that are at the forefront of simulated social experiences. For this study, I developed a questionnaire to assess attitudes towards current and near future personified technologies, including questions about participants'

current digital experiences, their interest in immersive virtual worlds, their role play (both on and offline), and the extent to which it could be possible to form friendships with "Siri" (the popular virtual agent) and with future humanoid robots (see Appendix F). I specifically chose to ask about Siri because participants were likely to have some experience with this type of virtual agent. I also included a question about sophisticated humanoid robots because these personified technologies exist, although they are not yet a pervasive presence in the United States. However, the distribution of the scores on the Siri item showed a floor effect ($M = 0.78$, $SD = 1.31$, N = 119), and was positively skewed for social robot item ($M = 1.72$, $SD = 1.62$, N = 142). Therefore, I did not include these items to assess individual differences.

Additional exploratory data analysis indicated that the base rate for participation in sophisticated online role-playing games was low (7%; n = 10). This was not wholly unexpected, as large descriptive studies of Massively Multi-player Online Role-playing Games (MMORPGS) indicate that, unlike college students, typical players are in their mid-twenties and employed full time (see Yee, 2014 for a review). However, gender was related to online game play, frequency of digital game play and participation in online virtual worlds (mostly MMORPGS). Males (53.3%, n = 16) were significantly more likely than females (0.9%, n = 7) to select digital games as one of their favorite things to do online, χ^2 (1, n = 144) = 39.41, $p < .001$, and reported playing digital games more frequently ($M = 5.70$, $SD = 1.56$) than females ($M = 3.81$, S$D = 2.15$), t (141) = 4.52, $p < .001$, $d = 1.01$. Additionally, a greater proportion of males (23%, n = 7) reported participating in online virtual worlds, such as League of Legends® and World of Warcraft®, compared to females (2.4%, n = 3).

Across the sample, there was a broader range of interest in fully immersive virtual reality technologies. Forty percent of participants (n = 56) indicated that they would be interested in purchasing and using fully immersive virtual technologies, while 25% (n = 35) indicated they were uncertain and 37% (n = 53) said they had no interest in these experiences. Interest in this fully immersive technology was also related to gender. The majority of the males (80%, n = 30) reported that they would definitely be interested in purchasing these technologies, compared with less than half of females (28.3%, n = 32).

The gender differences that emerged among items in this inventory replicates previous work in the field indicating that both interest in virtual games, as well in game content (e.g., games with social content vs. games with no social content) varies based on gender (see Yee, 2014 for a review). Therefore, I included gender as a factor in all of my subsequent analyses. I also included the item assessing the frequency of digital game play to investigate the contribution of familiarity with virtual environments to responses on the Properties Task.

Procedure

Participants completed the Properties Task and the individual difference measures through an online survey, administered through Qualtrics software (Qualtrics Research Suite©, 2015) and the University of Oregon SONA system. Via SONA, participants accessed a link to the online survey. On the first web page, participants read the informed consent form and were given the option to agree or to decline participation. If they declined, they were thanked for their time and the survey ended. If they agreed to participate, they first provided some basic demographic information (see Appendix G) and then completed the Properties Task, followed by the individual differences measures

in the following order: (1) the IRI (Davis, 1983), (2) the Digital Technologies Questionnaire, (3) the IDAQ (Waytz et al., 2010), and (4) the Adult Imaginary Companions Questionnaire (Taylor et al., 2003). After the questionnaires were completed, participants were presented with a debriefing form, which detailed the goals and hypotheses of the study, and how their participation contributed to growing knowledge in the field. After participants read the debriefing form, they were instructed to submit their responses and then were awarded one credit toward their required coursework.

Hypotheses

Pattern of Responses on the Properties Task

On the Properties Task, I hypothesized that adults would not differentiate between the real child and the child on the video chat program on autonomy, creative control, biology, psychology and social properties. However, my predictions about embodiment were less certain. I thought that adult concepts of embodiment might depend on their interpretation of the description. If participants responded based on what was possible for a child in the physical world, then they should attribute embodiment properties to the child on a video chat program. However, if participants only thought about what was possible given the nature of interactions with the child via a virtual medium, then they might be less willing to attribute embodiment properties to the child on the video chat program.

For the virtual child and the doll, I anticipated differentiation on autonomy, creative control, and embodiment. I expected that the virtual child would be perceived as autonomous and disembodied, whereas the doll would be perceived as lacking autonomy

but embodied. Based on the robotics literature (e.g., Kahn et al., 2013), I had further hypothesized that adults would recognize that both a virtual child and a doll are not alive (no differentiation), but still attribute more psychological functioning to the virtual child. However, I was less certain about the social properties adults would attribute to a virtual child and a doll. Based on the result of Study 2, physical embodiment might matter for the social properties that are attributed to a virtual child and a doll. In addition, I anticipated individual differences in the extent to which adults attribute psychological and social properties to a virtual child, and in the extent to which social properties are attributed to a doll.

Individual differences

To examine individual differences, I focused specifically on the attributions made to the virtual child and the doll. I hypothesized that participants with higher scores on the fantasy subscale of the IRI (Davis, 1983) and participants who play digital games frequently would be more likely to attribute psychological and social properties to a virtual agent. Additionally, I expected that adults with higher anthropomorphic tendencies would be more likely to attribute psychological and social properties to a virtual child and a doll. Finally, I thought that participants with past or current imaginary companions might also be more likely to attribute psychological properties and social properties to a virtual child and a doll.

Based on results from the Digital Technologies Questionnaire and previous findings in the gaming literature (e.g., Yee, 2014), I included gender as an individual difference. I expected that males might be more willing to attribute psychological and social properties to a virtual child than females. Additionally, based on findings from

research on children's imaginary companions (e.g., Gleason et al., 2000; Harter & Chao, 1992), I thought that gender differences might emerge in the psychological and social properties attributed to a doll. I expected that females would be more likely to attribute social and psychological properties to the doll.

Results

Pattern of responses on the Adult Properties Task

Exploratory data analysis revealed scattered missing data points across items on the Properties Task. However, the overall incidence of missing data was low. Of the 22,464 attribution scores (39 items × 4 entities × 144 participants), only 104 data points were missing (0.5% missing). Therefore, I did not correct for missing data, and when possible, I used a pairwise deletion method for all subsequent analyses.

Table 3 shows the means and standard deviations for the six property categories (collapsing across individual items) as a function of type of entity.[4] As expected, participants were consistent in reporting that the real child and the real child on a video chat program were biological entities who could function independently and possessed similar psychological attributes. However, when a real child appeared on a computer screen, adults treated the child as lacking a physical body. In addition, adults attributed significantly less social opportunities to the child on a video chat program compared to the real child, t (143) = 8.54, $p < .001$, $d = .71$. The difference in social opportunities

[4] This method has been used in previous research to examine property attributions across a range of items developed to assess biological, psychological and social properties (e.g., Bernstein & Crowley, 2008; Kahn et al., 2012; Jipson & Gelman, 2007). Although this method does not ensure that the items successfully capture their latent properties, the pattern of differentiation between entities described in this section provides some support for my interpretation of the individual items. Additionally, for attributions to the real child (where I had the strongest overall predictions), items within each property were highly correlated, $ps < .001$.

between the real child and the child on a video chat program was related to differences in embodiment, $r = .33$. $p < .001$. The more adults perceived differences between the real child and the child on a video chat program in embodiment, the more they favored the real child for social opportunities. This finding suggests that for adults, relationships with real people that occur through a virtual medium might be perceived as less available or desirable for social interaction.

Table 3

Study 3: Descriptive statistics for each entity by property

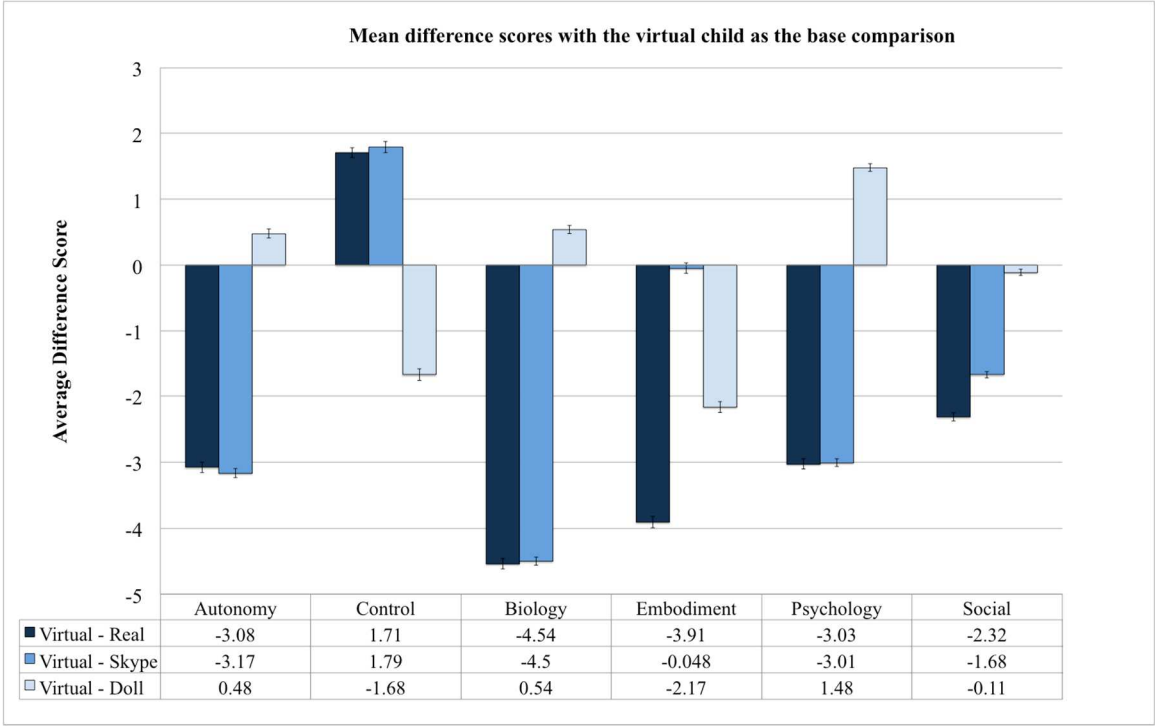
	Entity			
Property	Real child	Skype Child	Virtual Child	Doll
Autonomy (4 items)	5.09 (0.82)	5.20 (0.88)	2.01 (1.52)	1.53 (1.06)
Creative Control (4 items)	0.74 (1.03)	0.64 (0.89)	2.45 (1.64)	4.13 (1.71)
Biology (5 items)	5.49 (0.94)	5.74 (0.97)	0.94 (1.39)	0.40 (1.09)
Embodiment (5 items)	5.15 (1.13)	1.29 (1.56)	1.24 (1.63)	3.41 (1.21)
Psychology (10 items)	5.25 (0.92)	5.24 (0.94)	2.22 (1.31)	0.74 (1.13)
Social (11 items)	4.83 (1.03)	4.20 (1.06)	2.51 (1.13)	2.63 (0.99)

However, the primary focus of the Adult Properties Task was to examine concepts of the virtual child, and how these concepts might differ from the other target entities. To address these questions, I first obtain difference scores comparing with virtual child to the other target entities for each property. These difference scores were obtained by subtracting the average property attribution scores for the three other entities (real child, child on a video chat program, and doll) from the virtual child. I then used

these difference scores as the dependent measure in a 3 (comparison; virtual – real, virtual – video chat, virtual – doll) × 6 (property; autonomy, creative control, biology, embodiment, psychology, social) mixed model ANOVA with gender as the between subjects factor.

The main effects of comparison and property were significant, F (2, 286) = 188.78, $p < .001$, $\eta^2 = .57$ and F (5, 715) = 184.19, $p = .01$. $\eta^2 = .56$, respectively. The main effect of gender was also significant, F (1, 142) = 7.71, $p = .01$. $\eta^2 = .05$, but the effect size was small, and there were no significant interaction effects with the within-subjects factors, $ps > .05$. The results for this task are best understood in light of a significant comparison by property interaction, F (10, 1430) = 316.56, $p < .001$. $\eta^2 = .69$. To explore this interaction, I ran simple effects tests with a Bonferroni correction for multiple comparisons (see Figure 2 for a graphical representation). In what follows, I report how the virtual child compared to each of the other target entities.

How does the virtual child differ from the real child and real child on video chat program? As is shown in Figure 2, the pattern of differentiation between the virtual child and the real child, and the virtual child and the child on a video chat program were essentially identical for autonomy, creative control, biology, and psychology, $ps = 1.0$. As hypothesized, autonomy, biology and psychology were attributed equally more to both the real child and the child on a video chat program than to the virtual child, and creative control was attributed equally more to the virtual child than to the real child and the child on a video chat program. In other words, compared to the real children, the virtual child was perceived as lacking autonomy, as well as biological and psychological functioning.



	Autonomy	Control	Biology	Embodiment	Psychology	Social
Virtual - Real	-3.08	1.71	-4.54	-3.91	-3.03	-2.32
Virtual - Skype	-3.17	1.79	-4.5	-0.048	-3.01	-1.68
Virtual - Doll	0.48	-1.68	0.54	-2.17	1.48	-0.11

Figure 2. Pattern of differentiation between the virtual child and the other entities.

However, for embodiment and social properties, there was significantly less differentiation between the virtual child and the child on the video chat program compared to the differentiation between the virtual child and the real child, $ps \leq .002$. For embodiment, the difference between the virtual child and the child on a video chat program was close to zero, whereas there was nearly a four-point difference in favor of the real child over the virtual child on this property. Adults perceived both the virtual child and the child on a video chat program as similarly disembodied.

For the social property, the difference between virtual child and the real child was greater than the difference between the virtual child and the child on a video chat program. Social properties were still attributed more to the child on a video chat program than to the virtual child, but to a lesser degree than the real child. This finding suggests

that adults perceived the greatest social opportunities with people who are physically present.

How does the virtual child differ from the doll? For the virtual child and the doll, the pattern of differentiation was significantly different from the pattern of differentiation between the virtual child and the real child, and the virtual child and the child on a video chat program, *p*s < .001. Greater autonomy, biological and psychological properties were attributed the virtual child, and greater creative control was attributed to the doll. One-sample *t*-tests with a Bonferroni correction revealed that these average difference scores were all significantly different from zero, *p*s < .001, *ds* = .57 – 2.28. In other words, compared to the doll, the virtual child was perceived as more autonomous, with greater capacity for biological and psychological functioning. For embodiment, there was significantly more differentiation between the virtual child and the doll than the virtual child and the child on a video chat program, $p < .001$. Adults perceived the doll as more embodied than the virtual child, and even more embodied than the child on a video chat program.

Overall, the difference for the social property between the virtual child and the doll was near zero. Adults perceived both the virtual child and the doll as affording similar social opportunities. However, I was particularly interested in the sub-set of items in social property that were designed to capture the extent to which the relationship was reciprocal. Of the 11 social property items, there were 4 pairs (8 items) that addressed the same feature (e.g., love) but in different directions (i.e., self to agent vs. agent to self). To provide descriptive information about the way the participants viewed the relationships, I categorized the participants' responses for each pair of items as (1)

reciprocal if the participant indicated that both of the items in the pair were possible (e.g., scores of 4 or greater for both "can X love you?" and "can you love X?"), (2) self-to-agent unilateral if the score for the self (e.g., "can you love X") was 4 or greater, but the score for the agent (e.g., "can X love you") was 3 or less; (3) agent-to-self unilateral if the score for the agent (e.g., "can X love you") was greater than 4, but the score for the self (e.g., "can you love X") was 3 or less; or (4) no relationship if both scores were 3 or less.

Table 4 shows the relationship categories for each of the four pairs of item for the virtual child and the doll. As is shown in Table 4, a substantial minority of participants viewed the relationships as reciprocal. Unilateral relationships in which the participant told the agent secrets, loved and protected the agent, and kept the agent company were more common than the reverse (e.g., the virtual child telling the participant secrets, etc.) The most common response for the doll was to view the relationship as unilateral in which the participant told the doll secrets, loved and protected the doll, and kept the doll company. However, a substantial minority of the participants viewed the relationship with the doll as reciprocal (e.g., 33.33% for the questions about keeping company).

Because artificially intelligent agents are capable of simulating verbal and non-verbal forms of social reciprocity, I had predicted that adults would attribute greater opportunities for receiving social input from the virtual child compared to the doll. There was no evidence of this in the comparison of reciprocal relationships. A paired samples *t*-test on the number of times the participants' responses were categorized as endorsing a reciprocal relationship (out of four) revealed no significant difference in reciprocity for the virtual child ($M = 0.69$, $SD = 0.98$) and doll ($M = 0.63$, $SD = 0.96$), $t\ (139) = 0.53$, $p > .05$. However, unilateral relationships in which the direction was from the entity to the

self were less rare for the virtual child than for the doll. In particular, participants were more likely to endorse the possibility that the virtual child might tell secrets ($M = 2.61$, $SD = 1.99$) than the doll ($M = .91$, $SD = 1.84$), $t\ (141) = 7.34$, $p < .001$, $d = .61$.

Table 4

Study 3: Type of relationship by entity and by friendship feature

Property	Type of Relationship			
	No relationship	Unilateral Self>Agent	Unilateral Agent>Self	Reciprocal
Tell secrets				
Doll (n=143)	37 (25.87%)	85 (59.44%)	2 (1.40%)	19 (13.29%)
Virtual child (n=142)	52 (36.62%)	45 (31.69%)	15 (10.56%)	30 (21.13%)
Love				
Doll (n=143)	37 (25.87%)	93 (65.03%)	1 (.07%)	12 (8.39%)
Virtual child (n=142)	80 (56.34%)	46 (32.39%)	4 (2.81%)	11 (7.75%)
Protect				
Doll (n=144)	31 (21.53%)	97 (67.36%)	2 (1.39%)	14 (9.72%)
Virtual child (n=144)	80 (55.56%)	40 (27.78%)	9 (6.25%)	15 (10.42%)
Keep company				
Doll (n=144)	31 (21.53%)	52 (36.11%)	13 (9.03%)	48 (33.33%)
Virtual child (n=143)	51 (35.66%)	34 (23.78%)	14 (9.79%)	44 (30.77%)

In addition to categorizing the nature of the relation as reciprocal, unilateral or no relationship, I created relationship composite scores by averaging the scores (ranging from 0 to 6) across the 4 pairs of reciprocal items. An average score near 0 on this composite indicated that no relationship of any kind was possible. The more the participant endorsed the possibility of a relationship, the higher the composite score. In particular, the endorsement of reciprocal relationships contributed to higher scores. Thus, this measure was interpreted as an index of the extent to which the participant viewed it possible to have a relationship with the agent. The relationship composite scores for the virtual child ($M = 2.59$, $SD = 1.21$) were normally distributed and were not related to gender, $t\ (142) = 0.19$, $p = .85$. The comparison of the composite scores for the virtual child and the doll showed a small but significant preference for the doll, $t\ (143) = -2.84$, $p = .005$, $d = .47$.

In Study 2 with preschool age children, a preference for the stuff dog was found for items about friendship, specifically companionship, protection and love. This preference might have emerged due to differences between the stuffed dog and the virtual dog in their embodied forms and in opportunities for creative control. Therefore, I was particularly interested in examining the extent to which adults' overall preference for the doll on the relationship composite was related to these properties. To investigate how attributions of autonomy, creative control and embodiment to both the virtual child and the doll uniquely predict differences in the relationship composite, I first ran a set of Pearson's *r* correlations (see Tables 5 and 6).

Table 5

Study 3: Relations between properties attributed to the virtual child and composite difference scores

	Autonomy	Control	Embodiment	Composite Difference
Autonomy	1			
Control	**-.47****	1		
Embodiment	**.48****	-.15	1	
Composite Difference	**.30****	-.04	**.35****	1

** *ps* ≤ .008

Table 6

Study 3: Relations between properties attributed to the doll and composite difference

	Autonomy	Control	Embodiment	Composite Difference
Autonomy	1	*scores*		
Control	.03	1		
Embodiment	**.26****	**.27****	1	
Composite Difference	**-.22****	.07	.10	1

* $p < .05$, ** *ps* ≤ .007

From these correlations, attributions of autonomy to both the virtual child and the doll, and attributions of embodiment to the virtual child emerged as possible predictors. I then ran an initial linear regression model with the difference scores for the composites between the virtual child and the doll as the dependent measure. The overall model was significant, F (3, 140) = 13.24, $p < .001$ and accounted for 22% of the variance in the

difference scores. In this model, autonomy for the virtual child (b = 0.16) and the doll (b = -0.33), and embodiment for the virtual child (b = 0.22) were all significant predictors of the difference in the relationship composite scores for the virtual child and the doll, t (140) = 2.29, p = .02, t (140) = -3.68, p < .001, and t (140) = 3.64, p = .001, respectively. As attributions of autonomy and embodiment increased, opportunities for social relationships shifted toward the virtual child. For the doll, as attributions of autonomy to the doll increased, opportunities for social relationships shifted towards the doll. I also ran a hierarchical linear regression analysis with changes in R^2 to examine the unique contributions of each predictor to the variance accounted for by the overall model. The greatest overall contribution to the model was the autonomy attributed to virtual child (9%), followed by attributions of autonomy to the doll (7%), and lastly embodiment attributed to the virtual child (6%).

Relationship Composite and Properties Attributed to the Virtual Child

In this study, I was particularly interested in the extent to which attributions autonomy, creative control, and embodiment correlate with opportunities for relationship with this entity. Because research findings indicate that psychological functioning is attributed more to social robots than to inanimate artifacts (e.g., Kahn et al., 2013), I was interested in the degree to which attributions of psychological functioning to the virtual child would correlate with the opportunities for relationships with this entity.

I initially ran a set of Pearson's r correlations for the virtual child with a Bonferroni correction for all pairwise correlations. Table 7 shows the pattern of correlations for the virtual child, with significant correlations that survive the Bonferroni threshold in bold. The relationship composite psychology property was positively

correlated with psychology, $r = .60$, $p < .001$, autonomy, $r = .38$, $p < .001$, and embodiment, $r = .48$, $p < .001$, but not creative control, $r = -.01$, $p = .95$, *ns*.

Table 7

Study 3: Relations between properties attributed to the virtual child and relationship composite scores

	Autonomy	Creative Control	Embodiment	Psychology	Composite
Autonomy	1				
Control	**-.47****	1			
Embodiment	**.48****	-.15	1		
Psychology	**.69****	**-.22****	**.38****	1	
Composite	**.38****	-.01	**.47****	**.60****	1

** *ps* ≤ .008

Based on these initial correlations, I ran a linear regression model predicting the relationship composite for the virtual child from autonomy, embodiment and psychology. The overall model was significant, $F(3, 140) = 37.43$, $p < .001$ and accounted for 46% of the variance in the difference scores. In this model, autonomy ($b = -0.16$), embodiment ($b = 0.25$), and psychology ($b = 0.56$), were all significant predictors of the relationship composite, $t(140) = -2.14$, $p = .03$, $t(140) = 4.65$, $p < .001$, and $t(140) = 6.97$, $p < .001$, respectively. However, examination of multicollinearity diagnostics revealed significant problems with high inner correlations among the predictors, particularly for the relation between autonomy and psychology. To remedy this problem, I created a new psychology variable by regressing psychology onto autonomy and obtaining the standardized

residuals. These residuals (the variation in psychology not due to autonomy) were then used in a second model predicting the relationship composite from autonomy, residualized psychology, and embodiment. This new model remained significant, F (3, 140) = 37.43, $p < .001$ and accounted for 46% of the variance in the relationship composite scores. All of predictors were statistically significant, $ps \leq .003$, and multicollinearity diagnostics reached acceptable levels.

In this model, autonomy ($b = 0.18$), embodiment ($b = 0.25$) and psychology (not due to autonomy, $b = 0.54$) positively predicted the relationship composite, t (140) = 3.10, $p = .002$, t (140) = 4.66, $p < .001$, and t (140) = 6.97, $p < .001$, respectively. As expected, increases in the attributions of autonomy, embodiment and psychology (independent of autonomy) predicted increases in opportunities for relationships with a virtual child. To examine the unique contributions of each predictor to the variance accounted for by the overall model, I ran a hierarchical linear regression analysis with changes in R^2. The greatest overall contribution to the model was the psychological functioning (independent of autonomy) attributed to the virtual child (19%), followed by autonomy (15%), and lastly embodiment (10%).

Individual Differences

To examine individual differences, I focused specifically on the social and psychological properties attributed to the virtual child, and the social properties attributed to the doll. I did not include the attribution of psychological properties to the doll because the distribution of average attribution scores showed a floor effect (See Table 3). However, because attributions of autonomy to both the virtual child and the doll emerged

as a predictor of differences in the relationship composite, I chose to include these scores as a dependent variable in my individual differences analyses.

Individual differences in the properties attributed to the virtual child. Neither the IRI nor the having an imaginary companion was correlated with the attributions of autonomy, psychology or social properties to the virtual agent, so these variables were dropped from the remaining analyses, *ps* ≥ .55.

Individual differences in anthropomorphism as assessed by the IDAQ were positively correlated with the attributions of autonomy, $r = .19$, $p = .02$ and psychological properties to the virtual child. $r = .19$, $p = .03$, but not with social property attributions, $r = .14$, $p = .09$. Additionally, gender was related to the autonomy, $t\,(142) = 3.22$, $p = .002$, $d = .67$ and psychological properties attributed to the virtual child, $t\,(142) = 2.62$, $p = .01$, $d = .53$; in both instances, males were significantly more likely to attribute these properties to this entity than females. Additionally, the frequency with which participants reported playing digital games was positively correlated with the attribution of psychological properties to the virtual child, $r = .20$, $p = .02$, but not was not related to the attribution of autonomy, $r = .10$, $p = .22$, or social properties, $r = .03$, $p = .68$.

Because none of the individual difference measures were correlated with the social properties attributed to the virtual child, I ran two regression analyses: (1) predicting variance in the attributions of autonomy from gender and IDAQ composite scores, and (2) predicting variance in psychology from gender, IDAQ composite scores, and the frequency of digital game play. For the attribution of autonomy to the virtual child, the overall model was significant, $F\,(1, 140) = 7.22$, $p = .001$, and accounted for 9.3% of the variance. Gender ($b = -0.90$) was a significant predictor, and accounted for

6.7% of the variance in the overall model, t (140) = -2.96, p = .004. The addition of the composite IDAQ scores (b = 0.20) to the model was marginally significant, t (140) = 2.01, p = .05, and accounted for an additional 2.6% of the variance in the overall model.

For the attribution of psychological properties to the virtual child, the overall model was significant, F (4, 139) = 5.04, p = .002 and accounted for 9.8% of the total variance. In the full model, the composite IDAQ score (b = 0.20) was a significant positive predictor of psychological attributions, t (139) = 2.31, p = .004, and frequency of digital game play (b = 0.11) was marginally significant, t (139) = 2.02, p = .05. However, despite the size of the coefficient, gender (b = -0.41) was not a statistically significant predictor of variance in psychological attributions to the virtual child, t (139) = -1.47, p = .14. I suspected that this might be due to the strong relation between gender and frequency of digital game play. Examination of the multicollinearity diagnostics revealed some potential problems with these parameter estimates. To address this problem, I created new variable for the frequency of digital game play by regressing this variable onto gender and obtaining the standardized residuals. These residuals (variation in digital game play not due to gender) were then used in a second model predicting the attributions of psychological properties to the virtual child from gender, IDAQ composite scores, and residualized frequency of digital game play. In the new model, all of predictors were statistically or marginally significant, $ps \leq .05$, and multicollinearity diagnostics reached acceptable levels.

In this model, gender (b = -0.62), and IDAQ scores (b = 0.20) significantly predicted the attribution of psychological properties to the virtual child, t (139) = -2.36, p = .02, t (139) = 2.31, p = .02, respectively. The frequency of digital game play (not due

to gender, $b = 0.22$) was also marginally significant, $t\ (139) = 2.01$, $p = .05$. To examine the unique contributions of each predictor to the variance accounted for by the overall model, I ran a hierarchical linear regression analysis with changes in R^2. The greatest overall contribution to the model was gender differences (4.6%), followed equally by IDAQ composite scores (2.6%), and frequency of digital game play (2.6%).

Individual differences in social properties attributed to the doll. As was found in analyses with the virtual child, the IRI was not correlated with the attribution of these properties to the doll, nor was past or current history of imaginary companions, $ps \geq .41$. Additionally, gender was not related to the autonomous and social properties attributed to the doll, $t\ (142) = -0.13$, $p = .90$ and $t\ (142) = -0.11$, $p = .91$, respectively.

However, strong positive correlations were found between IDAQ scores and the attribution of autonomy and social properties to the doll, $r = .36$, $p < .001$, and $r = .25$, $p < .001$, respectively. In reach case, higher anthropomorphic tendencies were associated with greater attributions of autonomy and social properties to the doll. Simple linear regression analyses indicated that IDAQ composite scores were significant, positive predictors of the variance of in autonomy ($b = .31$, $R^2 = .13$) and social properties ($b = .19$. $R^2 = .06$) attributed to the doll, $t\ (141) = 4.54$, $p < .001$ and $t\ (141) = 2.92$, $p = .004$, respectively.

Item Selection for the Child Task

In addition to examining the properties adults attribute to a humanoid agent, one of the primary aims of this study was to develop a set of items that could successfully capture aspects of biological, psychological and social functioning for a follow-up study with children. I had three goals in selecting items for children based on the results of the

adult data. First, I wanted to ensure that the items I selected were based on theoretical claims about the characteristics of high-quality friendships. Second, I wanted to ensure that the selected items captured variation in aspects of a particular property (e.g., thinking, feeling), rather than repeating the same feature in slightly different ways (e.g., "Can X do things without you?" and "Can X do things when you are not around"). Finally, given the problems with attrition in Study 2, I wanted to find a parsimonious number of items that captured the main properties of interest (biological, psychological and social functioning).

For items designed to describe features of autonomy, biology, creative control, and embodiment, I first examined the mean attribution scores and frequency distributions for each item. I then obtained difference scores for each that maximally differentiated the real child from the doll (or the real child from the virtual child for embodiment items). The items that were closest to their expected mean values and maximally differentiated the real child from the doll were selected for the child study. This included one item about autonomy ("Can X do things when you are not around?"), one item about creative control ("Can you control what X is going to do?"), and two items about biological functioning ("Is X alive?" and "Does X have a heart that beats?"). However, none of the individual items designed to assess embodiment were particularly strong. Therefore, embodiment items were not included the Child Properties Task.

For psychological properties, many items appeared worthy of inclusion in the Child Properties Task. To reduce the total number of items, I examined the items that assessed similar attributes (e.g., "feelings") and then used the one that had the most concrete description. For example, the items "Can X get his/her feelings hurt?", and

"Can X feel lonely?" both indicate that the entity can have feelings. However, "Can X feel lonely?" described a more concrete emotional experience that might be more easily recognizable, especially by young children. I also included the item, "Can X listen to what you say?" in lieu of other strong items because of the surprising lack of differentiation between the real child and the doll (as indexed by the difference score). Thirty-eight percent of the adult sample (n = 55) thought it was possible or even likely that a doll could possess this ability (attribution scores ranging from 3 – 6). I was therefore interested to see how children might attribute this item to the four types of entities.

Finally, because the theoretical focus of this research is on children's concepts of the social reciprocities that are possible in real and imaginary friendships, six of the eight items that assessed bi-directional features of high quality friendships (e.g., Furman & Burhmester, 1985; Parker & Asher, 1993) were selected for the Child Properties Task. I chose not to include the bi-directional items about protection because I was concerned about the extent to which differences in embodiment might influence children's attributions. Because I did not include embodiment items in the child task, it would not be possible to examine how items about protection and items about embodiment might be related. I also included the item, "Can X help you feel better when you are sad?" because of the surprising lack of differentiation between the real child and the doll in this study (mean difference = 0.71). Eighty-six percent of adults sampled (n = 124) thought it was possible or even likely to be comforted by a doll (attribution scores ranging from 3 – 6). Appendix H lists the complete set of items (N = 16) that were used in the Child Properties Task, including two additional items designed to assess the perceived reality

status of each type of child ("S/he is a pretend kid" and "S/he is a real kid"). Note that the items were reworded as declarative statements based on the way the paradigm for the child task was designed.

In what follows, I report the results of repeat analyses with adults from the reduced set of items. This includes the overall pattern of responses on the Adult Properties Task and the reduced items that captured social reciprocity.

Pattern of Responses with the Reduced Items

On the reduced data, one participant was excluded due to missing data on items about autonomy and creative control. Therefore, the remaining analyses are based on a sample for 143 participants. Because there was only one item remaining for properties of autonomy and creative control, I ran a Pearson's *r* correlation with attributions to the real child to examine the relation between these two items in cases where I had the strongest predictions. The correlation between these two items was strong for the real child, $r = -.49$. $p < .001$. Therefore, I chose to collapse these two items into one property ("autonomy and creative control") for the subsequent analyses. I first recoded the item about creative control and then aggregated across the two items for each entity.

As in the original analyses, difference scores were obtained by subtracting the average property attribution scores across properties for the three other entities (real child, child on a video chat program, and doll) from the virtual child. I then ran a 3 (comparison; virtual – real, virtual – video chat, virtual - doll) × 4 (property; autonomy and creative control, biology, psychology, and social) mixed model ANOVA with gender as the between subjects factor and difference scores as the dependent measure. The results of this analysis were essentially identical to findings with the full set of items.

Only two differences were found. First, the main effect of gender was significant, F (1, 141) = 8.88, p =.003. η^2 = .06, and gender interacted with the main effect of comparison, F (2, 282) = 5.93, p =.003. η^2 = .04. A separate 2 (gender; males, females) × 3 (comparison; virtual – real, virtual – video chat, virtual - doll) mixed model ANOVA revealed that males differentiated between the virtual child and the real child, and the virtual child and the child on a video chat program significantly less than females, $ps \leq$ .004. However, there was no difference between males and females on the differentiation between the virtual child and the doll, p = .56. In other words, compared to females, males viewed the virtual child as being more similar to the real child and the child on a video chat program. Second, although adults still favored the doll on opportunities for social relationships, this difference was no longer statistically significant, t (143) = -1.19, p = .24.

Discussion

The primary goals of this study were to develop items that successfully capture concepts of biological, psychological and social functioning for a follow-up task with children, as well as to examine the properties adults attribute to a humanoid agent and the extent to which individual differences contribute to concepts of this entity. On the Adult Properties Task, my hypotheses were largely supported. For properties of autonomy, creative control, biology and psychology, adults treated the real child and a child on a video chat program as inherently similar. However, significant differences emerged between these two entities on embodiment and social properties. Adults viewed a child on a video chat program as disembodied in the same way as the virtual child. This could be due in part to the vignettes I created. By giving adults specific cues about the physical

location of the child on a video chat program, they might have been primed to focus on what was possible in the current context, rather than what was possible in the physical world.

In addition, adults differentiated the social opportunities between the virtual child and the child on a video chat program to the lesser degree than they did with the real child and the virtual child. The difference in the social opportunities attributed to both the real child and the child on a video chat program was related to differences in embodiment. The more adults differentiated between the two children on embodiment, the more they differentiated the social opportunities that were possible with each child. Given that items for the social property were developed based on features of high quality friendship, this result suggests that social interactions with real people that occur through virtual mediums might be perceived by adults as somewhat lower quality, perhaps due to the lack of physical presence and the absence of possibility for physical contact.

For the virtual child and the doll, my hypotheses about the attribution psychological and biological properties were supported. Adults clearly recognized that both a virtual child and a doll are not alive, but they were nevertheless more likely to attribute psychological functioning to the virtual child compared to the doll. This result replicates previous findings in the robotics literature indicating that both children and adults attribute properties to these entities that cut across living and non-living kinds (e.g., Jipson & Gelman, 2007; Kahn et al., 2012).

In addition, my intuition about the positive relation between attributions of psychological functioning and social relationships with the virtual child was supported. The more adults attributed psychological functioning the virtual child, they more likely

they were to attribute possibilities for relationships with this entity. Moreover, the attribution of psychological functioning to the virtual child was the strongest predictor of scores on the relationship composite.

However, gender differences were found among attributions to the virtual child. Males were significantly more likely than females to attribute psychological functioning and autonomy to virtual child. In addition, on the reduced set of items, males differentiated less between the virtual child and the real child, and the virtual child and the child on a video chat program compared to females. These gender differences could be due in part to differences in interest and experience with digital games. However, given the disparity in the distribution of gender in my sample, these results should be interpreted with caution. Moreover, the frequency of digital game play was predictive of the psychological functioning attributed to the virtual child, above and beyond gender differences. And individual differences in anthropomorphic tendencies further predicted attributions of psychological functioning to the virtual child. Taken together, these findings suggests that increased familiarity with virtual agents, as well as the tendency to anthropomorphize, might be associated with the perception of virtual agents as thinking, feeling beings.

Interestingly, greater attributions of psychological functioning to the virtual child did not translate into increased opportunities for social relationships with the virtual child compared to the doll. On the full set of items, adults favored the doll on opportunities for social relationships. This finding was not associated with gender differences, or attributions of embodiment and creative control to the doll. Instead, attributions of autonomy to the doll predicted increased opportunities for social relationships with the

doll, and adults with higher anthropomorphic tendencies were more likely to attribute autonomy and social properties to the doll. Although not assessed in my study, it is also possible that greater familiarity and experience with these artifacts might be associated with a preference for the doll over the virtual child on opportunities for social relationships.

The results from this study mirror what I found with preschool-age children in Studies 1 and 2. Despite adult perceptions of the virtual child as more autonomous and more psychological than the doll, there were no added social benefits for these simulated experiences. At the very least, adults did not differentiate between the virtual child and a doll on opportunities for social relationships, and when they did, they favored the inanimate artifact. This finding raises important questions about the design goals for artificially intelligent agents, and they functions they are intended to serve in our everyday lives. The results of this study suggest that despite their sophisticated programming, artificially intelligent entitles are akin to inanimate toys in the social opportunities they provide.

CHAPTER IV

STUDY 4: THE BIOLOGOCIAL, PSYCHOLOGICAL, AND SOCIAL PROPERTIES CHILDREN ATTRIBUTE TO A VIRTUAL AGENT

Introduction

In Study 3, adults attributed greater psychological functioning to a virtual child than to a doll, suggesting that virtual agents are perceived in ways that cut across ontological categories of living and non-living kinds. However, for the virtual child, the perception of having a greater capacity to think and feel did not translate into beliefs about enhanced social opportunities. Although adults perceived the doll as a non-biological and non-psychological entity, it was perceived as affording social opportunities similar to the virtual child. Do children take a similar view of a virtual child, and the social opportunities that such an entity can provide? In this study, I examined children's concepts of a child virtual agent, and the extent to which their concepts of this entity differ from concepts of a real child, real child on a video chat program and an inanimate doll.

To investigate children's concepts of humanoid agents, I adapted the procedure and stimuli developed in Study 3 with adults for use with preschool and school-aged children. Child participants were introduced to four agents (real child, child on a video chat program, virtual child and doll) and asked about the biological, psychological, and social properties of each. I had four main objectives in developing an alternative to the Social Affordances Task used in Studies 1 and 2: (1) to include a wider range of agents than was possible in Studies 1 and 2, (2) to use the results of Study 3 to select an optimal number of items that captured biological, psychological and social properties, (3) to make

the task interactive so that children would stay engaged, (4) to capture greater variation in children's intuitions about the target entities, and (5) to develop a paradigm that involved human agents rather than the dogs. In Study 4, I piloted this new properties task with children aged five to eight years to assess its age-appropriateness. I also included measures of media use, imaginary companions, and parasocial relationships, but given the small number of participants in this pilot, the goal was limited to providing preliminary information about individual differences that might be helpful for informing future research.

Method

Participants

Participants were thirty children aged five to eight-years-old and their parents, including four sibling pairs, who were recruited from a database of children born in a local, middle class community (mean age = 85.79 months, *SD* =11.81, age range = 63.5 months – 105.5 months, 17 females and 13 males). Of these children, four were 5-year-olds (13.33%), eleven were 6-year-olds (36.67%), 10 were 7-year-olds (33.33%) and five were 8-year-olds (16.67%). Twenty-five children were European-American, and five were of mixed ethnicity. An additional six children were dropped from the study: three because they did not understand the stimuli used in the Properties Task (i.e., they claimed that the real child was pretend), two because of inattention, and one because she thought that the child on a video chat program was a character on a TV show.

Materials for the Child Properties Task

Description of the picture stimuli. Participants were introduced to four gender-matched pictures of a real child, a real child on a video chat program (e.g., Skype™), a

virtual child and a doll. The virtual child and the child on the video chat program were portrayed on desktop computer screens to show that the social interactions that occur with these entities take place in a virtual medium. To help control for response biases due to idiosyncratic details of the individuals in the pictures, I selected four different images of real boys and four different images of real girls within the appropriate age range to use as base images. In these photographs, the children were looking directly at the camera with pleasant, closed-mouth smiles. Graphic designers then used these photographs to create images of the child on the video chat program, the virtual child and the doll. Thus for each image of real child, there was a corresponding image of a child on a video chat program, a virtual child, and a doll that looked similar. In total there were 32 images used in the task (16 images of boys and 16 images of girls).

Participants were shown four 5.5" × 6.5" cards with a description of each agent typed underneath its image. Participants saw one version of each of the target children. As determined by a Latin Square Design, across participants each of the target children occurred equally often as a real-life child, a child on a video chat program, a virtual child and a doll. For example, one male participant was introduced to real boy #1, a boy on a video chat program based on the image of real boy #2, a virtual boy based on the image of real boy #3, and a doll based on the image of real boy #4. Another Latin Square Design was used to determine the introduction order of each type of child. Tables 8 and 9 show the full set of images used in the Child Properties Task, including the 16 girl images and the 16 boy images.

Table 8

Study 4: Full set of male images used with boys in the Child Properties Task

Boy #1	
Boy # 2	
Boy # 3	
Boy # 4	

Table 9

Study 4: Full set of female imagines used with girls in the Child Properties Task

Girl #1	
Girl # 2	
Girl # 3	
Girl # 4	

Property items. The 14 property items were selected based on the results from Study 3 with adults: two items designed to assess autonomy and creative control, two items designed to assess biological functioning, three items designed to assess psychological functioning, and seven items designed to assess social functioning (7 items, including 6 items about reciprocity). I also included two additional items designed

to assess the reality status of each type of child: “S/he is a pretend kid” and “S/he is a real kid” (see Appendix H for the complete list of 16 items).

The items were worded as declarative statements which were printed on 3.5" × 4" cards beneath pictures of each type of child. Children were asked to indicate how true each item was for the target agent on the card on a 4-point yes/no Likert scale. They indicated their response by placing the card in one of four 11" × 7.5" boxes. As shown in Figure 3, one box was marked with a large X (“definitely not”), one with a small x (“probably not”), one with a small check mark (“probably yes”) and one with a large check mark (“definitely yes”)[5].

Figure 3. Boxes representing the four-point Likert scale response options.

[5] I had originally planned to use three boxes representing the response options, “definitely yes”, “definitely no”, and “maybe”. If children selected the “maybe” box, then they would be asked a clarifying question about the two midpoints of the scale, “Probably yes, or probably no?” However, in pilot testing, children clearly understood the 3-point scale, and found the follow up question for the “maybe” response option awkward. Additionally, some children sorted the images of the entities too quickly to allow the experimenter to follow-up after the “maybe” box was selected. Therefore, I opted to use the entire 4-point scale for this study.

Parent Measures

The individual difference measures selected for this study were adapted from research on children's imaginary companions, children's digital media use, and children's parasocial relationships (Bond & Calvert, 2014; Gleason, 2013; Rideout et al., 2010; Taylor, 1999). Both parents and children were asked to report on experiences with screen and print media, as well as a range of real and imaginary relationship partners. For media use, parents were asked to report on access, frequency of use, and attitudes about their children's media use, and children were asked to report on the content of their media experiences. For real and imaginary relationships, information was collected from both parents and children. In what follows, I describe the parent report measures, followed by the child report measures.

Children's Media Use Questionnaire (CMUQ; parent report). The CMUQ is a 66-item questionnaire adapted from a comprehensive telephone survey conducted by the Kaiser Family Foundation on media use in children ages 0- to 6-years-old (Rideout et al., 2003) (see Appendix I). The survey was designed to assess both media saturation and culture in American households, as well as young children's exposure to and familiarity with screen-based technologies. The original survey was updated to include devices that were not widely available in 2003 (e.g., computer tablets, eReaders, and smartphones). I organized the survey into three sections: (1) household media saturation and culture, as well as children's general media use; (2) children's media use and other play activities on a typical day, and (3) children's familiarity with video chat programs (e.g., Skype™) and participation in online virtual worlds for children. Under the section on general media use, parents were also asked to report on their attitudes towards their child's television

and movie viewing, computer use, video game play, and time spent reading. Parents responded to these items on 5-point Likert scales, where "1" indicated very negative views, "3" indicated neutral views and "5" indicated very positive views. One parent did not complete this inventory; therefore, the results are based on a sample of 29 parents.

The children in this sample had access to a wide range of electronic devices in their households. Twenty-six of the 29 parents (89.7%) reported owning televisions (mean number = 1.53, *SD* = 0.78, range = 0 to 3), as well as desktop, laptop, and/or computer tablets (mean number = 3.36, *SD* = 1.75, range = 1 to 10). In addition, 20 parents (69%) reported owning video game consoles and smartphones. Twenty-one of the 29 parents (72.4%) indicated that their children watched TV shows or movies on a typical day; fourteen parents (48.3%) indicated that their child typically watched TV shows and/or movies on desktop, laptop or computer tablets and 22 parents (75.9%) indicated that their child had streamed TV programs and movies on the Internet without assistance from an adult. Streaming television shows and movies online without adult assistance was not related to age, t (27) = -1.32, p = .20.

Of 29 parents who responded to this question, thirteen (44.83%) indicated that their children played computer games or video games on a typical day. The relation between playing digital games on a typical day and gender was trending, χ^2 (1, n = 29) = 2.66, p = .10. Males (61.54%%, n = 8) were somewhat more likely to play computer and video games on a typical day compared to females (31.25%, n = 5). Nevertheless, most children had at least some experience with digital games; only four children (13.33%), two who were from the same family, had never played computer or video games.

Parental attitudes towards children's television viewing, computer use and digital game play were normally distributed and positively correlated with each other, *rs* = .47 - .56, *ps* ≤ .005. Parents who expressed positive views about their child's television viewing were also likely to express positive views about computer use and digital game play. However, parental attitudes about children's computer use and digital game play were not associated with children's responses on the Child Properties Task. Further, given the lack of overall variance in children's exposure and experience with screen based devices, I focused specifically on children's digital game play on a typical day as an individual difference measure.

Parasocial Relationships Questionnaire (parent report). The parasocial relationships questionnaire was adapted from a measure by Bond and Calvert (2014) to assess the development of 5- to 8-year-old children's relationships with media characters and the experiences that characterize these relationships (see Appendix J). Parents were asked for qualitative descriptions of their child's favorite media character, and the mediums in which the child experienced the media character (e.g., videogames, television, toys). Using the 12-item inventory developed by Bond and Calvert, parents were then asked to report on their child's feelings, beliefs and experiences of their favorite media character, using a 5-point Disagree/Agree Likert Scale. This inventory consists of three subscales, measuring character personification (the extent to which children attribute psychological properties to the character and treat the character as a friend, *M* = 3.64, *SD* = 0.42, n = 5 items), social realism (the extent to which children experience the media character as "real", *M* = 2.25, *SD* = 0.83, n = 3 items), and attachment (the extent to which children are comforted by the character, *M* = 3.56, *SD* =

0.62, n = 3 items). Two of the three subscales (attachment and social realism) showed good internal consistencies, αs $\geq$ .80. However, the internal consistency for the personification subscale was poor, α = .49.

Children were identified as having a parasocial relationship if their parents indicated that their child had a past or current favorite media character, and if they were able to provide a description (e.g., who the media character is, how their children learned about it, and the ways in which the child engages with it). Three parents did not complete this inventory, thus the results are based on a sample of 27 parents. Twenty-two children (81.5%; 10 males and 12 females) met the criteria for having a parasocial relationship (e.g., Princess Lea from the star Star Wars™ series, Sponge Bob from Sponge Bob Square Pants®). Having a parasocial relationship was not related to age, t (25) = 1.54, p = .14.

Given the large number of parasocial relationships reported by parent in this sample, I did not include a dichotomous variable for the presence or absence of a parasocial relationship in the individual differences analyses. I instead focused on the three parasocial experiences subscales in relation to children's attributions on the Child Properties Task. However, none of the three subscales correlated with children's responses on the Child Properties Task; therefore, this measure was excluded from all remaining analyses.

Parent Role-play Questionnaire. The Parent Role-play Questionnaire is a 25-item inventory designed to assess parents' familiarity with their children's imaginary companions (Taylor et al., 2004). Parents were first asked if their child had a best friend, and/or a group of friends that his/her child liked to play with regularly. I included these

items because I had expected that the absence of real friends might correlate with children's attributions to the virtual child and the doll on the Child Properties Task. However, the majority of the children in this sample were identified as having a best friend (68.97%), a group of friends (96.67%), and many children had both (68.97%). Therefore, I did not include these items in the individual differences analyses.

Parents were then given a description of an imaginary companion, as asked if their child had a past or current imaginary companion. If parents indicated that their child had an imaginary companion, they were asked a series of forced-choice and open-ended questions about the physical characteristics and personality of the imaginary companion, the duration of the role-play and the other people involved (see Appendix K).

Child Measures

In addition to parent reports, information was collected from children about the content of their media use (e.g., the names of their favorite video games, and descriptions of these games), their favorite media characters, and relationships with imaginary companions.

Brief Media Use Interview. Exploratory data collected as part of Study 1 indicated that children might be better reporters than their parents about the content of their media experiences (e.g., the names of the favorite video games, television shows). Therefore, I developed this measure to identify children's favorite media activities and the content of those activities, as well as children's favorite media characters and their descriptions of these characters (see Appendix L). In this inventory, children were asked a series of questions in a semi-structured interview about their favorite books, television programs and movies, video games and media characters. Children were also asked

whether or not their parents had any rules regarding each activity and how they perceived their parents' attitudes towards these activities. However, children in this sample were often uncertain about how their parents felt about their screen-time and had difficulty recalling their parents' rules for their media use. Additionally, because little is currently known about the content of children's digital media experiences, I did not have specific hypotheses about how the content of children's digital media experiences might relate to responses on the Child Properties Task. Therefore, I did not include this measure in subsequent analyses. Instead, I used the descriptive information collected from children on this measure to discuss the overall findings.

Role-play Interview. In the role-play interview, children were first asked if they had a best friend, and if they had a group of friends that they liked to play with. Participants were then asked about imaginary companions using a semi-structured interview developed by Taylor, Cartwright, & Carlson (1993), with the following introduction: "Some friends are real, like the kids that live on your street, the ones you play with. And some friends are pretend friends. Pretend friends are make-believe, ones that you pretend are real. Do you have a pretend friend?" Children who responded positively were asked questions about the age, sex, physical characteristics, vividness, competency, and autonomy of the imaginary companion (see Appendix M).

Two independent coders who were not involved in data collection reviewed the following inventories: (1) children's initial responses to the role-play interview (2) parents' initial responses to role-play questionnaire (see parent measures) (3) notes based on follow-up discussions with parents regarding children's responses (see procedure) and, if needed, (4) follow-up interviews with children based on discussions with parents.

Children were coded as having an invisible friend if both the parent and child agreed that the child had either a current or past invisible friend and either the parent or the child was able to provide a "good" description (e.g., a description of the invisible friend's physical characteristics and personality). In addition, children who provided a particularly detailed description were coded as having an invisible friend even if the parent did not confirm the child's responses, because past research indicates that parents do not always know about their children's invisible friends (Taylor et al., 2004).

The criteria for coding personified objects were similar, except that the description had to include information about the objects' personality and/or mental states. This was required in order to differentiate transitional objects that were used primarily for comfort (Winnicott, 1953) from personified objects that children treat as characters with distinct personalities. The reliability for invisible friends and personified objects was 91%; disagreements were resolved by discussion.

Seventeen children (56.67%, 8 boys and 9 girls) met the criteria for having an imaginary companion: 12 were invisible friends (70.59%, 5 boys and 7 girls) and 5 were personified objects (29.41%, 3 boys and 2 girls). Of these imaginary companions, 12 (70.6%) were described as current companions and 5 (29.4%) were described as past companions. Having an imaginary companion (past or current) was not related to gender, χ^2 (1, n = 30) = 0.22, p = .64, or age, t (28) = 0.71, p = .48. Children's descriptions were diverse (e.g., a stuffed dog, who was good at "hide and seek" but "still has a lot to learn", an invisible fly who slept on the child's head and got "smelly" when he rummaged through the trash).

Procedure

Following the informed consent procedures, the lead experimenter escorted children into the testing room while a second experimenter remained with parents in the waiting area. Parents provided some basic demographic information (i.e., age, gender, ethnicity, occupation, marital status, and education level) and then completed the CMUQ, the Parent Role-play questionnaire, and the Parasocial Relationships Questionnaire.

In the testing room, the lead experimenter began with the Properties Task by describing the purpose of the task and the response scale. The experimenter told children, "First I'm going to need your help describing some kids. Let me show you what I mean by that." The experimenter then introduced children to the boxes that represented the 4-point response options. To assist children's understanding of the scale, the experimenter showed children four pictures of the same snowman (see Figure 4), with statements printed underneath that corresponded to all the possible response options: (1) "He is wearing a hat" (definitely yes), (2) "He is metal" (definitely no) (3) "He was made by some kids" (probably yes), and (4) "He is in a driveway" (probably no).

Figure 4. Example of the practice stimuli.

The experimenter modeled selecting a response option for each picture separately, and provided an explanation for selecting that particular response option. For example, for the picture of the snowman with the statement, "He is in a driveway", the experimenter said, "Well, he *could* be in a driveway, but a driveway is not a very good place for a snowman! He could get knocked over! So *I think* "probably no". Let's put him into this box right here. This is the 'probably no' box."

After the experimenter modeled all of the response options, she began the task by introducing children to the four different types of entities with accompanying pictures in an order determined by a Latin Square:

> "This is [boy: Ben/Noah/Patrick/Sam] [girl: Beth/Patty/Sarah/Samantha]. [Ben/Noah/Patrick/Sam] [Beth/Patty/Sarah/Samantha] is a little boy/girl that you play with."
>
> "This is [Ben/Noah/Patrick/Sam] [Beth/Patty/Sarah/Samantha]. [Ben/Noah/Patrick/Sam] [Beth/Patty/Sarah/Samantha] is a little boy/girl that you play with on a video chat program, like Skype™ or FaceTime®."
>
> "This is [Ben/Noah/Patrick/Sam] [Beth/Patty/Sarah/Samantha]. [Ben/Noah/Patrick/Sam] [Beth/Patty/Sarah/Samantha] is a little boy/girl character that you play with in a video game."
>
> "This is [Ben/Noah/Patrick/Sam] [Beth/Patty/Sarah/Samantha]. [Ben/Noah/Patrick/Sam] [Beth/Patty/Sarah/Samantha] is a little boy/girl doll that you play with.

The experimenter said, "I'm going to show you pictures of four boys/girls and tell you a little bit about them. Then, like with the pictures of the snowman, I'm going hand you pictures of the four boys/girl and read what is says under the pictures. Then, you're going to decide where each picture goes." As the experimenter introduced each entity, the 5.5" × 6.5" pictures of each type of child with the description typed underneath were tacked vertically onto a wall directly in front of the children in the order in which they

were presented. This allowed children to reference them while making their judgments during the task. However, note that unlike Studies 1 and 2, participants did not have direct exposure to each of the four child agents featured in the pictures.

For the child on a video chat program and the virtual child, the experimenter verified that participants were familiar with video chat programs and virtual characters by asking, "Do you know what Skype™ or Facetime® is?" and "Do you know what a video game character is?" All 33 children indicated that they understood what a video game character was, and only six children (18.2%) initially said they were unfamiliar with video chat programs. In these instances, the experimenter provided the following explanation of video chat programs: "It's like talking to someone on the phone, except it's on a computer, and you can see them, and they can see you." After providing this explanation, most children indicated that they had used a video chat program before, usually to chat with extended family members. Additionally, only one of the 29 parents that completed the CMUQ indicated that their child had not used a video chat program before.

To help ensure that participants would respond on the Properties Task based on their own intuitions, the experimenter then said, "Sometimes, you might put the pictures of the four boys/girls into the same box. Sometimes, you might put them into different boxes. That's okay! There are no right or wrong answers. I just want to know what you think." The experimenter then began the task by presenting the first item, in a set of four 3.5" × 4" images (of the real child, the child on a video chat program, the virtual child and the doll) and reading the identical statement that typed underneath each of the four entities. The experimenter reminded children of the response scale and prompted them to

make their judgments, saying, "Now you decide if it's true for each boy/girl and where each picture should go- into the 'definitely yes' box, the 'definitely no' box, the 'probably yes' box, or the 'probably no' box." Items were presented to children in unique randomized orders, in sets of four images that were randomly shuffled. Unless they showed signs of hesitation or confusion, children were not prompted after the first item. Children were not given any feedback on their responses.

Following the Properties task, the lead experimenter thanked children for their help. She then administered the Role-play interview, followed by a free play session in which children either drew pictures of their imaginary companions, or pictures of real and imaginary people. The second experimenter sat in the testing room with children during the free play session, while the lead experimenter followed-up with parents about children's responses to the Role-play interview. If parents described imaginary companions that the children did not mention, the lead experimenter re-interviewed children immediately following the free-play session. Otherwise, the lead experimenter proceeded with the Brief Media Use Interview. The entire session lasted between forty-five minutes and one hour. Children were given $10 for participating.

Hypotheses

Property Attributions

Research findings consistently show that young children attribute properties to social robots that cut across living and non-living kinds, including perceptual and psychological properties (e.g., Kahn et al., 2006; Jipson & Gelman, 2007). Therefore, I hypothesized that children in this study would recognize that the virtual child was a non-biological entity, but nevertheless attribute psychological properties to it. However, I

expected that the attribution of psychological properties to a virtual child would vary as a function of age and individual differences. For example, older children might be less willing to attribute psychological properties to a virtual child, whereas children with imaginary companions (regardless of age) might be more willing to attribute psychological properties to a virtual child. I also anticipated that children would be less likely to attribute psychological properties to a doll, but that this would also vary as a function of age and individual differences.

Based on the results from Study 2, I anticipated that children would attribute some features of social reciprocity to a virtual child (Aguiar & Taylor, 2015). In Study 2, children were more likely to attribute items about comfort, protection and love to the stuffed dog. It possible that these differences were primarily driven by differences in the embodied form of the entities (the presence or absence of a physical body). If so, then children in Study 4 might be less willing to attribute items about love and companionship to both the virtual child and the child on a video chat program, and more willing to attribute them to a real child and a doll. However, because I sampled an older age cohort and used an inanimate artifact that is typically marketed to girls, I anticipated possible age and gender differences. I also expected the social reciprocities attributed to a virtual child and a doll would vary as a function of other individual difference measures, including imaginary companions and experience with digital media.

Based on the results of Studies 1 and 2, my predictions about autonomy and creative control were less clear. For the virtual child, I hypothesized that children would recognize the agent's capacity for autonomous movement. And if my intuitions about the nature of experiences with virtual agents were correct, then children should also

recognize a lack of creative control over the virtual child's behaviors. However, I was more uncertain about the extent to which children would attribute properties of autonomy and creative control to a doll. In Studies 1 and 2, children were equally likely to attribute agentic properties to both the virtual dog and the stuffed dog. Therefore, I also expected some variation in the attributions of autonomy and creative control to the doll.

Reality status

Because many virtual agents can move autonomously and are capable of producing socially contingent responses based on human input, I hypothesized that children would perceive the virtual child as more real than imaginary. I expected that this would be particularly true for children who attribute psychological and social properties to the virtual child. I further expected that the perceived reality status of the virtual child would vary as a function of age and individual differences. For example, older children who have had more experience with digital games might be more likely to attribute fantasy status to the virtual child. It was also possible that the presence of an imaginary companion would predict the extent to which children viewed the virtual child as real. Children readily understand that their imaginary companions are not real (Taylor, 1999), and thus they might also assume that the virtual child was not real, even if they were aware that the entity could operate outside their creative control.

Results

Pattern of Responses on the Child Properties Task

Table 10 shows the means and standard deviations for the five property categories (collapsing across individual items) by age and as a function of type of entity. As expected, children (collapsed across age) attributed autonomy, as well as biological and

psychological functioning to the real child and the child on a video chat program. In addition, children perceived both of these entities as "real".

Table 10

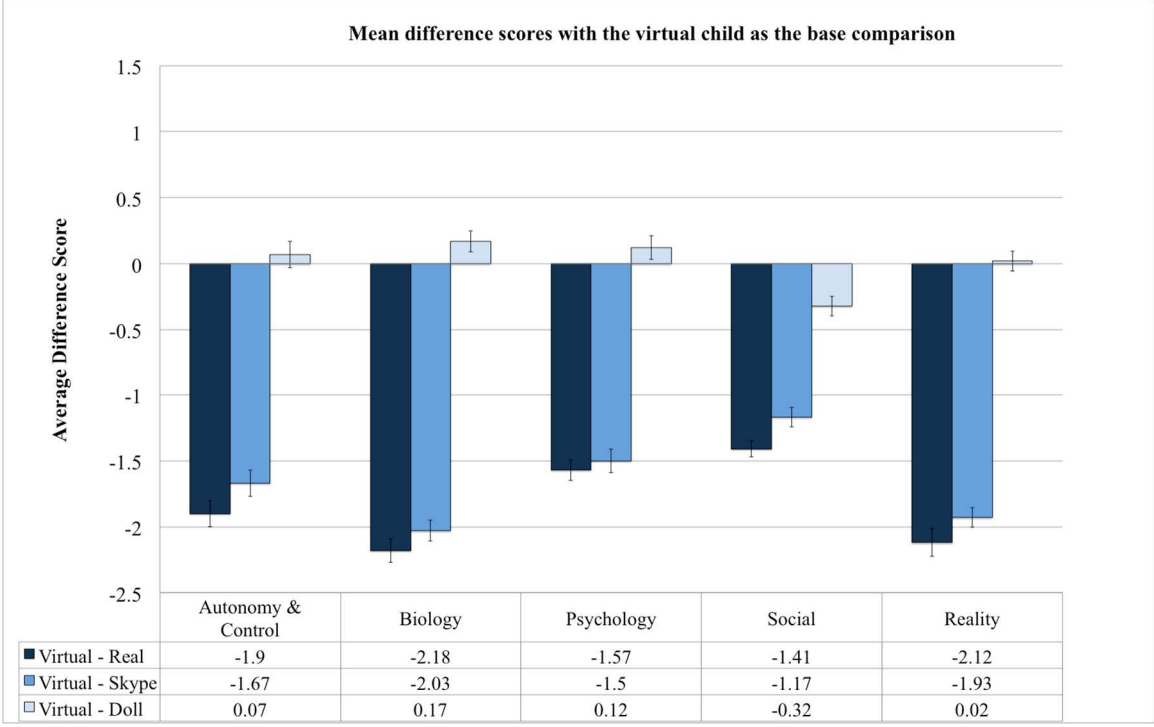
Study 4: Descriptive statistics for each entity by property and by age

	Property				
Entity	Autonomy & Control	Biology	Psychology	Social	Reality Status
Real					
5-year-olds (n=4)	1.88 (0.48)	2.13 (0.85)	1.83 (0.43)	2.14 (0.55)	2.5 (0.58)
6-year-olds (n = 11)	2.55 (0.57)	2.77 (0.52)	2.61 (0.49)	2.56 (0.43)	2.41 (0.77)
7-year-olds (n = 10)	2.85 (0.47)	2.90 (0.32)	2.90 (0.16)	2.84 (0.21)	2.95 (1.16)
8-year-olds (n = 5)	2.70 (0.27)	3.00 (0.00)	2.67 (0.41)	2.60 (0.57)	3.00 (0.00)
Average score	**2.58 (0.56)**	**2.77 (0.52)**	**2.61 (0.50)**	**2.60 (0.45)**	**2.80 (0.41)**
Video chat					
5-year-olds (n=4)	1.50 (1.08)	1.63 (0.48)	2.33 (0.61)	2.04 (0.32)	2.00 (1.41)
6-year-olds (n = 11)	2.18 (0.75)	2.64 (0.55)	2.33 (0.63)	2.29 (0.45)	2.32 (0.72)
7-year-olds (n = 10)	2.70 (0.54)	2.80 (0.35)	2.70 (0.33)	2.53 (0.58)	2.80 (0.35)
8-year-olds (n = 5)	2.70 (0.27)	3.00 (0.00)	2.87 (0.18)	2.46 (0.57)	3.00 (0.00)
Average score	**2.35 (0.77)**	**2.62 (0.58)**	**2.54 (0.51)**	**2.36 (0.51)**	**2.63 (0.72)**
Virtual					
5-year-olds (n=4)	0.88 (0.63)	0.88 (0.25)	1.67 (0.72)	1.39 (0.32)	0.25 (0.50)
6-year-olds (n = 11)	0.59 (0.66)	0.82 (0.75)	1.09 (0.60)	1.09 (0.50)	0.77 (0.96)
7-year-olds (n = 10)	0.75 (0.92)	0.35 (0.82)	0.80 (0.80)	1.21 (0.72)	0.20 (0.63)
8-year-olds (n = 5)	0.60 (0.42)	0.30 (0.45)	0.93 (0.55)	1.23 (0.55)	0.40 (.55)
Average score	**0.68 (0.70)**	**0.58 (0.71)**	**1.04 (0.70)**	**1.20 (0.56)**	**0.43 (0.86)**
Doll					
5-year-olds (n=4)	1.25 (.65)	0.63 (0.63)	1.29 (0.34)	1.03 (0.79)	0.75 (0.96)
6-year-olds (n = 11)	0.77 (0.75)	0.37 (0.55)	0.88 (0.64)	1.49 (0.62)	0.45 (0.57)
7-year-olds (n = 10)	0.20 (0.48)	0.30 (0.79)	0.70 (0.92)	1.76 (0.61)	0.35 (0.60)
8-year-olds (n = 5)	0.60 (0.89)	0.60 (0.65)	1.20 (0.69)	1.49 (0.75)	0.50 (0.50)
Average score	**0.62 (0.74)**	**0.42 (0.64)**	**0.93 (0.73)**	**1.52 (0.67)**	**0.50 (0.78)**

However, as in Study 3, the primary focus of the Child Properties Task was to examine concepts of the virtual child, and how these concepts might differ from the other target entities. To examine the pattern of differentiation between the virtual child and the three other entities (real child, child on a video chat program and doll), I used a similar method employed in Study 3. I created difference scores by subtracting the average property attribution scores for the real child, child on a video chat program, and doll from the virtual child. I then ran a 3 (comparison; virtual – real, virtual – video chat, virtual –

doll) × 5 (property; autonomy/creative control, biology, psychology, social, reality status) mixed model ANCOVA with gender as the between subjects factor, age in months as the covariate, and difference scores as the dependent measure.

Between subjects, the main effect of gender was not significant, F (1, 27) = 0.00, p = .99. In addition, there were no significant interaction effects involving gender: gender by comparison, F (2, 54) = 1.28, p = .22; gender by property, F (4, 108) = 0.72, p =.58; gender by comparison and by property, F (8, 216) = 0.14, p = .65. Within subjects, the main effect of comparison was not significant, F (2, 54) = 1.52, p =.23, and the main effect of property was trending, F (4, 108) = 2.21, p =.07. η^2 = .08. However, there was a significant comparison by property interaction effect, F (8, 216) = 3.03, p = .003. η^2 = .10. Figure 5 shows the patterns of differentiation between the virtual child and the other entities.



	Autonomy & Control	Biology	Psychology	Social	Reality
Virtual - Real	-1.9	-2.18	-1.57	-1.41	-2.12
Virtual - Skype	-1.67	-2.03	-1.5	-1.17	-1.93
Virtual - Doll	0.07	0.17	0.12	-0.32	0.02

Figure 5. Pattern of differentiation between the virtual child and the other entities.

How does the virtual child differ from the real child and the real child on a video chat program? For autonomy/creative control, biology, psychology and social properties, the pattern of differentiation mirrors what was found in Study 3 with adults. Collapsed across age, the patterns of differentiation between the virtual child and the real child, and between the virtual child and the child on a video chat program were similar for the properties of autonomy/creative control, biology, and psychology, $ps \geq .22$. These properties were attributed more to the real child and the child on a video chat program compared to the virtual child. In addition, the patterns of differentiation between the virtual child and the real child, and the virtual child and the child on a video chat program were similar for reality status, $p = .60$. This property was attributed more to both the real child and the child on the video chat program than to the virtual child. In other words, compared to the real children, the virtual child was perceived as lacking autonomy, as well as biological and psychological functioning. In addition, the virtual child was perceived as significantly less real than both the real child and the child on a video chat program.

For the social property, there was a trend for less differentiation between the virtual child and the child on the video chat program compared to the differentiation between the virtual child and the real child, $p = .08$. As was found in Study 3, social properties were attributed more to the child on a video chat program than to the virtual child, but to a somewhat lesser degree than the real child. This finding suggests that, like adults, children are sensitive to a social partner's physical presence when making judgments about opportunities for social engagement.

How does the virtual child differ from the doll? Children did not differentiate between the virtual child and the doll for reality status or autonomy/creative control. They were equally likely to view both the virtual child and the doll as pretend entities that were within their creative control (low autonomy scores and high control scores). Paired sample *t*-tests indicated that children did not differentiate between the virtual child and the doll for biological t (29) = 1.06, p = .30, or psychological properties, t (29) = 0.75, p = .46. However, children attributed more social properties to the doll than to the virtual child, t (29) = 2.40, p = .023, d = .44. Thus, children in this study viewed the inanimate toy as affording more social opportunities than the virtual child.

Of the 7 social property items, there were 3 pairs (6 items) that were designed to capture the extent to which the relationship was reciprocal. To provide descriptive information about the way the participants viewed the relationships, I categorized the participants' responses for each pair of items as (1) reciprocal if the participant indicated that both of the items in the pair were possible (e.g., scores of 2 or 3 for both "can X love you" and "can you love X"), (2) self-to-entity unilateral if the score for the self (e.g., "can you love X") was 2 or 3, but the score for the entity (e.g., "can X love you") was 0 or 1; (3) entity-to-self unilateral if the score for the entity (e.g., "can X love you") was 2 or 3, but the score for the self (e.g., "can you love X") was 0 or 1; or (4) no relationship if both scores were 0 or 1.

Table 11 shows the relationship categories for each of the three pairs of items for the doll and the virtual child. Self-to-entity unilateral relationships were relatively common for both the virtual child and the doll, but the entity-to-self unilateral direction was more common for the virtual child than the doll.

Table 11

Study 4: Type of relationship by entity and by friendship feature

Property	Type of Relationship			
	No relationship	Unilateral Self>Entity	Unilateral Entity>Self	Reciprocal
Tell secrets				
Doll	12 (40%)	14 (46.67%)	0	4 (13.33%)
Virtual child	18 (60%)	5 (16.67%)	5 (16.67%	2 (.07%)
Love				
Doll	6 (20%)	13 (43.33%)	0	11 (36.67%)
Virtual child	6 (20%)	12 (40%)	5 (16.67%)	7 (23.33%)
Keep company				
Doll	6 (20%)	1 (.03%)	9 (30%)	14 (46.67%)
Virtual child	13 (43.33%)	1 (.03%)	11 (36.67%)	5 (16.67%)

A paired samples *t*-test comparing the number of times the participants' responses were categorized as entity-to-self unilateral (out of 3) was significant, with the scores for the virtual child ($M = 0.67$, $SD = 0.76$) higher than the scores for the doll ($M = 0.30$, $SD = 0.47$), $t\ (29) = 2.48$, $p = .019$, $d = 45$. A substantial minority of participants viewed the relationships as unilateral. A paired samples *t*-test on the number of times the participants' responses were categorized as endorsing a reciprocal relationship (out of 3) revealed a significant difference, with the scores for the doll ($M = 0.97$, $SD = 1.03$) higher than the scores for the virtual child ($M = 0.47$, $SD = .82$), $t\ (29) = 2.29$, $p = .03$, $d = .42$.

One of the social items ("He can make you feel better when you are sad") was not part of a reciprocity pair, but provides additional evidence of the superiority of the doll over the virtual child for a relationship. Children were significantly more likely to indicate that the doll (M =1.70, SD = .92) could make them feel better than the virtual child (M = 1.23, SD = .94), t (29) = 2.19, p = .04, d = .40.

As in Study 3, I also examined social relationships by creating a composite relationship score averaging across the paired reciprocal items (n = 3 pairs, n = 6 items) for each entity (e.g., "Can X love you? Can you love X?") (see Table 12 for descriptive statistics).

Table 12

Study 4: Descriptive statistics for each item designed to assess social reciprocity

	Entity			
Item	Real child	Video chat child	Virtual child	Doll
S/he can tell you secrets.	2.56 (0.73)	2.40 (0.72)	0.87 (0.94)	0.67 (0.88)
You can tell him/her secrets.	2.60 (0.72)	2.27 (0.94)	0.87 (0.94)	1.50 (1.20)
S/he can keep you company.	2.63 (0.72)	2.30 (0.84)	1.60 (1.04)	2.00 (0.94)
You can keep him/her company.	2.67 (0.80)	2.43 (0.82)	1.00 (0.91)	1.37 (1.03)
S/he can love you.	2.63 (0.81)	2.43 (0.82)	1.13 (1.11)	1.16 (1.05)
You can love him/her.	2.70 (0.65)	2.50 (0.82)	1.67 (1.06)	2.23 (1.01)
Relationship Composite	2.63 (0.44)	2.39 (0.49)	1.19 (0.61)	1.49 (0.68)

The relationship composite scores ranged from 0 to 3, where averages near 0 indicated that a relationship of any kind with a virtual child or doll was not possible, averages near 1.5 indicated a possible unilateral relationship, averages near 3 suggesting a possible reciprocal relationship with the virtual child and the doll. The relationship composite scores for both the virtual child (M = 1.19, SD = 0.61) and the doll (M = 1.49, SD = 0.68) were normally distributed and positively correlated, r = .36, p = .049. The

relationship composite was not related to age (in months) for either the virtual child, r = 01, p = .97, or the doll, r = .123 p = .48. It was also not related to gender for either the virtual child or the doll, t (28) = 27, p = .79 and t (28) = 0.10, p = .92, respectively.

To examine the extent to which children differentiated opportunities for social relationships between the virtual child and the doll, I obtained difference scores by subtracting the relationship composite scores for the doll from the virtual child. Differentiation between the virtual child and the doll was not related to age, r = -.12, p = .54, or gender, t (28) = -0.13, p = .90. A one sample t-test indicated that that the mean difference (M = -0.30, SD = 0.73) was significantly different from zero, t (32) = -2.25, p = .03, d = .41. The direction of the difference indicates that relative to a virtual child, participants were significantly more likely to view a doll as a potential relationship partner.

Because children in Study 2 differentiated between a stuffed dog and a virtual dog on specific features of high quality friendship (e.g., love and companionship), I also conducted an individual item analysis on each bi-directional features of social reciprocity. Six paired samples t-tests revealed that children differentiated between the virtual child and the doll on the unidirectional item "You can love him/her" (mean difference = -0.57, SD = 1.22), t (29) = -2.54, p = .02, d = .46, and on the unidirectional item "You can tell him/her secrets" (mean difference = -0.63, SD = 1.25), t (29) = -2.79, p = .009, d = .51. The bi-directional items "S/he can keep you company" (mean difference = -0.40, SD = 1.33) and "You can keep him/her company" (mean difference = -0.37, SD = 1.03) were trending, t (29) = -1.65, p = .11, d = .30 and t (29) = -1.94, p = .06, d = .36, respectively. The direction of the difference indicates that children showed a preference for the doll on

these items. The differentiation between the virtual child and the doll on these items was not related to gender, *ps* > .50. Age was not related to the differentiation between the virtual child and the doll on items about companionship and love, *rs* = -.05 – -.02, *ps* ≥ .77; however age was related to the item about intimate disclosure, r = -.38, p = .04. Younger children were more likely to favor telling secrets to the doll than older children. However, it is important to note that these findings should be considered suggestive, as they would not survive a Bonferroni correction.

I had also planned to examine the extent to which differentiation between the virtual child and the doll on the relationship composite was associated with attributions of autonomy and creative control to both entities, as well as children's perception of the reality status for these entities. However, exploratory data analyses revealed floor effects for these properties.

Age related differences. Age (in months) interacted with the main effect of property, F (4, 108) = 2.73, p = .03, η^2 = .09, and the main effect of comparison, F (2, 54) = 8.72, p =.001, η^2 = .24, but was best understood in light of a three-way interaction between age, comparison, and property, F (8, 216) = 4.26, p < .001, η^2 = .14. To ease conceptual understanding of this three-way interaction, I ran a 3 (comparison) × 5 (property) ANOVA with age group (5-and 6-year-olds vs. 7- and 8-year-olds) as the discrete, between subjects factor. Simple effects tests with a Bonferroni correction were then used to examine all significant age related differences (see Table 4 for descriptive statistics by age)[6].

[6] I planned to parse the three-way interaction effect using regression analyses. However, significant problems with multicollineary emerged. Efforts to address these problems would have increased difficulty in conceptual interpretation.

For the property of autonomy/creative control, no age differences were found in the patterns of differentiation between the virtual child and the three other entities, *ps* ≥ .11. However, for biological, psychological, social, and reality status properties, age differences emerged. All of these differences were for the patterns of differentiation between the virtual child and the real child, and the virtual child and the child on a video chat program. No age related differences were found in the pattern of differentiation between the virtual child and the doll. For biological, psychological, social and reality status properties, younger children (5- and 6-year-olds) differentiated significantly less between the virtual child and the real child, and the virtual child and the child on a video chat program than older children (7- and 8-year-olds), *ps* ≤ .03. Taken together, these findings indicate that younger children viewed the virtual child as more similar to both the real child and the child on a video chat program than the older age cohorts.

Although there appeared to be age differences on the Child Properties Task, four of the initial seven 5-year-olds had to be dropped from the analyses because their responses indicated that they did not understand what the stimuli were meant to portray or could not attend to the task. Given the small sample size within each age cohort, age related findings are preliminary and should be interpreted with caution. More generally, the Child Properties Task did not work that well for the 5-year-olds in this study and might not be appropriate for children under 6 years of age. The video guessing game task used in Studies 1 and 2 worked better for this younger age group.

Individual Differences

To examine individual differences, I focused specifically on psychological and social properties attributed to both the virtual child and the doll. These attributions were

examined in relation to the following individual difference variables: gender, digital game play, and imaginary companions. Note that due to the small number of observations in each cell, I collapsed across past and current imaginary companions, as well as type of imaginary companion for the subsequent analyses. In what follows, I first report on the results of the individual differences analyses for the virtual child, followed by the doll.

For the virtual child, gender was not associated with attributions of psychological and social properties to the virtual child, t (28) = -0.13, p = .90 and t (28) = -0.17, p = .87, nor was having an imaginary companion, t (28) = -0.30, p = .77 and t (28) = -0.82, p = .42, respectively. Although playing digital games on a typical day was not related to psychological attributions to the virtual child, t (28) = -0.16, p = .87, it was marginally associated with social attributions, t (28) = -2.10, p = .04, d = 0.38. Children who played digital games on a typical day attributed greater social opportunities to the virtual child (M = 1.44, SD = 0.34) than children who did not play these games on a typical day (M = 1.02, SD = 0.64).

For the doll, gender was not associated with psychological nor social property attributions, t (28) = .87, p = .39 and t (28) = 0.16, p = .87, respectively. However, both digital game play on a typical day and the presence of an imaginary companion were associated with attributions to the doll. Children who played digital games on a typical day were significantly less willing to attribute psychological properties to the doll (M = 0.56, SD = 0.42) compared to children who did not play digital games regularly (M = 1.20, SD = 0.86), t (27) = 2.42, p = .02, d = .44. In addition, children with no past or current history of imaginary companions were less likely to attribute social opportunities

to the doll (M = 1.18, SD = 0.48) compared to children with a past or current history of imaginary companions (M = 1.75, SD = 0.68), t (28) = 2.59, p = .02, d = .47; however, the same was not true for psychological properties, t (28) = -0.29, p = .77.

Given the disparities in attributions to the doll that emerged as a result of different forms of play, I thought it might be possible that digital game play was negatively related to role-play for children in this sample. However, digital game play on a typical day was independent of a past or current history of imaginary companions, χ^2 (1, n = 29) = 0.08, p = .77. Children who played digital games on a typical day were just as likely to have imaginary companions as children to who did not play digital games daily.

Discussion

The primary aim of this research was to develop a paradigm that could successfully capture concepts of humanoid agents with children from a broad age range. Overall, for children over five years of age, the paradigm used here was successful in eliciting concepts of a child virtual agent, and the ways in which it might differ from a range of other social partners. Children aged six and older clearly understood the response scale, and the combination of fewer items paired with a card-sorting task helped younger age cohorts stay focused and engaged. In addition, they had sufficient experience with digital games and video chat programs to warrant the use of picture stimuli for both introducing the entities and sorting the items presented in this study. Finally, the use of a counterbalanced set of images helped control for responding due to the idiosyncratic features of the children pictured in the study.

These preliminary findings suggest some age related differences in responses to the picture stimuli. The responses of some of the 5-year-old children to the reality status

items suggests that the youngest children tended to doubt the reality status not only of the virtual child and the doll, but also the real child and child on a video chat program. It is possible that these responses could be due the use of picture stimuli. However, there is other research indicating that in some circumstances, young children can be more skeptical about the reality status of real people, places, and events than older children and adults (see Woolley & Ghossainy, 2013 for a review).

For children over five years, there was a clear differentiation between the biological and non-biological entities on reality status items. Children ages 6-years-old and up clearly perceived the real child and the child on a video chat program as probably or definitely real, and the virtual child and the doll as "probably not" real or "definitely not" real. Indeed, after being introduced to all four children, one 6-year-old girl stated that she was going to sort all of the items based on whether or not the children were "fake" or "real". This spontaneous comment might explain why the base rate for the attribution of social opportunities to the virtual child and the doll was somewhat lower than expected. It is possible that pitting the virtual child and the doll against real children primed child participants to attribute properties based on this overarching distinction.

Because all children in this sample were fairly confident that the virtual child was not real, there was no other support for the hypothesis that virtual agents are ontologically ambiguous entities that are distinct from inanimate toys. For example, although children were somewhat more likely to attribute psychological functioning to the virtual agent compared to doll, this difference was not statistically significant. Moreover, children across age cohorts viewed both the virtual child and the doll as lacking in autonomy and affording a high potential for creative control. Children's perceptions of the virtual child

as entirely pretend and within their creative control might be reflective of their current experiences with digital games. In the Brief Media Interview, children frequently cited favorite digital games such as MINECRAFT™ and Super Mario Brothers™, which feature pixilated, cartoon-like agents that lack sophisticated programming. Given these experiences, it is not surprising that children would readily identify such characters as pretend. It would be interesting to see how attributions might change based on interactions with more sophisticated humanoid agents, much like those that are being designed and programmed by Cassell and colleagues to serve as peer tutors (e.g., Yu et al., 2013; Zhao et al., 2014).

However, the lack of differentiation between a virtual child and a doll on autonomy/creative control was not found for the social property. Overall, children attributed the social property more to the doll than to the virtual child, and children were more likely to favor the doll as a reciprocal relationship partner. In addition, as was found in Study 2 with preschool age children, specific features of high quality friendship were attributed more to the doll than to the virtual child. These features included the capacity to feel love towards the entity, to disclose secrets to the entity, and to experience a reciprocal sense of companionship. Because I was not able to examine embodiment directly in this study, it is not possible to determine if these distinctions were based on the presence or absence of a physical body. As was found in Study 3 with adults, the somewhat lower social attributions to the child on a video chat program relative to the real child suggest that children recognize the importance of physical presence in opportunities for high quality relationships. Nevertheless, it is noteworthy that distinctions between the virtual agent and the inanimate artifact found in Study 2 were

replicated in Study 4 with a different embodied artifact -- one that was hard and plastic rather than plush and soft.

Analyses of individual differences hint at the potential role experience might play in children's concepts of virtual agents and inanimate toys. Children with a past or current history of imaginary companions attributed greater social opportunities to the doll compared to children who did not engage in this form of role-play. It is possible that children with imaginary companions were more practiced in simulating social relationships with inanimate toys, and were therefore more likely to see potential for relationships with these artifacts. Similarly, children who played digital games daily were more likely to attribute psychological functioning to the virtual child, and less likely to attribute psychological functioning to the doll. Therefore, it is possible that interest in and familiarity with virtual games influences children's concepts of the agents that inhabit these digitized spaces, and the ways in which they perceive more traditional toys. However, it is important to note that gender was associated with digital game play on a typical day. As was found in Study 3 with adults, males were more likely to engage in this actively daily than females. This preliminary finding raises questions for researchers interested in developing virtual agents for the purpose of educational interventions. For example, if females are less familiar with and less interested in virtual games and virtual characters, will this have an impact on their ability to establish rapport with a virtual agent, and their ability to learn from them?

Because of the small sample size and wide age range, the findings reported here should be considered exploratory, and will need to be replicated with a larger sample. However, in combination with Studies 1 and 2, this follow-up study helps shed additional

light on children's concepts of virtual agents, and how they differ from more traditional toys. Despite the differences in the virtual entities and artifacts presented to children, age ranges, and paradigms used to assess children's intuitions about these entities, the results are fairly consistent: inanimate artifacts are preferred as relationship partners over virtual agents.

CHAPTER V

GENERAL DISCUSSION

Summary of Major Findings

Across all four studies, one surprisingly consistent finding emerges: children and adults rarely differentiated between a virtual agent and an inanimate artifact on opportunities for high quality friendship, but when they did, these features were attributed more to the inanimate artifact than the virtual agent. These findings emerged across age ranges and across the embodied forms of the target entities.

Summary of Studies 1 and 2

In Study 1, preschool age children failed to differentiate between a virtual dog and a stuffed dog when asked about autonomous movement. This was particularly surprising, given that they had direct exposure to the virtual dog and could clearly see that the dog was capable of moving on its own and responding in socially contingent ways. In Study 2 when children were forced to choose between the virtual dog and the stuffed dog on opportunities for friendship, education and entertainment, the two dogs were endorsed equally often for items about autonomous movement, as well as for items about opportunities for learning. However, some items about entertainment elicited a greater preference for the virtual dog. Discrimination was also shown on specific features of high quality friendship, including comfort, protection and love. For these items, children tended to favor the stuffed dog over the virtual dog.

The results of these preliminary studies suggest that children might favor opportunities for friendship with an inanimate toy and opportunities for entertainment with a virtual agent. The selectivity in children's responses to statements about a stuffed

dog versus a virtual dog is consistent with social provisions theory developed by Weiss (1974), indicating that relationships provide specific social affordances that can sometimes overlap across different types of relationships-- including those with imaginary friendships (Gleason & Hohmann, 2006). However, the items developed to assess features of friendship in these studies did not capture social reciprocity, which is the foundational feature of friendships (Gleason, 2013; Rubin et al., 2013; Rubin, Bukowski, & Parker, 2006). In addition, differences in the embodiment of the virtual dog and the stuffed dog might have influenced children's responses to the friendship items, particularly those about comfort and protection. And because the entities used in this study were dogs, these results are not generalizable to other virtual agents and toys. Finally, children's spontaneous utterances during the task suggested some ontological ambiguity about the virtual dog that was not captured in the Social Affordances Task. For example, a number of children claimed that the virtual dog was "real", or appeared confused about the reality status of the dog (e.g., specifically asking the experimenter whether or not the virtual dog was a real dog.)

It is unlikely that confusion about the status of the virtual dog was due to a more general inability to distinguish fantasy from reality. Across a number of studies, research findings indicate that young children are able to distinguish fantasy from reality in many different contexts (see Woolley & Ghossainy, 2013 for a review). Moreover, when they make mistakes in their judgment, they are just as likely to mistake real people and events for imaginary ones (Woolley & Ghossainy). One possibility is that confusion about a virtual dog reflects the ontological complexity of new personified technologies. In the robotics literature, findings indicate that children recognize that robots are not alive, but

still attribute psychological and perceptual properties to these agents (e.g., Kahn et al., 2006; Jipson & Gelman, 2007). To examine the extent to which this might be true for children's concepts of virtual agents, in Studies 3 and 4, I investigated the biological and psychological properties children and adults attribute to a humanoid agent, and how the social reciprocities inherent in real and imaginary relationships might relate to ontological ambiguities.

Summary of Study 3

With adults, there was evidence to suggest that virtual agents are also conceptualized in ways that cut across living and non-living kinds. Adults clearly recognized that both a virtual child and a doll were not alive, but they were more likely to attribute psychological functioning to the virtual child than to the doll. In addition, attributions of psychological functioning to the virtual child were associated with increased attributions of the features that define high quality friendships. The more adults attributed psychological functioning to the virtual child, the more they perceived potential for relationships with this entity.

The attribution of friendship features to the virtual agent was also related to embodiment. Although the virtual agent was perceived as significantly less embodied than a doll, the more participants perceived the virtual agent as having a physical body, the more likely they were to attribute opportunities for unilateral and reciprocal relationships to the agent. Finally, relative to a doll, adults were more likely to view a virtual child as having some capacity for autonomous functioning. On average, adults attributed greater autonomy and less creative control to the virtual child compared to the doll.

However, both gender and anthropomorphic tendencies were associated with attributions of autonomy and psychological functioning to the virtual child. Males were more likely to attribute these properties to the virtual child than females, perhaps due to greater interest in and familiarity with virtual reality and virtual games found in my sample. This finding is not surprising, given that gender differences in digital game play, including interest in digital games and motivations for play, are well established in the literature (e.g., Lucas & Sherry, 2004; Olsen, 2010; Yee, 2014). Adults higher in anthropomorphic tendencies were also more likely to attribute autonomy and psychological functioning to the virtual child. Although the current literature has focused on the role of an agent's anthropomorphic features in influencing social behavior online (see Blascovich & Bailenson, 2011 for a review), to the best of my knowledge, this is the first study to show a link between an individual's orientation towards anthropomorphic thinking and basic concepts of artificially intelligent agents. In general, this finding suggests the individuals with higher anthropomorphic tendencies might be more willing to view as virtual agent as sentient, and this could have implications for the types of experiences and relationships they might foster with such entities.

Nevertheless, despite greater attributions of psychological functioning to the virtual agent, and despite the individual differences that were associated with these attributions, adults did not attribute greater opportunities for reciprocal relationships to the virtual child relative to the doll. Instead, differences emerged in the types of unilateral relationships that were possible with a virtual child and a doll. Although adults did not think it could be possible for a doll to communicate love and secrets to them, they were more likely to view this as a possibility with a virtual child. This finding is

consistent with the idea that virtual agents are capable of responding in socially contingent ways. However, the recognition that the virtual child might be more capable of providing one side of a relationship compared to a doll did not translate into greater opportunities for both unilateral and reciprocal relationships with the virtual child. Across all of the items designed to assess different aspects of social functioning, including reciprocity, attributions to the virtual child were mostly indistinguishable from attributions to the doll. And within the subset of items designed to assess opportunities for social reciprocity, adults favored the inanimate doll as a potential relationship partner. Taken together, the results of Study 3 with adults mirror what was found among preschool age children in Studies 1 and 2. When adults differentiated between the virtual child and the doll on features of high quality friendships, the inanimate doll was viewed as a more likely relationship partner.

Summary of Study 4

In Study 3, adults attributed properties to a virtual child in ways that cut across both living and non-living kinds. They conceptualized a virtual child as a non-biological entity that might nevertheless possess the capacity to think and feel. This finding is consistent with the "new ontological category hypothesis", suggesting that artificially intelligent agents are conceptualized as simultaneously "alive and not alive" (Kahn et al., 2013; Severson & Carlson, 2010). However, 5- to 8-year-old children in Study 4 did not demonstrate ontological ambiguity in their judgments about a virtual child. Like their judgments about the doll, children conceptualized the virtual child as non-living entity who was unlikely to be able to think and feel. In addition, children viewed both the virtual child and the doll as non-autonomous entities, offering similarly high

opportunities for creative control. This finding sheds some possible light on the lack of differentiation between the virtual dog and the stuffed dog on items designed to assess agency in Studies 1 and 2. Children's failure to differentiate between the stuffed dog and the virtual dog on these items might have been driven by the overall perception that both entities could be entirely within their creative control.

As was found with adults, children in Study 4 indicated a preference for the doll on items within the social property. Overall, children attributed this property more to the doll than to the virtual child, and also indicated a preference for the doll on opportunities for reciprocal relationships. An analysis of the individual features of high quality friendships revealed a preference for the doll on items assessing love, companionship, and intimate disclosure. Children indicated that they were more likely to love a doll, more likely to tell a doll secrets and more likely to experience a reciprocal sense of companionship with the doll. This finding replicates the preference for the stuffed dog in Study 2 on items about companionship and love. Because I was not able to assess the role embodiment in Study 4, it is not possible to determine if this preference for the doll would still hold after controlling for differences in physical presence. However, the lower social attributions to the child on a video chat program relative to the real child suggests that physical embodiment might play an important role in opportunities for high quality friendships. In future research, the role of embodiment in children's concepts of these entities should be assessed.

In my original hypothesis, I had speculated that the recognition of a virtual child's ability to simulate social reciprocities would be related to attributions of psychological functioning, and that the agent's reality status would be more ambiguous than that of a

doll. However, in addition to perceiving the virtual child as non-autonomous, non-psychological entity that affords more limited social opportunities than a doll, children were unequivocal about viewing both the virtual child and the doll as entirely pretend. Although age related differences were found among the attributions of real/pretend status, these differences could be due to some of the 5-year-olds' skepticism about the reality of all four entities, including the real child and the child on a video chat program. The use of picture stimuli in Study 4 might account for some of the doubt expressed by 5-year-olds in my sample, but is consistent with other research indicating that in certain contexts, young children can doubt the reality status of real people and plausible events (Woolley & Ghossainy, 2013).

Individual differences emerged in the social opportunities attributed to the virtual child and the doll. Children who played digital games on a typical day (the majority of whom were males) were less likely to attribute psychological functioning to the doll, and more likely to attribute social opportunities to the virtual child than children who did not play digital games daily. In addition, children with past or current imaginary companions were more likely to attribute social opportunities to the doll than children who did not engage in role-play. Because the sample size was small, these findings are preliminary, but suggest that future research should investigate how familiarity and interest in different types of play is related to perceptions of these entities as social partners. For example, it is possible that children who play digital games regularly are more likely to view a virtual agent as a potential friendship partner than inanimate toys.

Nevertheless, children's overall judgments about the virtual child point to one likely conclusion: for children in Study 4, the inanimate doll was viewed as a more likely

relationship partner than the virtual child. In other words, children conceptualized the virtual child in ways to suggest that they are somewhat inferior to other inanimate toys they might play with. These findings are surprisingly consistent with those found in Studies 1 and 2 with preschool age children and Study 3 with adults. In each of the four studies presented in this dissertation, children and adults were more likely to attribute social opportunities to an inanimate artifact than they were to a virtual agent. Moreover, unilateral features of high quality friendships – love in particular – were attributed more to the inanimate artifact. Across all four studies, children and adults reported that they were more likely to love an inanimate artifact than a sophisticated virtual character. These findings have important implications about the design goals for virtual agents. Efforts to create a range of sophisticated intelligent agents that can show signs of thinking, feeling and caring for us might not translate into meaningful relationships with these entities. And this, in turn, could affect how we treat these entities, as well as the degree to which we can care for and experience companionship from them. On the other hand, there was some indication that children and adults expect that virtual agents are capable of providing social input. In Studies 3 and 4, adults and children were more likely to attribute opportunities for unilateral relationships in which the entity provides social feedback to the virtual child than to the doll. The expectation of input from virtual agents is consistent with the view of these agents as providing one directional social opportunities, such as entertainment and education.

Limitations and Future Directions

Although findings across all four studies were fairly consistent, there are alterative explanations for these results, as well as directions for future research that

warrant discussion. These include (1) the role of familiarity in child and adult concepts of virtual agents and inanimate artifacts, (2) parasocial relationships and the role parents play in shaping children's experiences with virtual agents and artifacts, and (3) how measurement issues can cloud interpretation within the four studies presented in this dissertation. Each of these limitation and future directions will be discussed in turn.

The Role of Familiarity

The consistency with which children and adults judged the inanimate artifact as the preferred entity for love, in combination with the results of individual difference analyses underscores the important role familiarity might play in the conceptualization of virtual agents and inanimate artifacts. It is likely that many – if not all – of the adults sampled in Study 3 grew up with inanimate stuffed animals and/or dolls that they loved and treated like comfort objects. And for some of these adults, their beloved childhood toys became the basis of imaginary companions that they remembered and described in the Imaginary Companions Questionnaire. Therefore, their long-term familiarity with inanimate artifacts like dolls might have influenced their judgments about the social experiences such entities could provide.

In addition, based on the most recent data available (Rideout, 2013), younger children have more limited experiences with virtual characters in apps, websites and video games, which might partially account for their preference for the stuffed dog for items about comfort, protection, and love. For these affordances, it is likely that children had more direct experience with the comfort, protection and love that is possible with stuffed animals. The wider age range of children in Study 4 was included in part to increase the likelihood that children would be more familiar with virtual agents. This

effort was largely successful; all of the children were familiar with virtual characters and one parent reported that their child had a parasocial relationship with a character in the popular video game MINECRAFT™. The increased familiarity with virtual characters might account for the ways in which children perceived the virtual child as providing them with some social feedback. Moreover, the individual differences in digital game play and role-play were associated with perceptions of both the virtual child and the doll as potential relationship partners.

As artificially intelligent agents become a more ubiquitous presence in the lives of children, it will be important in future research to more systematically unpack the roles familiarity and experience plays in children's concepts of virtual agents and the social opportunities they provide. In addition, given the lack of information currently available about the content of children's digital media experiences, it would be invaluable to examine how the content of children's experiences with virtual games, and the social experiences they have in these settings, influences their understanding of artificially intelligent agents. Finally, the nature of virtual environments is shifting increasingly away from two-dimensional screens and towards fully immersive digital experiences. As these technologies pervade American households, it will important to investigate how experiences with virtual characters in immersive environments differ from screen-based entities, as well as the extent to which differences in media platforms shape children's concepts of the entities that inhabit these digitized spaces.

The Roles of Parents and Parasocial Relationships

For young children, familiarity with virtual characters and inanimate toys is largely contingent upon the opportunities parents and other caregivers provide. Parents

generally choose the virtual characters that children will experience in apps, websites and video games. Games that closely simulate real world experiences might be off-putting for many parents of young children. For example, parents might worry that highly realistic virtual games could hamper their children's ability to differentiate real experiences from fantastical ones. Parents might also be concerned that virtual characters that simulate real world experiences might unduly influence children's behaviors, particularly for virtual games with more mature content. This might partially explain why game developers create virtual worlds for young children like those that were described by children in Study 4: digital games that focus on animals, are clearly fantastical, or feature virtual agents that have cartoonish features.

Given the range of experiences described by children in Study 4, it is unlikely that they would have encountered humanoid agents like the ones I used in the Child Properties Task. Therefore, it is likely that children attributed properties to the virtual agent based on their current experiences. Consequently, it is not surprising that the virtual child was perceived as a pretend entity. In future research, it would be interesting to examine the extent to which direct exposure with sophisticated humanoid agents, such as the "peer tutors" developed by Cassell and colleagues (e.g., Yu et al., 2013; Zhao et al., 2014), might influence the properties children attribute to such entities.

Parents might also provide some insight into the ontological status of virtual agents through the conversations they have with their children about these entities. For example, parents might encourage young children to think of virtual agents as pretend entities that are not capable of thinking, feeling, and acting on their own. However, a recent study by Jipson and Gelman (2016) indicates that parent testimony might actually

scaffold ambiguities in children's judgments about artificially intelligent entities. In this study, parents spoke to their 3- and 5-year-old children about a robotic dog in ways that were similar to both a living animal (e.g., psychological and sensory properties) and an inanimate toy (e.g., breakable). Moreover, these conversations had the greatest influence on children's intuitions about unobservable properties (e.g., psychological and sensory properties). Finally, across biological, psychological, sensory and artifact properties, children's talk about the robotic dog closely mirrored that of their parents. Future research should examine the ways in which parents talk to their children about artificial intelligence and virtual agents, and how these conversations might shape children's intuitions about these entities.

In addition to scaffolding children's knowledge about personified technologies, it is likely that parents influence children's interest in pretend play with inanimate toys. Because parents today grew up playing with dolls and stuffed animals (and not sophisticated personified technologies), they might be more likely to encourage play with stuffed animals and dolls than with virtual characters in digital games. This in turn could shape children's thoughts about virtual characters, and the properties they attribute to them. In Study 4, parental attitudes toward media use were not associated with children's responses on the Child Properties Task. However, this could be due restricted sample size and the wide age range assessed in Study 4. Future research should consider the ways in which parental attitudes and encouragement shapes children's intuitions about personified technologies.

Some of this research is already underway. Recent work has shown that parents play an important role in shaping children's relationships with beloved media characters

from other media platforms, such as television and film. For example, Bond and Calvert (2014) found that parental encouragement (e.g., desiring children to form relationship with the media character), in combination with repeated media exposure and toy engagement were predictive of the development of children's parasocial relationships. Given that many characters featured in movies and television programs now also appear in popular apps, websites and video games, it is likely children would experience these socially relevant virtual characters in ways that are different from more generic virtual agents (Blascovich & Bailenson, 2011). A number of studies have shown that children are more likely to trust and to learn from socially relevant television characters than they are from unfamiliar characters (Lauricella et al., 2011; Schlesinger, Flynn, & Richert, 2016).

Interactions with beloved media characters embodied as sophisticated virtual characters could have a profound impact on children concepts of these entities, as well as their perceptions of the social affordances they provide. This might be particularly true for applied contexts, in which virtual agents are designed to train academic and/or social skills. Indeed, both adults in Study 3 and children in Study 4 recognized that even a generic virtual child had some capacity to provide social feedback, suggesting that they might recognize some opportunities for learning from these entities.

Nevertheless I suspect that socially relevant media characters might not have a lasting impact on children's lives in the ways that both real and imaginary friendships can have. The typical parasocial relationship lasts about two years, and parasocial "breakup" commonly occurs because children outgrow the media character (Bond & Calvert, 2014). Friendships, both real and imagined, can last throughout childhood, and both real and

imaginary friends can grow with children. In future research, it would be worthwhile to investigate how children's concepts of a socially relevant virtual agent differs from a generic one, and the ways in which this might impact an agents' influence on children's learning and behaviors. It would also be interesting to examine if parasocial breakup with media characters degrades their perceptions of these entities, and if this in turn could have deleterious effects on their ability to learn from these characters.

Measurement Issues

In addition to the ways in which familiarity, parental influence and limited social relevance might have influenced child and adult judgments about virtual agents, the development of the properties used in all four studies presented some interpretive challenges that warrant caution. In Studies 1 and 2, many of items that were primarily designed to capture friendship features were also rated by an adult sample as highly correlated with agency (the ability to move and act independently). Therefore, for many items, interpretation was somewhat difficult. Study 3 was designed to address some of the difficulties we experienced in Studies 1 and 2; however similar problems emerged, particularly for items designed to assess autonomy and psychological functioning. Although adult attributions to the real child and the child on a video chat program were largely consistent with my expectations, the interpretation of any one item was problematic. For example, the item "S/he can listen to what you say" was designed to assess psychological functioning, but could also be interpreted as an item about perceptual abilities (e.g., "S/he can hear").

In addition, some of the items were interpreted in ways that I had not expected. In Study 3 with adults, none of the items designed to assess embodiment were attributed in

ways consistent enough for use in Study 4 with children. Adults largely treated the child on a video chat program as disembodied, perhaps due to the location cues I presented in the vignette. If the child had been described without cues to location, the attribution of this property to the child on a video chat program might have been different. In addition, some adult participants showed evidence of over-interpreting a given item, particularly for those assessing autonomy and creative control. Because the target entities were all children, some adults believed both the real child and the child on a video chat program had more limited abilities to move about freely -- perhaps because children are not adults who can say and do as they please.

Some children in Study 4 also interpreted items in ways that were unexpected. For example, for the item "S/he can do things when you are not around", one 6-year-old girl indicated, "probably yes" for the virtual child and doll. She spontaneously justified her response by explaining that her younger brother could play with both the virtual child and the doll when she was not around, so in her mind, it was likely that both entities would be able to do things without her. This justification makes intuitive sense, although it was not how I had intended the item to be interpreted.

In addition to the difficultly in interpreting individual items, developing a means to capture social reciprocity was challenging. For Studies 3 and 4, I developed bi-directional features of high quality friendships that were operationalized in two ways. The first was to code attributions on these items into relationship types (no relationship, unilateral, and reciprocal). However, this categorical approach loses information and might mischaracterize the perceived nature of at least some of the relationships when participant's responses are close to the category boundaries. A second approach was to

create a relationship composite score, where the possibility for relationships was measured on a continuum. Although this method was able to capture the degree to which children and adults thought a relationship was possible with each of the four target entities, it did not clearly capture their concepts of social reciprocity. These issues could potentially be address in future research, using a combination of behavioral measures in which behavioral reciprocities are coded, as well as property attribution measures, much like those used in this research and elsewhere in the literature (e.g., Jipson & Gelman, 2016).

Overall, the measurement issues present within each of the four studies warrants caution in interpretation, and these findings should be replicated in future studies with larger and more representative samples. However, the overall consistency with which children and adults attributed items across all four studies in this dissertation research provides some confidence in my interpretation of the items and in my overall findings.

Final Comments

According to Blascovich and Bailenson (2011), "the shift to an ever more virtual world – of which the Internet was only one step – may be something close to inevitable" (pp. 8). Although virtual agents have been present in children toys for several decades (e.g., "Simon Says®" and Speak and Spell®) (Turkle, 2011), children now spend more time with digital media than they spend in school; time spent in these virtual realities is usurped only by sleep (American Academy of Pediatrics, 2013). And recent advances in AI have lead to the creation of new, sophisticated types of virtual entities that serve a functionally different purpose from the toys of previous generations. According to Turkle

(2011), the goals for synthetic agents have shifted from building knowledge or helping children practice skills to providing companionship.

Studies with social robots suggest that children attribute at least some features of real-life friendships to imaginary others. With advances in the programming of social reciprocities in virtual agents, children might increasingly view virtual agents as potential friendship partners. Given that friendships with real peers and imaginary companions have the capacity to influence shape children's development, it is possible that virtual agents could also impact children's lives, in ways similar to both real and imaginary friendships. Indeed, intervention research suggests that virtual agents are capable of shaping short-term academic performance and social functioning (Finkelstein et al. 2012; Finkelstein et al., 2013; Milne et al., 2010).

My foray into research on children's concepts of virtual agents began seven years ago when during a phone interview about imaginary companions, an 8-year-old boy asked me, "Does an imaginary companion count if it's on a video game?" The preliminary studies described in this dissertation provide an empirical foundation for beginning to address this question. Based on the children and adults sampled in this research, the overall findings of this dissertation research suggest that virtual agents are similar to imaginary companions in many ways. For children, these entities are much like imaginary companions in that they are pretend characters that operate entirely within their creative control. However, unlike imaginary companions, virtual agents afford more limited social opportunities and are less likely to be loved by children and adults alike. These results raise important questions about the role virtual agent are intended to play in our day-to-day lives. Developers of these personified technologies are seeking to

closely simulate the social relationships we have with real people in the real world. The ultimate goal for these artificially intelligent agents is to create thinking, feeling entities with whom we can share our lives (Turkle, 2011). However, the results of these studies suggest that these efforts might be misguided. Despite the sophisticated capacity to function as social partners, children and adults appear more likely to turn to the simple, open-ended artifacts for social opportunities, and for love in particular. This raises an important, final point: Personified technologies are increasingly able to simulate real-life relationships; however, we might not need or want them.

APPENDIX A

ITEMS FOR THE ADULT PROPERTIES TASK

Autonomy (4)
Can X always interact when you want to?
Does X have a life of his/her own?
Can X do things without you?
Does X do things when you are not around?

Biological (5)
Does X breathe?
Can X sweat?
Is X alive?
Does X have a heart that beats?
Does X get hiccups?

Creative Control (4)
Do you control what X is going to say?
Do you control what X is going to do?
Do you decide what X likes and what X doesn't like?
Do you decide where X goes when s/he's not with you?

Embodiment (5)
Could you give X a hug?
Could you hold X's hand?
Could you tie X's shoe?
Could you accidentally bump into X?
Could you try on X's jacket?

Psychological (10)
Could X get his/her feelings hurt?
Could X think?
Could X pretend?
Could X tell a lie?
Could X feel lonely?
Could X make a mistake?
Does X know what s/he wants to be when s/he grows up?
Could X understand your feelings?
Could X be amused by something you said?
Could X listen to what you say?

Social (11)
Can like your more than he/she likes other people?
Could X tell you secrets?
Could you tell X secrets?

Could X keep you company?
Could you keep X company?
Could X love you?
Could you love X?
Could X protect you?
Could you protect X?
Could X help you feel better when you are sad?
Can X see you the same way you see him/her?

Definitely not	Probably not		Maybe	Probably yes		Definitely yes
0	1	2	3	4	5	6

APPENDIX B

ADULT PROPERTIES TASK INSTRUCTIONS

Instructions for adults:

In this next activity, you will be asked to make judgments about: (1) a child, (2) a child on a Skype video chat, (3) a virtual child character in a videogame, and (4) a doll. First, you will be asked to imagine a simple scenario. Next, you will be asked a series of "yes or no" questions. The responses you give are really important! We will be using your responses, along with others, to select items for a follow up study with children.

The wording of the questions is designed for children, but we are really interested in knowing what *you* think. Please take your time and read each of the questions carefully. Answer the questions based on what *you* think.

APPENDIX C

INTERPERSONAL REACTIVITY INDEX

The following statements ask about your thoughts and feelings in a variety of situations. For each statement, indicate how well it describes you by choosing the appropriate number. Read each statement carefully. Answer as honestly as you can. Thank you.

Does not describe me at all	Does not describe me	Describes me somewhat	Describes me well	Describes me very well
1	2	3	4	5

1. I daydream and fantasize, with some regularity, about things that might happen to me. (F)
2. I often have tender, concerned feelings for people less fortunate than me. (EC)
3. I sometimes find it difficult to see things from the "other guy's" point of view. * (PT)
4. Sometimes I don't feel very sorry for other people when they are having problems. * (EC)
5. I really get involved with the feelings of the characters in a novel. (F)
6. In emergency situations, I feel apprehensive and ill-at-ease. (PD)
7. I am usually objective when I watch a movie or play, and I don't often get completely caught up in it. * (F)
8. I try to look at everybody's side of a disagreement before I make a decision. (PT)
9. When I see someone being taken advantage of, I feel kind of protective towards them. (EC)
10. I sometimes feel helpless when I am in the middle of a very emotional situation. (PD)
11. I sometimes try to understand my friends better by imagining how things look from their perspective. (PT)
12. Becoming extremely involved in a good book or movie is somewhat rare for me. * (F)
13. When I see someone get hurt, I tend to remain calm.* (PD)
14. Other people's misfortunes do not usually disturb me a great deal. * (EC)
15. If I'm sure I'm right about something, I don't waste much time listening to other people's arguments. * (PT)
16. After seeing a play or movie, I have felt as though I were one of the characters. (F)
17. Being in a tense emotional situation scares me. (PD)
18. When I see someone being treated unfairly, I sometimes don't feel very much pity for them. * (EC)
19. I am usually pretty effective in dealing with emergencies. * (PD)
20. I am often quite touched by things that I see happen. (EC)
21. I believe that there are two sides to every question and try to look at them both. (PT)
22. I would describe myself as a pretty soft-hearted person. (EC)
23. When I watch a good movie, I can very easily put myself in the place of a leading character. (F)
24. I tend to lose control during emergencies. (PD)

25. When I'm upset at someone, I usually try to "put myself in his shoes" for a while. (PT)
26. When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me. (F)
27. When I see someone who badly needs help in an emergency, I go to pieces. (PD)
28. Before criticizing somebody, I try to imagine how I would feel if I were in their place. (PT)

APPENDIX D

INDIVIDUAL DIFFERENCES IN ANTHROPOMORPHISM QUESTIONNAIRE

1. To what extent is the desert lethargic?
2. To what extent is the average computer active?
3. To what extent does technology—devices and machines for manufacturing, entertainment, and productive processes (e.g., cars, computers, television sets) have intentions?*
4. To what extent does the average fish have free will?*
5. To what extent is the average cloud good-looking?
6. To what extent are pets useful?
7. To what extent does the average mountain have free will?*
8. To what extent is the average amphibian lethargic?
9. To what extent does a television set experience emotions?*
10. To what extent is the average robot good-looking?
11. To what extent does the average robot have consciousness?*
12. To what extent do cows have intentions?*
13. To what extent does a car have free will?*
14. To what extent does the ocean have consciousness?*
15. To what extent is the average camera lethargic?
16. To what extent is a river useful?
17. To what extent does the average computer have a mind of its own?*
18. To what extent is a tree active?
19. To what extent is the average kitchen appliance useful?
20. To what extent does a cheetah experience emotions?*
21. To what extent does the environment experience emotions?*
22. To what extent does the average insect have a mind of its own?*
23. To what extent does a tree have a mind of its own?*
24. To what extent is technology—devices and machines for manufacturing, entertainment, and productive processes (e.g., cars, computers, television sets)—durable?
25. To what extent is the average cat active?
26. To what extent does the wind have intentions?*
27. To what extent is the forest durable?
28. To what extent is a tortoise durable?
29. To what extent does the average reptile have consciousness?*
30. To what extent is the average dog good-looking?

Note. IDAQ items are marked by *. All items are rated on a 0 (not at all) to 10 (very much) scale.

APPENDIX E

ADULT IMAGINARY COMPANION QUESTIONNAIRE

An imaginary companion is someone who is make-believe; an imaginary person or animal that you talk to or think about a lot. Sometimes an imaginary companion is completely invisible and sometimes it is an object, like a very special stuffed animal or doll.

1. Do you currently have an imaginary companion? yes _____ no _____
   -**If yes**, is it invisible or is it an object? _____
   -**If object**, how is this stuffed animal, doll, or object different from other stuffed animals, dolls, or objects?_____
   -Please describe your imaginary companion _____

2. What about when you were younger, when you were a child? Did you have an imaginary companion then? yes _____ no _____
   -**If yes**, was it invisible or was it an object? _____
   -**If object**, how was this stuffed animal, doll, or object different from other stuffed animals, dolls, or objects?_____
   -Please describe your previous imaginary companion _____

APPENDIX F

DIGITAL TECHNOLOGIES QUESTIONNAIRE

This questionnaire is about electronic/digital games and your opinions about new technologies, such as virtual assistants (like Siri for iphone) and social robots.
This first set of questions asks about games played on any of the following devices: desktop/laptop computers, game consoles (like an Xbox), hand-held game consoles (like a Nintendo DS), video game consoles paired with headsets or simulators, apps on smartphones (like an iPhone), and apps on computer tablets (like an iPad). Please think about all of these devices as your respond to the following questions.

1. How often do you play electronic/digital games?

- ❍ Never **(1)**
- ❍ Less than once a month **(2)**
- ❍ About once a month **(3)**
- ❍ About 2 -3 times a month **(4)**
- ❍ About once a week **(5)**
- ❍ About 2 – 3 times a week (6)
- ❍ Several times a week **(7)**
- ❍ Everyday **(8)**

2. What device do you typically use to play digital games? Check all that apply.

- ❑ A TV with a game console
- ❑ A computer with a game console
- ❑ A console with a virtual headset (like Oculus Rift)
- ❑ A computer with Internet access
- ❑ A hand-held game console
- ❑ A computer tablet
- ❑ A smartphone
- ❑ Other:_____

3. What are your favorite things to do online? Check all that apply:

- ❑ Streaming TV shows, movies, or online videos (e.g., youtube)
- ❑ Participating in social networking sites (like Facebook)
- ❑ Participating in online forums (like reddit)
- ❑ Playing online videogames
- ❑ Streaming/reading online news
- ❑ Streaming/reading celebrity gossip/entertainment
- ❑ Buying and selling things (like on Etsy, Ebay)
- ❑ Conducting online research for fun (like Wikipedia)
- ❑ Other:_____

4. In 2016, fully immersive virtual games will be available for people to play at home. In other worlds, people will be able to transform their living rooms into an immersive virtual world. If this were affordable, would you be interested in purchasing and using this new technology?

- ❍ Yes
- ❍ No
- ❍ Don't know/not sure

8. Please explain your answer.

For the next set of questions, we are interested in your familiarity with online virtual worlds, including role-playing games like Final Fantasy, EverQuest, and World of Warcraft. We are also interested in your familiarity with other types of role-playing games. Finally, we are interested in your familiarity with virtual assistants, such as Siri for iPhone, and your opinions about social robots.

5. Do you currently participate in online virtual worlds, such as SecondLife, or Massively Multiplayer Online Role Playing Games (MMORPGs), like World of Warcraft or Eve Online?

- ❍ Yes **(1)**
- ❍ No **(2)**

6. How frequently do you participate in these virtual worlds/virtual games?

- ❍ Never **(1)**
- ❍ Less than once a month **(2)**
- ❍ About once a month **(3)**
- ❍ About 2 -3 times a month **(4)**
- ❍ About once a week **(5)**
- ❍ About 2 – 3 times a week (6)
- ❍ Several times a week **(7)**
- ❍ Everyday **(8)**

7. What are the names of the virtual worlds/MMORPGs where you have accounts?

8. Do you play other types of offline role-playing games, such as Dungeons and Dragons?

- ❍ Yes **(1)**
- ❍ No **(2)**

9. What offline role-playing games do you play?

10. Did you dress up for Halloween this year?

- ❍ No, I didn't
- ❍ Yes, but I didn't put much effort into my costume
- ❍ Yes, and I put some effort into my costume
- ❍ Yes, and I put a lot of effort into my costume
- ❍ Other_____

11. Do you participate in costume play/costume conventions, like Comic-Con or Star Wars conventions?

- ❍ Yes **(1)**
- ❍ No **(2)**

12. What costume play/costume conventions do you participate in?

13. Do you currently use a virtual assistant, such as Siri on an iphone or Alexa, by Amazon.com?

Yes **(1)**

No **(2)**

14. How often do you use a virtual assistant?

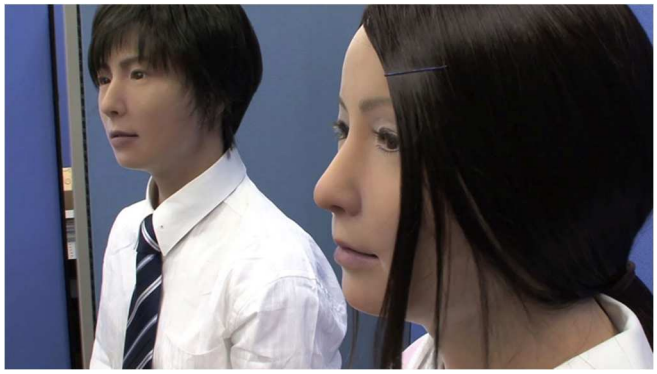
- ❍ Only one time **(1)**
- ❍ Less than once a month (2)
- ❍ About once a month **(3)**
- ❍ About once a week **(4)**
- ❍ Several times a week **(5)**
- ❍ Everyday **(6)**

15. Using the scale below, do you consider your virtual assistant a close companion or friend, with "0" indicating not at all, and "6" very much?

0	1	2	3	4	5	6
Not at all possible			Somewhat possible			Very possible

16. Please explain your answer.

17. Japanese roboticist, Hiroshi Ishiguro, has developed some of the first human-like social robots, that look and talk like us. The pictures below show two examples of these robots.



If these robots could perform household chores, such as cooking, cleaning, washing dishes and doing laundry, would you want one in your home?

- ❍ Yes
- ❍ No
- ❍ Don't know/not sure

18. Please explain your answer.

19. Using the scale below, do you think these types of robots could become close companions or friends, with "0" indicating "no, not likely", and "6" indicating "yes, likely"?

0	1	2	3	4	5	6
No, not at all possible			Somewhat possible			Very possible

20. Please explain your answer.

21. This questionnaire is a work in progress. We would greatly appreciate your feedback. Is there anything about your use of new technologies that you think is related that we did not include?

APPENDIX G

ADULT DEMOGRAPHIC QUESTIONNAIRE

What is your age?_____

What is your gender? Male Female Transgender Prefer not to respond

What is your cultural background/ Race-Ethnicity?:
□ White/Caucasian
□ Mixed race/ethnicity
□ Black/African American
□ Hispanic, Latino or Spanish
□ Asian
□ Asian Indian
□ Hawaiian Native
□ Pacific Islander
□ Middle Eastern
□ Alaskan Native or Native American
□ Other group (Please write in):_____
□ Prefer not to respond

What is the highest education level you have attained?
- □ No formal education
- □ Grade school
- □ Some high school
- □ Some college or 2-year degree
- □ Bachelor's degree
- □ Graduate degree
- □ Other (please specify) _____

What is the highest education level <u>your mother</u> has attained?
- □ No formal education
- □ Grade school
- □ Some high school
- □ Some college or 2-year degree
- □ Bachelor's degree
- □ Graduate degree
- □ Other (please specify) _____

Year in school: Freshman Sophomore Junior Senior Post Baccalaureate
Other: _____

Major: _____Minor: _____

APPENDIX H

ITEMS FOR THE CHILD PROPERTIES TASK

Autonomy/Creative Control (2)
S/he can do things when you are not around.
You can control what s/he is going to do.

Biological (2)
S/he is alive.
S/he has a heart that beats.

Psychological (3)
S/he can think.
S/he can feel lonely.
S/he can listen to what you say.

Social (7)
S/he can tell you secrets.
You can tell him/her secrets.
S/he can keep you company.
You can keep him/her company.
She can love you.
You can love him/her.
S/he can help you feel better when you are sad.

Reality Status (2)
S/he is a pretend kid.
S/he is a real kid.

Definitely not	Probably no	Probably yes	Definitely yes
0	1	2	3

APPENDIX I

CHILDREN'S MEDIA USE QUESTIONNAIRE (PARENT REPORT)

Media Use Questionnaire

This questionnaire is about your child's media use. This includes electronic media (such as computers and cell phones) and print media (such as books and magazines).

The first set of questions is about media use in your household and your child's general media use. Please think about the electronic devices and print media in your household, including any that are in your bedroom or a child's bedroom. In answering, please don't count anything that is not hooked up or is put away in storage.

1. Which of the following electronic devices and print media do you have in your household? Check all that apply:

□ TVs, DVD players (including Blu-Ray), and/or VCRs

□Desktop computers, laptop computers, and/or computer tablets (like iPad)

□Video game consoles (like Xbox), hand-held game consoles (like Nintendo DS), and/or smartphones (like an iPhone)

□Printed books, printed magazines and/or eReaders (like Kindle)

Section A. Television and Movies

The following set of questions is about TV shows, movies, and the devices your child uses to watch these programs (such as TVs, computers and video game consoles). If you do not have TVs, DVD players or VCRs in your household, AND your child DOES NOT watch TV shows or movies, please skip to Section B.

2. How many TVs do you have in your household? Please write a **number** in the space provided. _____ TVs

3. Do you have cable or satellite TV?

□ Yes

□ No

□ Not sure/Don't know

4. How many VCRs and/or DVD players (including Blu-ray) do you have in your household? Please write a **number** in the space provided.
_____ VCRs and/or DVD players

5. Approximately how many videos and/or DVDs for children do you have at home?
- ❍ None
- ❍ 1 to 10
- ❍ More than 10
- ❍ More than 50

6. Has your child ever had any "Baby Einstein" videos or DVDs like "Baby Bach" or "Baby Mozart"?
- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

7. How often does your child watch TV shows and/or movies?
- ❍ Everyday
- ❍ Several times a week
- ❍ Several times a month
- ❍ Never
- ❍ Not sure/Don't know

8. What device does your child typically use to watch TV shows and/or movies? Check all that apply.
- ❑ A TV
- ❑ A TV with a video game console
- ❑ A TV with a DVD player or Blu-ray player
- ❑ A TV with a VCR
- ❑ A desktop computer, laptop computer or computer tablet
- ❑ A smartphone
- ❑ A hand-held video game console

9. Where does your child typically watch TV shows and/or movies? Check all that apply.
- ❑ At home
- ❑ At a friend's house
- ❑ In a car, train, bus, and/or airplane
- ❑ At restaurants
- ❑ At parties
- ❑ Other _____

10. Does your child have a TV or a TV with a video player or DVD player (including Blu-ray) in his/her bedroom?

❍ Yes
❍ No
❍ Not sure/Don't know

11. (If your child does not have a TV or video player in his/her bedroom, please skip to #12) Please indicate which of the following is true of the TV in your child's bedroom. Check all that apply.

❑ It gets some cable or satellite channels
❑ It gets only regular channels
❑ It is used for watching movies or playing video games
❑ It is not currently used or not currently working

12. Please indicate which of the following your child has done by himself or herself. Check all that apply. Next to each item you check, please indicate at about what age your child first did the activity.

❑ Turned on a TV _____
❑ Changed the channels of a TV with a remote control _____
❑ Asked to watch a particular TV show, channel or movie _____
❑ Turned on a VCR, DVD, or Blu-ray player_____
❑ Put in a video or DVD into a player _____
❑ Streamed a TV show or movie on the Internet or with Netflix_____

13. Do you have any rules about your child's TV and/or movie watching? If "yes", please write in your rules in the space provided below the "yes" response.

❍ Yes

_____
_____
_____
_____
_____

❍ No
❍ Not sure/Don't know

14. How do you feel about your child's TV and/or movie watching? Please circle a number.

1	2	3	4	5
Very negative	Somewhat negative	Neither positive or negative	Somewhat positive	Very positive

15. When someone is at home in your household, how often is the TV on?
- ❍ Always
- ❍ Sometimes
- ❍ Rarely
- ❍ Never
- ❍ Not sure/Don't know

16. How often is the TV on when your family is eating meals?
- ❍ Always
- ❍ Sometimes
- ❍ Rarely
- ❍ Never
- ❍ Not sure/Don't know

17. When you have something important to do, how likely are you to put on a movie or TV show for your child to watch so that you can get it done?
- ❍ Very likely
- ❍ Somewhat likely
- ❍ Not too likely
- ❍ Not all at likely
- ❍ Not sure/Don't know

18. What is your child's favorite TV show?

19. What is your child's favorite movie?

Section B. Computers and the Internet

The following set of questions is about computers and the Internet. If you do not have desktop/laptop computers or tablets in your household, AND your child DOES NOT use these devices, please skip to Section C.

20. How many computers, laptop computers, and/or computer tablets (like an iPad) do you have in your household? Please write a **number** in the space provided.
_____ Computers

21. Does your household have Internet access?
- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

22. What type of Internet access do you have in your household?
- ❍ Dial-up
- ❍ Wireless
- ❍ High speed
- ❍ High speed wireless
- ❍ Not sure/Don't know

23. Does your child have access to the Internet in his/her bedroom?
- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

24. Does your child have any of the following at home? Check all that apply.
- ❑ A computer mouse designed especially for children
- ❑ A computer keyboard or keyboard topper designed especially for children
- ❑ A toy computer
- ❑ None of the above

25. How often does your child use the computer?
- ❍ Everyday
- ❍ Several times a week
- ❍ Several times a month
- ❍ Never
- ❍ Not sure/Don't know

26. Please indicate which of the following your child has done by himself or herself. Check all that apply. Next to each item you check, please indicate at about what age your child first did the activity.
- ❑ Turned on a computer _____
- ❑ Used a computer without sitting on a parent's lap _____
- ❑ Used a mouse to point and click _____
- ❑ Put a CD and/or DVD into a computer _____
- ❑ Asked to go to a particular website _____
- ❑ Went to a particular website _____
- ❑ Looked at websites for children _____
- ❑ Sent an email _____

27. Do you have any rules about your child's computer use? If "yes", please write in your rules in the space provided next to the "yes" response.

❍ Yes

_____
_____
_____
_____
_____

❍ No

❍ Not sure/Don't know

28. How do you feel about your child's computer use? Please circle a number.

1	2	3	4	5
Very negative	Somewhat negative	Neither positive or negative	Somewhat positive	Very positive

29. What is your child's favorite website?

Section C. Video Games

The following set of questions asks about video games played on any of the following devices: desktop/laptop computers, game consoles (like an Xbox), hand-held game consoles (like a Nintendo DS), apps on smartphones (like an iPhone), and apps on computer tablets (like an iPad). Please think about all of these devices as your respond to the following questions.

If you do not have any video game players in your household, AND your child DOES NOT play video games, please skip to Section D.

30. How many video game players do you have in your household?

_____ Video game players

31. Approximately how many video games and/or computer games does your child have at home, including any that are shared with brothers or sisters?

- ❍ None
- ❍ 1 to 10
- ❍ More than 10
- ❍ More than 50

32. Does your child have a video game player in his/her bedroom?

- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

33. How often does your child play video/computer games?

- ❍ Everyday
- ❍ Several times a week
- ❍ Several times a month
- ❍ Never
- ❍ Not sure/Don't know

34. What device does your child typically use to play video/computer games? Check all that apply.

- ☐ A TV with a game console
- ☐ A computer with a game console
- ☐ A hand-held game console
- ☐ A computer tablet
- ☐ A smartphone

35. Where does your child typically play video/computer games? Check all that apply.

- ☐ At home
- ☐ At a friend's house
- ☐ In a car, train, bus, and/or airplane
- ☐ At restaurants
- ☐ At parties
- ☐ Other _____

36. Please indicate which of the following your child has done by himself or herself. Check all that apply. Next to each item you check, please indicate at about what age your child first did the activity.

- ❑ Turned on a smartphone/computer tablet _____
- ❑ Played a game on a smartphone/computer tablet _____
- ❑ Turned on an hand-held video game player _____
- ❑ Played a hand-held video game _____
- ❑ Turned on a video game console _____
- ❑ Played a game on a video game console _____

37. Do you have any rules about your child's video/computer game playing? If "yes", please write in your rules in the space provided next to the "yes" response.

- ❍ Yes

_____
_____
_____
_____
_____

- ❍ No
- ❍ Not sure/Don't know

38. How do you feel about your child's video/computer game playing? Please circle a number.

1	2	3	4	5
Very negative	Somewhat negative	Neither positive or negative	Somewhat positive	Very positive

39. What is your child's favorite video game?

Section D. Books, Magazines and eReaders

The following set of questions is about written media, including books, magazines, eReaders and eBooks. If you do not have any books, magazines, or eReaders in your household, AND your child DOES NOT read or IS NOT read to, please skip to Section E.

40. Approximately how many printed books do you have in your household?

- ❍ None
- ❍ 1 to 10
- ❍ More than 10
- ❍ More than 50

41. How any eReaders (like a Kindle) do you have in your household? Please write a **number** in the space provided.
_____ eReaders

42. Approximately how many electronic books (eBooks) do you have in your household?
- ❍ None
- ❍ 1 to 10
- ❍ More than 10
- ❍ More than 50

43. Approximately how many printed books for children do you have in your household?
- ❍ None
- ❍ 1 to 10
- ❍ More than 10
- ❍ More than 50

44. Approximately how many eBooks for children do you have in your household?
- ❍ None
- ❍ 1 to 10
- ❍ More than 10
- ❍ More than 50

45. Does your household subscribe to any newspapers or magazines- printed and/or electronic?
- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

46. What newspapers or magazines - printed or electronic - does your household currently subscribe to?

47. Does your child know how to read?
- ❍ Yes (please indicate the age they first learned to read) _____
- ❍ No
- ❍ Not sure/Don't know

48. How often does your child read a book alone or with someone else?

- ❍ Everyday
- ❍ Several times a week
- ❍ Several times a month
- ❍ Never
- ❍ Not sure/Don't know

49. When your child reads alone or with someone else, what type of book is typically used?

- ❍ A printed book
- ❍ An eBook
- ❍ Not sure/Don't know

50. Do you have any rules about your child's reading activities? If "yes", please write in your rules in the space provided next to the "yes" response.

- ❍ Yes

_____
_____
_____
_____
_____

- ❍ No
- ❍ Not sure/Don't know

51. How do you feel about your child's reading activities? Please circle a number.

1	2	3	4	5
Very negative	Somewhat negative	Neither positive or negative	Somewhat positive	Very positive

<u>Section E. Media Use on a Typical Day</u>

This next set of questions is about your child's typical media use. For the following questions, please think about what your child did yesterday. If yesterday was not a typical day, please think back to the last day you and your child followed your typical routine.

52. Did your child spend any time doing the following activities on that day?

- ❑ Watching TV shows or movies
- ❑ Playing computer games and/or video games
- ❑ Using a computer for something other than games
- ❑ Reading or being read to
- ❑ Playing inside with toys
- ❑ Playing outside with toys

53. (***If your child did not watch TV or movies, please skip to #56***) How much time did your child spend watching TV shows or movies?

- ❑ Less than 1 hour
- ❑ 1 hour – 2 hours
- ❑ 2 hours – 3 hours
- ❑ 3 hours – 4 hours
- ❑ 4 or more hours

54. For most of the time your child was watching TV shows and/or movies, did your child do any of that in their bedroom?

- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

55. For most of the time your child was watching TV shows and/or movies, was someone else also watching, or was your child doing this alone?

- ❍ Mostly watched with someone else
- ❍ Mostly watched alone
- ❍ Not sure/Don't know

56. (***If your child did not play computer games or video games, please skip to #59***) How much time did your child spend playing computer games or video games?

- ❑ Less than 1 hour
- ❑ 1 hour – 2 hours
- ❑ 2 hours – 3 hours
- ❑ 3 hours – 4 hours
- ❑ 4 or more hours

57. For most of the time your child was playing computer games or video games, did your child do any of that in their bedroom?

- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

58. For most of the time your child was playing computer games or video games, was someone else playing with your child, or was your child doing this alone?

- ❍ Mostly played with someone else
- ❍ Mostly played alone
- ❍ Not sure/Don't know

59. (***If your child did not use a computer for something other than games, please skip to #62***) How much time did your child spend using a computer for something other than games?

- ❑ Less than 1 hour
- ❑ 1 hour – 2 hours
- ❑ 2 hours – 3 hours
- ❑ 3 hours – 4 hours
- ❑ 4 or more hours

60. For most of the time your child was using the computer for something other than games, did your child do any of that in their bedroom?

- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

61. For most of the time your child was using the computer for something other than games, was someone else using the computer with your child, or was your child doing this alone?

- ❍ Mostly used the computer with someone else
- ❍ Mostly used the computer alone
- ❍ Not sure/Don't know

Section F. Video Chat Programs and Virtual Worlds

For the next set of questions, we are interested in your child's familiarity with video chat programs, like Skype or FaceTime. We are also interested in whether your child is a member of an online virtual world.

62. Has your child ever chatted with someone on a video chat program, like Skype or FaceTime?

- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

63. How frequently does your child use a video chat program like Skype or FaceTime?

- ❍ Not sure/Don't know
- ❍ Only one time
- ❍ About once a month
- ❍ About once a week
- ❍ Several times a week
- ❍ Everyday

64. Does your child currently have a membership account in a virtual world for kids, like ClubPenguin?

- ❍ Yes
- ❍ No
- ❍ Not sure/Don't know

64. (***If your child does not have a membership account in a virtual world for kids, please skip to #66***) What is the name of the website where your child has an account?

65. How frequently does your child play in an online virtual world for kids?

- ❍ Not sure/Don't know
- ❍ Only one time
- ❍ About once a month
- ❍ About once a week
- ❍ Several times a week
- ❍ Everyday

66. This questionnaire is a work in progress. We would greatly appreciate your feedback. Is there anything you would like to tell us about your child's media use that we did not include?

Thank you!! Your participation is greatly appreciated!

APPENDIX J

PARASOCIAL RELATIONSHIPS QUESTIONNAIRE (PARENT REPORT)

Parasocial Relationships Questionnaire

Many children have a favorite media character, such as Daniel Tiger from "Daniel Tiger's Neighborhood", Hans Solo, from "Star Wars", or Hannah Montana from the Hannah Montana show. Children might watch a TV show, movie or read a book that features their favortie media character. They might have stuffed animals or toys that represent their favorite media character. Children might also play videogames or apps that feature their favorite media character, and wear clothing with pictures of their favorite media character.

1. Does your child currently have a favortie media character? yes _____ no _____

If no, did your child have a favorite media character in the past? yes _____ no _____

If your child has **never** had a favorite media character, please skip all of the remaining questions.

If your child has **ever** had a favorite media character, please continue.

Description of media character:

2. What is the name of your child's favorite media character?_____

3. Is it a person _____, an animal (what kind?) _____, or something else (please describe)_____?

4. Is the media character a male _____ a female _____ or are you not sure _____?

5. How did your child first develop an interest in this media character (in other words, how did your child learn about this media character)?

6. Does your child own a stuffed animal/or toy of this media character? yes _____ no _____

7. Does your child play videogames or apps that feature this media character? yes _____no _____

8. Does your child have clothing, bedding, and/or other household items that feature their favorite media character? yes _____no _____

9. How do you feel about your child having a favorite media character?

very positive _____ comfortable _____ uncomfortable _____

Why do you feel this way?

_____

Additional comments:

Feelings, beliefs, and experiences of a favortie media character:

You will now see statements that describe children's feelings, beliefs and experiences of their favorite media characters. Please tell us how well each statement describes your child. Please read each statement and decide whether you "Agree" or "Disagree" with description of your child's feelings, beliefs and experiences of his/her favorite media character. Use the following scale to indicate how much you agree with each statement:

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

Please be sure to circle a number for each item. Thank you very much!

10. My child knows that this favorite media character is not real.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

11. This favorite media character makes my child feel safe.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

12. My child believes that this favorite media character has needs.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

13. My child gets sad when this favorite media character gets sad or makes a mistake.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

14. My child thinks that this favorite media character has thoughts and emotions.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

15. When my child's favorite media character acts out a behavior on screen (like dancing, singing, or playing a game), my child believes that the character is performing the behavior in real life.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

16. My child believes that this favorite media character has wants.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

17. My child believes that this favorite media character is real.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

18. My child trusts this favorite media character.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

19. The voice of this favorite media character soothes my child.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

20. This favorite media character makes my child feel comfortable.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

21. My child treats this favorite media character as a friend.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree

Thank you very much!

APPENDIX K

PARENT ROLE-PLAY QUESTIONNAIRE

PARENT ROLE-PLAY QUESTIONNAIRE

Please fill out following information about yourself:

1. Gender ___ male ___ female 2. Age _____

3. Your relationship to child:
___ Mother
___ Father ___ Other (please indicate relationship) _____

4. Education level (please check highest level attained):
___ No formal education
___ Grade school
___ Some high school
___ Some college or 2-year degree
___ Bachelor's degree
___ Graduate degree
___ Other (please specify) _____

5. Religion _____

6. Marital status: (Please check one)
___ Married ___ Single
___ Divorced ___ Separated
___ Other (Please specify) _____

7. Occupation (self)_____ (spouse)_____

8. What is (are) the age and gender of your child(ren)?
(M/ F)_____ (M/ F) _____
(M/ F)_____ (M/ F) _____

9. Who looks after your child(ren) when they are not in school? _____

10. Your cultural background/ Race-Ethnicity (check all that apply)
___ White/Caucasian ___ Black/African American ___ Hispanic, Latino, or Spanish
___ Asian ___ Asian Indian ___ Hawaiian Native
___ Pacific Islander ___ Middle Eastern ___ Alaskan Native or Native American
__ Other group (Please write in):_____

11. Your child's cultural background/ Race-Ethnicity (check all that apply)
___ White/Caucasian ___ Black/African American ___ Hispanic, Latino, or Spanish
___ Asian ___ Asian Indian ___ Hawaiian Native
___ Pacific Islander ___ Middle Eastern ___ Alaskan Native or Native American
__ Other group (Please write in):_____

Friendships

1. Does your child have a best friend? yes _____ no _____

2. Does your child have a group of friends that s/he likes to play with?

yes _____ no _____

Imaginary companions

Many children enjoy pretending to interact with someone who is not real. For example, they might talk to an invisible character that they have created or that is based on a real person who is not actually present (e.g., a favorite cousin who lives far away). The pretend interactions might also be with a special stuffed animal or doll. For some children, this type of pretend play is frequent and the child is described as having an imaginary companion.

1. Does your child currently have an imaginary companion? yes _____ no _____

If no, did your child have an imaginary companion in the past? yes _____ no _____

If your child has **never** had an imaginary companion, please skip to Question #16.

If your child has **ever** had an imaginary companion, please continue.

Description of imaginary companion:

2. Is the imaginary companion completely invisible _____ or is it a toy _____?

If the imaginary companion is a **toy**, does your child treat the toy primarily as a comfort object (i.e., she or he carries it around and/or sleeps with it) or does she or he treat it as if it was another person (e.g., talks to it, listens to what it says, describes its life to others, etc.).

Comfort object _____ another person _____ both _____

3. What is the name(s) of the imaginary companion(s)?

_____

If your child has many, which one does he or she play with the most?

_____

4. Is it a person _____, an animal (what kind?) _____, or something else (please describe)_____?

5. Is the imaginary companion a male _____ a female _____ or are you not sure _____?

6. Does your child talk about the imaginary companion as being a particular age (e.g., 4 years old) or provide any information about its age (e.g., very old, adult, child, infant…)?

7. If the imaginary companion is **invisible**, what do you know about the physical characteristics of the imaginary companion (e.g., size, hair color, clothing)?

If the imaginary companion is a **toy**, please describe the toy:

8. What do you know about the personality and behavior of the imaginary companion (e.g., does your child describe the imaginary companion as being funny, shy…)?

9. Can the imaginary companion do anything special (e.g., fly)?

Types of activities with imaginary companion:

10a. Some parents directly observe their child talking to or interacting with the imaginary companion. Other parents learn about the imaginary companion indirectly – their child tells them about what the imaginary companion is like and what it is doing.

Do you see your child interacting with the imaginary companion? yes _____ no _____

Does your child tell you about the imaginary companion? yes _____ no _____ Please describe:_____

10b. When your child is playing with the imaginary companion (please check one option):

_____ he or she is almost always alone.

_____ sometimes he or she is alone and sometimes other people are involved in the play.

_____ almost always there are other people involved in the play (who? _____ parent _____siblings _____friend)

Please describe:_____

11. Does your child make a special voice for the imaginary companion?
yes _____ no _____

Please describe:

_____

12. Does your child use the imaginary companion to escape blame (e.g., says the imaginary companion broke the vase) _____, to bargain (e.g., says the imaginary companion gets to stay up late) _____ or does she or he us the imaginary companion in other types of interactions with you? Please describe_____

Duration and frequency of activities with imaginary companion:

13. How old was your child when the imaginary companion first appeared?

_____

Were there any special circumstances that coincided with the appearance of the imaginary companion (e.g., birth of sibling, move to new place)?

_____

14. For past imaginary companions, when did your child stop playing with the imaginary companion?

_____

Were there any special circumstances that coincided with the disappearance?

_____

15. During the period in which your child had an imaginary companion, how often did your child play with or talk about the imaginary companion?

Only once or twice _____ occasionally ____ frequently ____ almost every day ____

Your reactions to the imaginary companion:

16. How do you feel about your child having an imaginary companion (if your child does not have an imaginary companion, how would you feel if he or she did)?

very positive _____ comfortable _____ uncomfortable _____

Why do you feel this way? _____

Additional comments:

Thank you very much!

APPENDIX L

BRIEF MEDIA USE INTERVIEW (CHILD REPORT)

Brief Media Use Interview

Now I'm going to ask you some questions about the things you like.

1. Do you have a favorite book (comic book/magazine)? **(If no, skip to #2)** yes _____ no _____

a. What do you like about it?

b. Do your parents have rules about the time you spend reading? yes _____ no _____

c. Do your parents like you to spend time reading? Would they like you to read more or less?

2. Do you have a favorite TV show or movie show? **(If no, skip to #3)** yes _____ no _____

a. What do you like about it?

b. Do your parents have rules about the time you spend watching TV or movies? yes _____ no _____

c. Do your parents like you to spend time watching TV shows and movies? Would they like you to watch TV and movies more or less?

3. Do you play video games- like on a TV, or computer or a phone? **(If no, skip to #5)**
yes _____ no _____

a. Do you have a favorite game? **(If no, skip to #5)** yes _____ no _____

b. Tell me about the game.

c. Do your parents have rules about the time you spend playing video games? yes _____ no _____

d. Do your parents like you to spend time playing video games? Would they like you to play video games more or less?

5. Do you have a favorite character - like from a book, TV show, movie or video game? **(If no, skip to the end)**
yes _____ no _____

a. What is this character's name?

b. Where did you learn about_____(name)? From a book, TV show, movie, videogame?

c. Tell me about_____(name).

d. Is it a person _____ animal (what kind)_____, or something else (what is it)_____?

e. Is it a boy _____ girl _____?

d. What does (name) look like?

g. Do you have a toy/stuffed animal/doll/action figure of _____(name)?
yes _____ no _____

APPENDIX M

ROLE-PLAY INTERVIEW

ROLE PLAY INTERVIEW – CHILD

Now I am going to ask you about friends.

1. Do you have a best friend? yes _____ no _____

2. Do you have a group of friends that you like to spend time with? yes _____ no _____

Now I'm going to ask you some questions about pretending. Some friends are real like the kids who live on your street, the ones you play with- like your best friend. And some friends are pretend friends. Pretend friends are ones that are make-believe, that you pretend are real.

1. Do you have a pretend friend? yes _____ no _____
If "no": Have you ever had a pretend friend? yes _____ no _____
If "no", but parent said "yes": Who is (name given by parent)?_____

2. What is/was your friend's name?_____
If many are listed: Which is the one you play with the most? _____
(At end, ask child for information about the other ICs.)

3. Was/Is your friend a toy like a stuffed animal or a doll _____, or was/is it completely pretend _____?
(**If child says "completely pretend" confirm by saying:** "It's invisible." If child says "no", ask, "Is it toy or doll?")
Invisible? yes _____ no _____ Toy or doll? yes _____no _____

4. Is it a person _____ animal (what kind)_____, or something else (what is it)_____?

5. Is it a boy _____ girl _____?

6. How old is (name of pretend friend)? _____

7. What does (name) look like?_____
_____

8. How did you meet
(name)?_____
_____

9. When you want to play with (name), how do you get him/her to show up?
_____
_____

10. When you and (name) are together, what do you like to
do?_____
_____

11. Can (name) do anything special? (**If child just says yes, ask:** Can you tell me about that?)_____
_____

12. What do you like most about
(name)?_____
_____

13. What do you not like about
(name)?_____
_____

14. Do you play with (name) a lot or not very much? A lot _____ not very much_____

(If "a lot")	almost every day_____	less than that_____
(If "not very much")	just one time_____	more than that_____

15. When you play with (name), is it just you and (name) or are other people there (e.g., mom, friend, etc.)?
_____
_____

16. Where does (name) go when s/he is not with
you?_____
_____

17. Can you tell me why (name) is your friend?

_____

_____

18. For previous pretend friends: What happened to (friend)?_____

_____

19. When did you stop playing with (friend)?_____

_____

20. Why did you stop playing with (friend)?

_____

_____

21. Would you please draw a picture of (name)?

22. (If applicable) Can you please tell me about (other ICs)?

Other notes:

REFERENCES CITED

Aboud, F. A., & Mendelson, M. J. (1996). Determinants of friendship selection and quality: Developmental perspectives. In W. M. Bukowski, A. F. Newcomb, & W. W. Hartup (Eds). *The company they keep: Friendship in childhood and adolescence*. Cambridge, UK: Cambridge University Press.

Aguiar, N. R., & Taylor, M. (2015). Children's concepts of the social affordances of a virtual dog and a stuffed dog. *Cognitive Development*, *34*, 16-27.

Ames, L. B., & Learned, J. (1946). Imaginary companions and related phenomena. *Journal of Genetic Psychology, 69*, 147-167.

Bartneck, C., Kanda, T., Ishiguro, H., & Hagita, N. (2009, September). My robotic doppelgänger-A critical look at the uncanny valley. In *Robot and Human Interactive Communication, 2009. RO-MAN 2009. The 18th IEEE International Symposium on* (pp. 269-276). IEEE.

Berndt, T. J. (1996). Exploring the effects of friendship quality on social development. In W. M. Bukowski, A. F. Newcomb, & W. W. Hartup (Eds). *The company they keep: Friendship in childhood and adolescence*. Cambridge, UK: Cambridge University Press.

Bender, L., & Vogel, B. F. (1941). Imaginary companions of children. *American Journal of Orthopsychiatry, 11*, 56-65.

Benson, R. M., & Pryor, D. B. (1973). When friends fall out: Developmental interference with the function of some imaginary companions. *Journal of American Psychoanalytic Association, 21*(3), 457-473.

Berndt, T. J. (2002). Friendship quality and social development. *Current directions in psychological science*, *11*(1), 7-10.

Berndt, T. J. (2004). Children's friendships: Shifts over a half-century in perspectives on their development and their effects. *Merrill-Palmer Quarterly*,*50*(3), 206-223.

Berndt, T. J., & Hawkins, J. A. (1991). Effects of friendship on adolescents' adjustment to junior high school. Unpublished manuscript, Purdue University, Department of Psychological Sciences, West Lafayette, IN.

Berndt, T.J., Hawkins, J.A., & Jiao, Z. (1999). Influences of friends and friendships on adjustment to junior high school. Merrill-Palmer Quarterly, 45, 13–41.

Berndt, T. J., & McCandless, M. A. (2009). Methods for investigating children's relationships with friends. In K. H. Rubin, W. M. Bukowski, & B. Laursen (Eds.). Handbook of peer interactions, relationships, and groups. New York, NY: The Guilford Press.

Berndt, T. J., & Keefe, K. (1995). Friends' influence on adolescents' adjustment to school. *Child development*, *66*(5), 1312-1329.

Bigelow, B. J. (1977). Children's friendship expectations: A cognitive-developmental study. *Child Development*, 246-253.

Bigelow, B. J., & LaGaipa, J. J. (1980). The development of friendship values and choice. *Friendship and social relations in children*, 15-44.

Blascovitch, J., & Bailenson, J. N. (2011). *Infinite reality – Avatars, eternal life, new worlds, and the dawn of the virtual revolution*. New York, NY: William Morrow.

Bonne, O., Canetti, L., Bachar, E., De-Nour, A. K., & Shalev, A. (1999). Childhood imaginary companionship and mental health in adolescences. *Child Psychiatry and Human Development, 29*(4), 277-286.

Bond, B. J., & Calvert, S. L. (2014). A model and measure of US parents' perceptions of young children's parasocial relationships. *Journal of Children and Media*, *8*(3), 286-304.

Bond, B. J., & Calvert, S. L. (2014). Parasocial breakup among young children in the United States. *Journal of Children and Media*, *8*(4), 474-490.

Bukowski, W. M., Hoza, B., & Boivin, M. (1994). Measuring friendship quality during pre-and early adolescence: The development and psychometric properties of the Friendship Qualities Scale. *Journal of social and Personal Relationships*, *11*(3), 471-484.

Carlson, S. M., Tahiroglu, D., & Taylor, M. (2008). Links between dissociation and role play in a nonclinical sample of preschool children. *Journal of Trauma & Dissociation, 9*(2)*,* 149-171

Cassell, J. (2000). *Embodied conversational agents*. MIT press.

Cassell, J., Geraghty, K., Gonzalez, B., & Borland, J. (2009). Modeling Culturally Authentic Style Shifting with Virtual Peers in Proceedings of ICMI-MLMI. Nov. 2-6, Cambridge, MA

Cauce, A. M. (1986). Social networks and social competence: Exploring the effects of early adolescent friendships. *American Journal of Community Psychology*, *14*(6), 607-628.

Cillessen, A. H. N. (2009). Sociometric methods. In K. H. Rubin, W. M. Bukowski, & B. Laursen (Eds.). Handbook of peer interactions, relationships, and groups. New York, NY: The Guilford Press.

Coetzee, H., & Shute, R. (2003). "I run faster than him because I have faster shoes": Perceptions of competence and gender role stereotyping in children's imaginary friends. *Child Study Journal, 33*(4), 257-272.

Crick, N. R., Murray-Close, D. I. A. N. N. A., Marks, P. E., & Mohajeri-Nelson, N. A. Z. A. N. I. N. (2009). Aggression and peer relationships in school-age children. *Handbook of peer interactions, relationships, and groups*, 287-302.

Cutrona, C. E., & Russell, D. W. (1987). The provisions of social relationships and adaptation to stress. *Advances in personal relationships*, *1*(1), 37-67.

Finkelstein, S., Yarzebinski, E., Vaughn, C., & Cassell, J. (2013). Modeling ethnicity into technology: Using virtual agents to understand sociolinguistic variation. In *Proceedings of NWAV 42,*, Oct 17- 20, 2013, Pittsburgh, PA

Finkelstein, S., Scherer, S., Ogan, A., Morency, L.P., & Cassell, J. (2012). Investigating the Influence of Virtual Peers as Dialect Models on Students' Prosodic Inventory. In *Proceedings of WOCCI (Workshop on Child-Computer Interfaces) at INTERSPEECH 2013*, September 14-15, 2012, Portland, OR

Fox, J., Ahn, S. J., Janssen, J., Yeykelis, L., Segovia, K., & Bailenson, J. N. (in press). Avatars versus agents: A meta-analysis quantifying the effect of agency. Human-Computer Interaction.

Freier, N. G. (2008, April). Children attribute moral standing to a personified agent. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 343-352). ACM.

Freud, A. (1968). Indications and contraindications for child analysis. *The Psychoanalytic Study of the Child, 23*, 37-46.

Furman, W. (1996). The measurement of friendship perceptions: Conceptual and methodological issues. In W. M. Bukowski, A. F. Newcomb, & W. W. Hartup (Eds). *The company they keep: Friendship in childhood and adolescence*. Cambridge, UK: Cambridge University Press.

Furman, W., & Adler, T. (1982). The friendship questionnaire. *Unpublished manuscript, University of Denver*.

Furman, W., & Bierman, K. F. (1983). Developmental changes in young children's conceptions of friendship. *Child Development, 34*, 549-556.

Furman, W., & Bierman, K. (1984). Children**'**s conceptions of friendship: A multimethod study of developmental changes. *Developmental Psychology*, 20, 925**–**931.

Furman, W., & Buhrmester, D. (1985). Children's perceptions of the personal relationships in their social networks. *Developmental Psychology*, 21(6), 1016 – 1024.

Furman, W., & Childs, M. K. (1981, April). A temporal perspective on children's friendships. Paper presented at the biennial meeting of the Society for Research in Child Development, Boston.

Furman, W., & Wehner, E. A. (1994). Romantic views: Toward a theory of adolescent romantic relationships. In R. Montemayor (Ed) *Advances in adolescent*

development, Vol. 6: Relationships in adolescence. Newbury Park, CA: Sage Publications, Inc.

Gleason, T. R. (2002). Social provisions of real and imaginary relationships in early childhood. *Developmental Psychology, 38*(6), 979-992.

Gleason, T. R. (2013). Imaginary relationships. In M. Taylor (Ed.) *The Oxford Handbook of the Development of Imagination.* New York, NY: Oxford University Press.

Gleason, T. R., & Hoffman, L. M. (2006). Concepts of real and imaginary friendships in early childhood. *Social Development, 15*(1), 128-144.

Gleason, T. R., Sebanc, A. M., & Hartup, W. W. (2000). Imaginary companions of preschool children. *Developmental Psychology, 36*(4), 419-428.

Gottman, J. (1983). How children become friends. *Monographs of the Society for Research in Child Development*, 48.

Harter, S., & Chao, C. (1992). The role of competence in children's creation of imaginary friends. *Merrill-Palmer Quarterly, 38*, 350-363.

Hartup, W. W. (1975). The origins of friendships. *Friendship and peer relations*, 11-26.

Hartup, W. W. (1992). Friendships and their developmental significance.*Childhood social development: Contemporary perspectives*, 175-205.

Hartup, W. W. (1996). The company they keep: Friendships and their developmental significance. *Child development*, *67*(1), 1-13.

Hartup, W. W., (2006). Relationships in early and middle childhood. In A. L. Vangelisti & D. Perlman (Eds.), The Cambridge Handbook of Personal Relationships, pp. 177 –190, Cambridge, England: Cambridge University Press.

Hartup, W.W. (2009). Critical issues and theoretical viewpoints. In K. H. Rubin, W. M. Bukowski, & B. Laursen (Eds.). Handbook of peer interactions, relationships, and groups. New York, NY: The Guilford Press.

Hartup, W. W., & Stevens, N. (1997). Friendships and adaptation in the life course. *Psychological bulletin*, *121*(3), 355.

Hartup, W. W., & Stevens, N. (1999). Friendships and adaptation across the life span. *Current directions in psychological science*, *8*(3), 76-79.

Hayes, D. S., Gershman, E., & Bolin, L. J. (1980). Friends and enemies: Cognitive bases for preschool children's unilateral and reciprocal relationships. *Child Development*, 1276-1279.

Hodges, E. V., Boivin, M., Vitaro, F., & Bukowski, W. M. (1999). The power of friendship: protection against an escalating cycle of peer victimization. *Developmental psychology*, *35*(1), 94.

Hoff, E. (2005). A friend living inside me: The forms and functions of imaginary companions. *Imagination, Cognition and Personality, 24,* 151-189.

Howes, C. (1983). Patterns of friendship. *Child Development*, 1041-1053.

Howes, C. (1996). The earliest friendships. *The company they keep: Friendship in childhood and adolescence*, 66-86.

Jipson, J. L., & Gelman, S. A. (2007). Robots and rodents: Children's inferences about living and nonliving kinds. *Child Development, 78*(6), 1675-1688.

Kahn, P. H., Friedman, B., Pérez-Granados, D. R., & Freier, N. G. (2006). Robotic pets in the lives of preschool children. *Interaction Studies, 7*(3), 405-436.

Kahn, P. H., Gary, H. E., & Shen, S. (2013). Children's social relationships with current and near-future robots. *Child Development Perspectives, 7*(1), 32-37.

Kahn, P. H., Jr., Kanda, T., Ishiguro, H., Freier, N. G., Severson, R. L.,Gill, B. T., et al. (2012). "Robovie, you'll have to go into the closet now": Children's social and moral relationships with a humanoid robot. *Developmental Psychology*, 48, 303–314.

Klausen, E. & Passman, R. H. (2007). Pretend companions (imaginary playmates): The emergence of a field. *The Journal of Genetic Psychology, 167*(4), 349-364.

Krcmar, M. (2010). Can social meaningfulness and repeat exposure help infants and toddler overcome the video deficit. Media Psychology, 13, 31–53.

Ladd, G. W., Kochenderfer, B. J., & Coleman, C. C. (1996). Friendship quality as a predictor of young children's early school adjustment. *Child development*,*67*(3), 1103-1118.

Lauricella, A. R., Gola, A. A. H., & Calvert, S. L. (2011). Toddlers' learning from socially meaningful video characters. *Media Psychology*, *14*(2), 216-232.

Lillard, A. S., & Kavanaugh, R. D. (2014). The contribution of symbolic skills to the development of an explicit theory of mind. *Child development*, *85*(4), 1535-1551.

Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication research*, *31*(5), 499-523.

Mauro, J. A. (1991). The friend that only I can see: A longitudinal investigation of children's imaginary companions . Unpublished doctoral dissertation, University of Oregon.

Mendelson, M. J., Aboud, F. E., & Lanthier, R. P. (1994). Kindergartners' relationships with siblings, peers, and friends. *Merrill-Palmer Quarterly (1982-)*, 416-435.

Mendelson, M. J., & Aboud, F. E. (1999). Measuring friendship quality in late adolescents and young adults: McGill Friendship Questionnaires. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, *31*(2), 130.

Milne, M., Luerssen, M. H., Lewis, T. W., Leibbrandt, R. E., & Powers, D. M. (2010, July). Development of a virtual agent based social tutor for children with autism spectrum disorders. In *Neural Networks (IJCNN), The 2010 International Joint Conference on* (pp. 1-9). IEEE.

Mori, M. (1970). Bukimi no tani [The uncanny valley]. Energy, 7(4), 33–35.

Murphy, L. B. (1962). *The widening world of childhood: Paths toward mastery.* New York: Basic Books.

Nagera, H. (1969). The imaginary companion: Its significance for ego development and conflict resolution. *The Psychoanalytic Study of the Child, 24*, 89-99.

Nass, C., Moon, Y., & Green, N. (1997). Are Machines Gender Neutral? Gender□ Stereotypic Responses to Computers With Voices. *Journal of applied social psychology*, *27*(10), 864-876.

Nass, C. I., & Yen, C. (2010). *The man who lied to his laptop: what machines teach us about human relationships*. New York, NY: Current.

Newson, J., & Newson, E. (1968). *Four years old in an urban community*. London: George Allen & Unwin.

Nowak, K. L., & Rauh, C. (2005). The influence of the avatar on online perceptions of anthropomorphism, androgyny, credibility, homophily, and attraction. *Journal of Computer□Mediated Communication*, *11*(1), 153-178.

Olsen, C. K. (2010). Children's motivations for video game play in the context of normal development. *Review of General Psychology*, 14(*2*), 180-87.

Parker, J. G., & Asher, S. R. (1993). Friendship and friendship quality in middle childhood: Links with peer group acceptance and feelings of loneliness and social dissatisfaction. *Developmental Psychology, 29,* 611-621.

Pearson, D., Rouse, H., Doswell, S., Ainsworth, C., Dawson, O., Simms, K., Edwards, L. & Faulconbridge, J. (2001). Prevalence of imaginary companions in normal child population. *Child: Care, Health and Development, 27,* 12-22.

Poulin, F., & Chan, A. (2010). Friendship stability and change in childhood and adolescence. *Developmental Review*, *30*(3), 257-272.

Rideout, V. (2013). *Zero to eight: Children's media use in America 2013.* San Francisco: Common Sense Media.

Rideout, V., Foehr, U., & Roberts, D. (2010). *Generation M2: Media in the Lives of 8- to 18-year-olds*. Menlo Park, CA. The Kaiser Family Foundation.

Rose, A. J. (2002). Co–rumination in the friendships of girls and boys. *Child development*, *73*(6), 1830-1843.

Rubin, K. H., Bowker, J. C., McDonald, K. L., & Menzer, M. (2013). Peer relationships in childhood. In P. D. Zelazo (Ed.) The Oxford *Handbook of Developmental Psychology*, *II* (pp. 242 – 275). Oxford, England: Oxford University Press.

Rubin, K. H., Bukowski, W. M., & Parker, J. G. (2006). Peer interactions, relationships, and groups. *Handbook of child psychology*.

Rubin, K. H., Lynch, D., Coplan, R., Rose□Krasnor, L., & Booth, C. L. (1994). "Birds of a feather…": Behavioral concordances and preferential personal attraction in children. *Child Development*, *65*(6), 1778-1785.

Sadeh, A., Hen-Gal, S., & Tikotzky, L. (2008). Young children's reactions to war related stress: A survey and assessment of an innovative intervention. *Pediatrics, 121,* 46-53.

Schaefer, C. E. (1969). Imaginary companions and creative adolescents. *Developmental Psychology, 1*(6), 747-749.

Schlesinger, M. A., Flynn, R. M., & Richert, R. A. (2016). US preschoolers' trust of and learning from media characters. *Journal of Children and Media*, 1-20.

Schmidt, M. E., & Bagwell, C. L. (2007). The protective role of friendships in overtly and relationally victimized boys and girls. *Merrill-Palmer Quarterly*,*53*(3), 439-460.

Seiffge-Krenke, I. (1997). Imaginary companions in adolescence: Sign of a deficient or positive development?. *Journal of Adolescence, 20,* 137-154.

Severson, R. L., & Carlson, S. M. (2010). Behaving as or behaving as if? Children's conceptions of personified robots and the emergence of a new ontological category. *Neural Networks*, 23, 1099-1103.

Seyama, J. I., & Nagayama, R. S. (2007). The uncanny valley: Effect of realism on the impression of artificial human faces. *Presence: Teleoperators and Virtual Environments*, *16*(4), 337-351.

Sherry, J. L. (2001). The effects of violent video games on aggression. *Human communication research*, *27*(3), 409-431.

Singer, J. L., & Singer, D. G. (1981). Television, imagination, and aggression: A study of preschoolers . Hillsdale, N.J.: Lawrence Erlbaum Associates, Publishers.

Singer, D. G. (1993). *Playing for their lives: Helping troubled children through play therapy*. New York: The Free Press.

Singer, D. G., & Singer, J. L. (1990). *The house of make-believe: Children's play and developing imagination*. Cambrige, MA: Harvard University Press.

Singer, J. L., & Streiner, B. F. (1966). Imaginative content in the dreams and fantasy play of blind and sighted children. *Perceptual and Motor Skills, 22*, 475-482.

Strasburger, V. C., Hogan, M. J., Mulligan, D. A., Ameenuddin, N., Christakis, D. A., Cross, C., ... & Moreno, M. A. (2013). Children, adolescents, and the media. *Pediatrics*, *132*(5), 958-961.

Stocker, C., & Dunn, J. (1990). Sibling relationships in childhood: Links with friendships and peer relationships. *British Journal of Developmental Psychology*, *8*(3), 227-244.

Svendsen, M. (1934). Children's imaginary companions. *Archives of Neurology and Psychiatry, 2,* 985-999.

Taylor, M., & Aguiar, N. R. (2013). How real is the imaginary? Children's capacity to gain comfort from imaginary relationships. In S. A. Gelman & M. R. Banaji (Eds.), *Navigating the social world: The early years,* Oxford University Press.

Taylor, M., & Carlson, S. M. (1997). The relation between individual differences in fantasy and theory of mind. *Child development*, *68*(3), 436-455.

Taylor, M., Carlson, S. M., Maring, B. L., Gerow, L., & Charley, C. M. (2004). The characteristics and correlates of fantasy in school-age children: Imaginary companions, impersonation, and social understanding. *Developmental Psychology, 40*(6), 1173-1187.

Taylor, M., Carlson, S. M., & Shawber, A. B. (2007). Autonomy and control in children's interactions with imaginary companions. In I. Roth (Ed.) *Imaginative Minds*. Oxford, UK: British Academy and Oxford University Press.

Taylor, M., Hulette, A. C., & Dishion, T. J. (2010). Longitudinal outcomes of young high-risk adolescents with imaginary companions. *Developmental psychology*, *46*(6), 1632.

Taylor, M., & Mannering, A. M. (2006). Of Hobbes and Harvey: The imaginary companions created by children and adults. *Play and development: Evolutionary, sociocultural, and functional perspectives*, 227-245.

Taylor, M., Sachet, A. B., Mannering, A. M., & Maring, B. L. (2013). The assessment of elaborated role-play in young children: Invisible friends, personified objects and pretend identities. Social Development, 22, 75-93.

Taylor, M., Shawber, A. B., & Mannering, A. M. (2009). Children's imaginary companions: What is it like to have an invisible friend. In K. D. Markman, W. M. P. Klein, & J. A. Suhr (Eds.) *Handbook of Imagination and Metal Simulation*. New York, NY: Psychology Press.

Tsai, Y. F. L., & Kaufman, D. M. (2009). The socioemotional effects of a computer-simulated animal on children's empathy and humane attitudes.*Journal of Educational Computing Research*, *41*(1), 103-122.

Turkle, S. (2007). Authenticity in the age of digital companions. *Interaction Studies*, *8*(3), 501-517.

Turkle, S. (2011). Alone together: Why we expect more from technology and less from each other. New York, NY: Basic Books.

Weiss, R. (1974). The provisions of social relationships. In Z. Rubin (Ed.), Doing unto others (pp. 17–26). Englewood Cliffs, NJ: Prentice-Hall.

Wetzel, C. G., & Insko, C. A. (1982). The similarity-attraction relationship: Is there an ideal one?. *Journal of Experimental Social Psychology*, *18*(3), 253-276.

Woolley, J. D. (2006). Verbal–behavioral dissociations in development. *Child Development*, *77*(6), 1539-1553.

Woolley, J. D., & E Ghossainy, M. (2013). Revisiting the fantasy–reality distinction: Children as naïve skeptics. *Child development*, *84*(5), 1496-1510.

Yee, N. (2014). *The proteus paradox: How online games and virtual worlds change us-and how they don't*. New Haven, CT: Yale University Press.

Yee, N., Bailenson, J. N., & Rickertsen, K. (2007, April). A meta-analysis of the impact of the inclusion and realism of human-like faces on user experiences in interfaces. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 1-10). ACM.

Yu, Z., Gerritsen, D., Ogan, A., Black, A., & Cassell, J.(2013). Automatic Prediction of Friendship via Multi-model Dyadic Features. In *Proceedings of the 14th annual SIGdial Meeting on Discourse and Dialogue.*Aug 22-24 2013, Metz,France.

Zhao, R., Papangelis, A., & Cassell, J. (2014). Towards a Dyadic Computational Model of Rapport Management for Human-Virtual Agent Interaction. In Bickmore,

Sidner & Marsella (Eds.) *Intelligent Virtual Agents (IVA) 2014. Lecture Notes in Computer Science Volume 8637, pp. 514-527.*