Building Meaningful Parasocial Relationships Between Toddlers and Media Characters to Teach Early Mathematical Skills

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Published online: 21 Nov 2013.

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Very young children have difficulty transferring what they view onscreen to their offscreen worlds. This study examined whether familiarizing toddlers with a character would improve toddlers' performance on a subsequent seriation task. Toddlers were randomly assigned to one of three conditions: (1) a familiarized character condition where toddlers viewed character-based videos and engaged in character-based play over a 3-month period before viewing the seriation video demonstration; (2) an unfamiliarized character condition where the toddler only saw the seriation video demonstration; and (3) a no-exposure control group where the toddler did not see the seriation video demonstration or have any involvement with the character. All toddlers were tested on the same seriation task at age 21 months, with the familiarized character group beginning the study at age 18 months and the

> *other groups participating only at age 21 months. Toddlers in the familiarized character condition, but not the unfamiliarized character condition, completed the seriation task significantly better than the no-exposure control group. Within the familiarized character condition, toddlers who nurtured the character during play subsequently had higher seriation scores. The results suggest that meaningful relationships with media characters can help toddlers learn early mathematical skills.*

Infants and toddlers in the United States are exposed to screen-based media approximately 1–2 hours per day (Common Sense Media, 2011), yet they experience a video deficit in which they learn better from a live presentation than from a video presentation (e.g., Anderson & Pempek, 2005; Barr & Hayne, 1999; Kuhl, Tsao, & Liu, 2003; Schmitt & Anderson, 2002; Troseth & DeLoache, 1998). Children may not learn well from videos, in part, because these presentations lack social relevance to children, with onscreen people and characters who: a) are unable to reply with a reciprocal, *contingent interaction* to a child's actions, which is one definition of interactivity (O'Doherty et al., 2011), or b) lack *social meaning* for the child (Krcmar, 2010).

Research, however, has failed to use a consistent definition of the term *interactivity*. For example, some research has examined interactivity as a contingent reply to children's actions through the use of technological tools, such as closed circuit television, that enable the onscreen adults to address the children by name and to respond to them in real time. Experiences with onscreen characters who respond contingently to the viewers eliminate the video deficit effect in young children (Nielsen, Simcock, & Jenkins, 2008; Troseth, Saylor, & Archer, 2006). However, Rafaeli and Ariel (2007) define interactivity more broadly as being a perception of an interaction, including *parasocial interactions* in which a viewer treats an onscreen character as if they are in a two-way conversation.

Meaningful relationships (see Lauricella, Gola, & Calvert, 2011) vary for each person, but children's mothers are a clear example of a meaningful social relationship for youngsters. Not surprisingly, children learned better from onscreen presentations by their mothers than by strangers, even if both individuals responded contingently to their actions (Krcmar, 2010), perhaps because mothers are not only familiar to their children, but are also someone children have learned from in the past. Today, media characters also become familiar figures to children, as they are featured on multiple types of screens as well as in other environments through toys and branded foods. As a result, media characters also can become meaningful social partners to children through what is known as a *parasocial relationship*. Hoffner (2008) defined a parasocial relationship as an emotionally tinged relationship between a person and a media character. In general, parasocial relationships fill some of

the same emotional needs as social relationships in face-to-face interactions (Hoffner, 2008). Little is known about how these relationships impact early development, but toddlers do learn from onscreen meaningful characters more so than non-meaningful characters, with those who were exposed to the non-meaningful character performing no better than a control group who did not view a demonstration (Lauricella et al., 2011). In addition, smiling during the presentation was a significant covariate for seriation performance, but calling the character by name was not (Lauricella et al., 2011).

This article explores the role of parasocial relationships in very young children's learning from media by introducing toddlers to a novel character that they view on video and a related puppet that they play with in their homes over time. We placed special importance on toddlers calling the character by name, smiling while playing with the character, and their prosocial behavior of nurturing the puppet version of the character, all of which may indicate an emotional relationship with the character (Batson, Lishner, Cook, & Sawyer, 2010). These person-oriented prosocial behaviors directed toward the character served as measures of an early parasocial relationship, which were then used to predict toddlers' learning of a subsequent seriation transfer task presented by that character onscreen.

SOCIAL CONTINGENCY AND SOCIAL MEANINGFULNESS

Media researchers have long demonstrated that there is a social component to learning (Bandura, 1986, 1997; Bandura & Huston, 1961; Horton & Wohl, 1956), but it has been conceptualized and measured in different ways. One approach has been viewer imitation of a role model's social behaviors or social interactions on video (see Bandura, 1986, 1997). Another approach has been viewer learning through parasocial interactions and parasocial relationships with characters (Hoffner, 2008; Horton & Wohl, 1956). Both theories emphasize the importance of the social meaningfulness of onscreen characters for learning to occur.

Although the terms parasocial interaction and parasocial relationship were originally used interchangeably (Horton & Wohl, 1956), these terms have now been separated conceptually to distinguish potentially one-time parasocial interactions with characters, from ongoing, meaningful relationships with media characters (i.e., parasocial relationships; Schramm & Hartmann, 2008). Parasocial interactions and parasocial relationships can overlap, but can also occur independently of one another. Building on this distinction, we define parasocial relationships as an ongoing relationship with a character that involves social meaningfulness, while parasocial interactions occur when a child replies to an onscreen character prompt that involves the perception of social contingency (Lauricella et al., 2011).

Social Contingency

Children learn by observing how media characters interact with one another (Bandura, 1986; O'Doherty et al., 2011), just as they learn by observing other people in their offscreen lives (Bandura, 1986). Social cognitive theory, the framework in which the subprocesses of observational learning occur, suggests that children acquire information through attention to, retention of, production of, and motivation to perform a model's behavior (Bandura, 1986). Preschool and primary school children learn and display prosocial and antisocial behaviors and make inferences about how characters feel (e.g., Calvert, Huston, Watkins, & Wright, 1982; Sprafkin, Liebert, & Poulos, 1975; Stein & Friedrich, 1972). In this case, learning can still occur without the illusion of social contingency between the child's behaviors and the characters' onscreen actions. Rather, children learn as spectators of others' social interactions (O'Doherty et al., 2011), thus, experiencing observational learning (Bandura, 1986).

In children's programming, parasocial interaction is simulated by having an onscreen character talk directly to the audience (Lauricella et al., 2011). Using production techniques that create the illusion of a sense of contingency between the child's and the character's actions, periodic pauses are built into the program where the character directly addresses the audience, waits for the child to reply, and then acts as if the child did reply (Lauricella et al., 2011). Fred Rogers originally pioneered this technique in *Mister Rogers' Neighborhood*, and, more recently, programs like *Blue's Clues* and *Dora the Explorer* have adopted this approach (Calvert & Wartella, 2014). During the program pauses, children initially watch quietly as the character addresses them, but children become more interactive after repeatedly viewing the program (Anderson et al., 2000), with experienced viewers verbally replying more to the character than inexperienced viewers (Crawley et al., 2002). In particular, children talk to characters as if they are having a conversation, which is thought to facilitate learning by fostering engagement with the program content through interaction with the character (Anderson et al., 2000). For example, the more that children interacted when a character asked them to do so, the better they learned the program content (Calvert, Strong, Jacobs, & Conger, 2007). Although the character's behavior is not truly responsive to children's actions, children often respond to the character and act as if they are engaging in a true interaction (Calvert, 2012).

Social Meaningfulness

Ongoing exposure to characters leads to familiarity, and some characters take on special meaning to children as exposure increases (Calvert, 2012). These characters are part of children's play as well as their viewing experiences, with parents reporting that almost 97% of children under age 6

have toys or other products (e.g., clothes) associated with a preferred media character (Rideout, Vandewater, & Wartella, 2003). When characters are part of children's everyday home experiences, they are readily available as play partners, often even more so than children's peers (Calvert, 2012). Just as some young children treat imaginary friends as if they are real (Singer & Singer, 2005), so too do they treat certain media characters as if they are real (Wright, Huston, Reitz, & Piemyat, 1994). This tendency to treat imaginary characters as if they are real makes children's play a particularly germane setting to observe parasocial relationships with media characters.

The few studies that examine children's parasocial relationships use self-report measures with older children (e.g., Hoffner, 1996). Seven- to 12-year-olds' liking of media characters (i.e., how much the children rated the character as their favorite—defined in the study as parasocial interactions) was significantly positively correlated with their perceptions that the characters were kind, helpful, and caring (Hoffner, 1996). Behaviorally, tender feelings for others are essential for actions that involve caretaking (Batson et al., 2005). Similarly, young children display their empathic feelings during play, such as when they take care of their dolls (Singer & Singer, 2005). Consequently, nurturing, prosocial behaviors directed from the child toward a character may indicate the strength of an emotionally tinged, parasocial relationship. An additional behavioral indicator of warm feelings toward individuals or characters may be smiling. Research demonstrates that toddlers were more likely to smile when the meaningful character Elmo was demonstrating an onscreen seriation task than when the unfamiliar character DoDo was doing the same exact task onscreen, indicating that toddlers had feelings about Elmo that were consistent with a parasocial relationship (Lauricella et al., 2011).

CHILDREN'S LEARNING FROM SOCIALLY MEANINGFUL CHARACTERS

The social meaningfulness of a character is associated with children's increased learning. When compared to children who were unfamiliar with *Blue's Clues*, familiar viewers improved over time in general problem solving skills, flexible thinking, pattern perception, and prosocial behavior (Anderson et al., 2000). Preschool-aged girls reported that they really liked the female character Dora from *Dora the Explorer*; those who liked Dora more also performed better at a divergent task that Dora had modeled onscreen than those who liked her less (Calvert et al., 2007). Even toddlers learned seriation skills better from observing the meaningful character Elmo demonstrate the task than they did from an unfamiliar character (Lauricella et al., 2011).

Because children treat toy characters as if they are real people during symbolic play (Singer & Singer, 2005), playing with characters after viewing

them onscreen may provide a bridge between the symbolic world of television and offscreen settings. Initial studies of *Sesame Street*, for instance, found that preschool-aged children who were encouraged to view *Sesame Street* and who received promotional materials learned more than children who were not encouraged to view the program (Ball & Bogatz, 1970). Similarly, preschool-aged children demonstrated more prosocial behaviors after viewing the television program *Mister Rogers' Neighborhood* when exposure was followed by puppet play with an adult who helped children rehearse the prosocial program themes than when children did not engage in program-related puppet play (Friedrich & Stein, 1975). However, 4- to 6-year-old children only named letters slightly better when they had supplemental versus no supplemental classroom materials after viewing *Between the Lions*, and there were no significant differences on early literacy, sound fluency, and nursery rhyme awareness scores as a function of classroom supplemental materials (Piotrowski, Jennings, & Linebarger, 2012). Thus, materials and experiences as supplements to videos are differentially useful for children's learning.

Media-based character toy play and exposure to videos of specific characters may provide insight about how early parasocial relationships emerge through familiarity and become meaningful to some children as exposure increases. Calling a character by name (Calvert, 2002; Lauricella et al., 2011) and engaging in nurturant, prosocial behaviors such as care-taking activities (e.g., giving a character a bath, feeding the character, tucking the character in for a nap) are behaviors that may attribute personhood to a character. In this study, we examined prosocial-directed behaviors and other person-directed behaviors, such as calling a character by name, as an indicator of an emotional parasocial relationship.

SERIATION: AN EARLY MATHEMATICAL SKILL

In 2009, 15-year-old U.S. students' average mathematical literacy scores were below the average score of students in 34 Organization for Economic Co-operation and Development countries, which represent the world's most advanced economies (U.S. Department of Education, 2011a). Just two years later, the U.S. average mathematics score for fourth graders was higher than the international average but was still below eight other international education systems including systems in Singapore, China, and Japan (Provasnik et al., 2012). In his State of the Union address, President Obama argued that a key challenge that our nation faces is to innovate and educate our children so that we can compete with the rest of the world for jobs (U.S. Department of Education, 2011b). STEM- (science, technology, engineering, and mathematics) related professions are the fastest growing occupations, and college students with STEM majors become well-paid employees (U.S.

Department of Education, 2011b). Therefore, a challenge that our nation faces is to teach STEM skills to our students.

Piagetian tasks, which have long been used to assess the development of children's logico-mathematical skills (Flavell, 1963; Piaget, 1954), are foundational to more advanced math skills (Kroesbergen & Van Luit, 2003). In one Piagetian task, seriation, objects are ordered by underlying conceptual properties, such as size (Flavell, 1963; Piaget, 1954; Siegel, 1972). Understanding numerical systems involves an understanding of ordered relationships in which more than two objects are compared at a time, such as knowing that four objects involve one more object than three objects and that three objects have one more object than two objects (Kirova & Bhargava, 2002). Put another way, number systems involve an understanding of relative as well as absolute amounts, and seriation provides a foundation for this kind of understanding (Flavell, 1963; Piaget, 1954).

Meta-analyses of mathematics interventions with elementary school children who have special needs indicate beneficial effects for mathematics interventions that teach Piagetian skills, such as seriation, when compared to other interventions or to control groups (Kroesbergen & Van Luit, 2003). Therefore, teaching young children seriation skills moves our nation forward in preparing them for school entry and subsequent mastery of more complex mathematical tasks. Because young children often view television and video content, developing ways to teach children seriation lessons from their favorite characters is a desirable, as well as a feasible, approach for improving early STEM skills (e.g., Lauricella et al., 2011).

THE PRESENT STUDY

The purpose of this study was to examine whether three months of familiarizing toddlers with a novel media character improves their subsequent performance on a seriation task after observing the character perform that task onscreen. The seriation performance of toddlers in the familiarized meaningful character condition was compared to toddlers in an unfamliarized condition who had no prior exposure to the character before observing him in the seriation video and to a control group who did not view the seriation video demonstration or have any exposure to the character. The performance of toddlers in the unfamiliarized condition was also compared to the no-exposure control group. All seriation sessions took place in children's homes.

For the familiarized condition only, we examined how toddlers played with the characters during periodic play sessions over a three-month period to create an index of the strength of their parasocial relationships with the character. More specifically, the strength of a parasocial relationship was measured by examining emotional, socially directed behaviors during play

in which children smiled and acted as if the character was a person, as indicated by interacting with the toy character in prosocial nurturant ways and calling him by name. The more smiling, naming, and emotional nurturing behaviors that children demonstrated toward the character during toy play, the more children were expected to learn from that character onscreen in the subsequent seriation transfer task.

The specific hypotheses were that:

H1: After viewing the video of the character performing the seriation demonstration, toddlers in the familiarized meaningful character condition will seriate the cups better than toddlers in the unfamiliarized condition and those in the no-exposure control group.

H2: For children in the familiarized meaningful character condition only, playtime behaviors indicative of a meaningful parasocial relationship with the character (smiling, calling him by name, and engaging in prosocial nurturing behaviors with the character during playtime) will positively predict their seriation scores.

METHOD

Participants

Forty-eight toddlers (22 males) were randomly assigned to one of three conditions: a familiarized meaningful character, an unfamiliar character, or a no-exposure control condition. Participants were predominately Caucasian ($n = 36$), but also included Asian American ($n = 1$), African American ($n = 1$), Hispanic ($n = 1$), and other or mixed ethnicity ($n = 9$) children. Parents' years of education ranged from 12 to 25 years ($M = 17.87$, $SD = 2.40$): 62% had a Master's degree or higher. Toddlers in the familiarized meaningful character condition ($n = 16$; 7 males) began participating in the study when they were 18 months old ($M = 561$ days, $SD = 10.61$ days) and were observed three times across a three-month period.[1] Toddlers in the unfamiliar character condition ($n = 16$; 7 males) and the no-exposure control group ($n = 16$; 8 males) were seen once when they were 21 months old ($M = 651$ days, $SD = 8.84$ days).

Materials

DoDo toys and DVD. When toddlers in the familiarized meaningful character condition were 18 months old, two research assistants visited them in their homes and introduced them to a popular Taiwanese television character named DoDo, a character that looks like a kangaroo and is unknown to children in the United States. At this first visit, the toddlers were given

a familiarization DVD that was 12 minutes long and comprised of six 2-minute animated clips of DoDo eating breakfast, having a birthday party, eating a snack, playing in the rain, drawing, and taking care of his toy bear. The original clips used to create the DVD were in Mandarin Chinese, but were dubbed into English using a playful child-friendly voice. The DVD format portrayed the characters interacting with one another, and no attempts were made to create pseudo parasocial interactions with the child audience. Children were also given a DoDo puppet (13 cm wide, 32 cm in height), a child-sized red backpack identical to the one that DoDo carried in the DVD, and a miniature DoDo doll that could be attached to the backpack. At Visit 2, toddlers, who were then 19.5 months of age, received a DoDo coloring book and DoDo stickers.

Over a three-month period (from 18 months to 21 months of age), mothers were asked to show their toddlers the familiarization DVD, and encouraged to view it with their child at least twice a week. Mothers were also asked to have their toddlers play with the DoDo toys, and they were encouraged to play with their toddler using the toys at least twice a week. During the three sessions when experimenters visited the toddler, parents were involved in toddler-child video viewing and toy play with the character. Parents and children were videotaped throughout all sessions. Toddlers kept the toys and DVD when the study ended.

Parent surveys. When toddlers in all three experimental groups were 21 months old, parents were asked to fill out a brief questionnaire about how long their toddlers had been exposed to media, familiarity with and feelings toward DoDo, prior experience playing with nesting cups (the target seriation transfer task used in this study), general family demographic information, and the short form of the MacArthur Communicative Development Inventory Checklist (CDI) Level II, which measured toddler's productive language skills by asking parents to check off all words from a list that their toddler had said before (Fenson et al., 2000). Parents of toddlers in the familiarized meaningful character condition completed the short form of the CDI at two time points (18 months and 21 months), but only the scores from 21 months are used in this study. CDI scores were calculated by summing the total number of words that parents indicated their children said.

Nesting cups. Five cups of varying colors (green, purple, orange, pink, and yellow) were used for the seriation task. The cups ranged in size from 3.65 cm in diameter and 6.19 cm in height to 11.75 cm in diameter and 10.32 cm in height. The same set of nesting cups was used for all video demonstrations and subsequent testing of seriation skills.

Seriation treatment video. A four-minute video of DoDo demonstrating how to seriate cups that had been created for a previous study (see Lauricella et al., 2011) was used to teach the seriation task. In this video, the DoDo puppet demonstrated how to seriate the five plastic nesting cups in order from smallest to largest two times. DoDo first showed the toddlers all five

cups nested together and said, "Look, we are going to put the cups together like this, see?" Then DoDo lined the cups up from smallest to largest while saying, "First we take the teeny tiny cup and put it here; then we put this one here; next we put this one here; then we put this cup here; and last we take the really big cup and put it here." Next DoDo put each cup inside the other. First the smallest cup (1) was placed in cup 2; then these two nested cups were placed in cup 3; then these three nested cups were placed in cup 4; and, finally, all nested cups were placed into the largest cup (5). While nesting the cups, the character said, "Now we are going to put the cups together. First we take the teeny tiny cup and put it in this one; then we take this cup and put it in this one; then we take this cup and put it in this one; and last, we take all the cups and put them in the really big cup." Toddlers were shown all five cups nested inside each other again while DoDo said, "See, we put the cups together!"

Throughout the video, DoDo used parasocial interaction techniques to address the audience by looking directly into the camera while talking to the audience (Lauricella et al., 2011). This technique gave the illusion that the character was looking right at the child when introducing himself to the audience (e.g., "Hi, my name is DoDo!"), asking the audience questions (e.g., "Will you play with DoDo?"), and giving the audience positive verbal feedback (e.g., "Thank you! You good helper!"; Lauricella et al., 2011).

Procedure

All sessions took place in children's homes. Toddlers in the familiarized meaningful character condition were observed in their home at 18, 19.5, and 21 months of age and were encouraged to play with the DoDo toys and view the DoDo DVD at home across the three months. At each visit in the familiarized meaningful character condition, the experimenter video-taped parents and their toddlers playing together with the DoDo puppet for approximately five minutes. The toddlers were also videotaped while watching the 12-minute familiarization DVD during all three sessions. There-fore, toddlers in the familiarized meaningful character condition had video attention data and play session data from three visits. During the third home visit at age 21 months, each toddler viewed the DoDo Seriation treatment video first and then completed a seriation, sequencing task. The toddlers subsequently participated in a 5-minute play session and viewed the 12-minute familiarization DVD, as was done in the previous two visits.

Children in the unfamiliarized character condition and the no-exposure control group were seen only at age 21 months, at which point they were tested on seriation skills. Participants in the unfamiliarized character condition viewed the same seriation treatment video featuring DoDo (who for them was an unfamiliar character), and then completed the seriation task.

Participants in the no-exposure control group viewed no video prior to completing the seriation task.

Seriation test session. At the 21-month-visit, toddlers in all three groups participated in the seriation test session in their home. All parents completed questionnaires and the MacArthur CDI while the child played with the experimenters until he or she felt comfortable. To control for any potential experimenter bias or any influence that a familiar experimenter might have during the testing phase of the study, a novel experimenter visited toddlers in the familiarized meaningful character condition. Toddlers in the two treatment conditions first viewed the seriation video while sitting in their parent's lap approximately two feet from a laptop computer screen.

After viewing the seriation video, the experimenter randomly placed the five separated plastic nesting stacking cups in front of the toddlers in the familiarized and the unfamiliarized conditions (see Lauricella et al., 2011). As the cups were presented, the experimenter said, "Now it's your turn to play with the cups." Children were then given two minutes to play with the cups. Toddlers in the no-exposure control group did not see the video demonstrations and were only given the five cups to play with. The toddlers were videotaped while watching the video and stacking the cups.

Coding

Seriation scores. Coding for the seriation task was consistent with an earlier study by Lauricella and colleagues (2011). Coders watched the video of the test session and recorded the order of each complete set of seriated cups, defined as the final set of cups nested together or lined up in sequential order before the toddler disassembled it.[2] A toddler did not receive credit if he or she turned a cup upside down or began stacking rather than nesting or lining up the cups (see DeLoache, Sugarman, & Brown, 1985; Lauricella et al., 2011).

All complete sets of nested cups were scored for seriation performance based on a system developed by Wright and colleagues (1984) and adapted for use by Lauricella and colleagues (2011). First, one point was awarded for each smaller cup that was placed inside or beside a larger cup. For example, cup 1 and 2 in cup 3 = 1 point (for cup 1 in cup 2) + 2 points (for cups 1 and 2 in cup 3) = 3 points. Toddlers received additional points for each cup that was in the correct sequential order. For example, cup 1 and 2 inside or beside cup 3 = 2 additional points (1 point for cup 1 in cup 2, and 1 point for cup 2 in cup 3). The total points were summed to create a seriation score (5 total points for this example). Toddlers' best seriation score during the two-minute time frame was used in later analyses. Fifty percent of the sample was double coded for reliability, yielding an intraclass correlation of $r = 1.0$.

Behaviors During Home Play Sessions

For children in the familiarized character condition, videotapes of the children's play sessions at ages 18, 19.5, and 21 months were analyzed. Research assistants coded for the frequency of behaviors in which the child and parents treated the DoDo puppet as if he were a person. These behaviors included a) engaging in prosocial nurturant behaviors directed toward DoDo and b) saying DoDo's name during the play sessions. For children, examples of prosocial nurturant behaviors included sharing juice with DoDo, laying DoDo down for a nap, and giving DoDo a bath. For parents, examples included making statements that encouraged these prosocial nurturant behaviors, (e.g., "Can DoDo have some of your juice?," "It is time for DoDo's nap," or "Go give DoDo a bath"). Smiling for parents and toddlers was also coded during the play sessions at each of the visits. For child behaviors, intraclass correlation coefficients assessing reliability for the codes were $r = 1.00$, $r = .98$, $r = .89$, respectively. For parent behaviors, intraclass correlation coefficients were $r = .99$, $r = .99$, and $r = .80$, respectively.

The toddlers' and parents' behaviors during play sessions were coded using Noldus The Observer XT 7.0 software. The number of times each of the prosocial nurturing behaviors occurred was coded by experimenters and then summed across all three play sessions to create composite scores on each item.[3] To control for slight variations in the total amount of observation time, the frequency of each behavior was divided by the total amount of time the child and parent were observed throughout the course of the study. Similarly, the proportion of time that the child was smiling was calculated by dividing the total duration of time over the three play sessions that the child was smiling by the duration of time their mouths were onscreen and not obstructed from view (e.g., the DoDo puppet or their hands were not in front of their mouths).

RESULTS

Descriptive Statistics

Table 1 presents the means and standard deviations for toddlers' raw CDI scores (for a similar analysis, see Lauricella et al., 2011), cup ownership, months of media exposure, and proportion of visual attention to the seriation video. A one-way analysis of variance (ANOVA) revealed a significant difference in children's CDI scores at 21 months of age by condition, $F(2,45) = 4.34$, $p = .02$, $\eta_p^2 = .16$. Post hoc Tukey's tests demonstrated that the toddlers in the no-exposure control condition had significantly higher scores on the expressive language measure than the toddlers in the familiarized, but not the unfamiliarized, condition. However, CDI scores were not significantly correlated with seriation scores. There were no significant differences in

TABLE 1 Means and Standard Deviations (in Parentheses) of Child Background Variables, Video Attention, and Seriation Scores

	Familiar character	Unfamiliar character	No-exposure control
CDI score (21 months)	33.75 (20.71)	45.44 (26.28)	56.56 (17.90)
Total number of months of toddlers' media exposure	8.50 (5.33)	10.57 (4.87)	12.10 (5.27)
Number of children who own cups (out of 16 in each group)	11	11	15
Proportion of visual attention to DoDo seriation video	.89 (.09)	.91 (.06)	N/A
Unadjusted best seriation score	8.81 (4.51)	7.50 (4.40)	5.44 (5.21)
Adjusted best seriation score (standard error)	9.06 (1.16)	7.75 (1.16)	4.95 (1.19)

Note. CDI scores were raw scores at 21 months. Adjusted means accounted for cup ownership.

toddlers' proportion of attention to the seriation video, prior exposure to videos or television content, or ownership of nesting cups by condition. Nevertheless, 94% of toddlers in the control group owned nesting cups compared to only 69% of those in both the familiarized and unfamiliarized conditions, which meant that the toddlers in the control group had more opportunities to play with nesting cups before seriation testing took place. Because owning nesting cups was significantly correlated with seriation scores, ownership of nesting cups was used as a covariate in subsequent analyses examining toddlers' seriation scores.

Parents reported that 100% of the toddlers in the familiarized meaningful character condition knew who DoDo was at their 21-month visit, but none of the toddlers in the no-exposure control or unfamiliarized character condition knew who he was. Over the three-month period, toddlers' exposure to DoDo varied within the familiarized meaningful character condition. Specifically, most toddlers ($n = 14$) played with DoDo toys or viewed the DoDo DVD in all or in all but one week over the three-month period. Two toddlers did not view the DVD or play with DoDo for two or three weeks of the three-month study. According to parental report at the 21-month visit, five toddlers considered DoDo their very favorite character, six toddlers liked DoDo very much, four toddlers moderately liked DoDo, and one toddler did not like DoDo.

Seriation Performance in the Three Conditions

An analysis of covariance (ANCOVA) compared toddlers' best seriation scores by the three conditions (familiarized meaningful character, unfamiliarized character, no-exposure control), controlling for whether the children owned nesting cups. The adjusted and unadjusted means and standard deviations of seriation scores by condition are presented in Table 1. The predicted main

effect of condition was marginally significant, $F(2,44) = 3.09$, $p = .056$, $\eta_p^2 = .12$. As predicted, a planned comparison revealed that toddlers in the familiarized meaningful character condition scored significantly higher on the seriation task than those in the no-exposure control group ($p = .019$), while the unfamiliarized condition did not perform significantly better on the seriation task than the control group ($p = .10$). Contrary to expectations, the familiarized condition did not perform significantly better than the unfamiliarized condition ($p = .43$). Thus, H1 was partially supported.

Seriation Performance Within the Familiarized Group

Using Pearson's correlations, the relations between toddlers' best seriation scores, and their composite play behavior scores (i.e., scores summed across all three play sessions) were examined. As predicted, toddlers' best seriation scores were positively correlated with the number of times they engaged in prosocial nurturing behaviors towards DoDo across the three play sessions ($r = .545$, $p = .029$). By contrast, toddlers' composite score of smiling across the three play sessions was not significantly correlated with seriation scores, nor was toddlers' composite score of calling DoDo by name. Thus, Hypothesis 2 was partially supported.

   Given that the composite score of prosocial nurturing behaviors was significantly correlated to toddlers' best serration scores, the composite score was entered into a linear regression as the independent variable to assess the amount of variance in seriation scores that could be explained by the frequency of children's nurturing behaviors. Nurturing playtime behavior scores significantly predicted 29.7% of the variance in seriation scores ($\beta = .55$, $p = .029$).

   Given that parents may play a role in toddlers' learning by familiarizing them with the character, we also ran Pearson product moment correlations between the toddler naming, smiling, and toddler prosocial nurturant behaviors with the comparable behaviors of their parent, as well as the correlation of these parent variables in relation to their children's seriation scores. There were no significant correlations between the targeted child and parent behaviors.

DISCUSSION

The purpose of this study was to examine whether increasing the social meaningfulness of a character positively affected 21-month-old toddlers' learning of a subsequent mathematical task after observing that character perform the task on video. In prior research, children learned better from the meaningful character Elmo than they did from the unfamiliar DoDo character, even though the characters demonstrated the same seriation task

(Lauricella et al., 2011). Unlike previous research, this study was able to examine familiarity with characters more precisely by controlling the child's length of exposure and experience with a character by using the character DoDo who was from another country and, hence, initially unfamiliar to children. Toddlers who were familiarized with a novel character for three months prior to viewing an onscreen demonstration of a transfer seriation task learned how to sequence the cups significantly better than toddlers in the control group, but those in the unfamiliar character condition did not. In other words, toddlers who had the character in their homes as a plush toy to play with and to view on DVDs were able to subsequently learn an early STEM skill from observing that character perform a seriation task on a video.

Contrary to expectations, toddlers in the familiarized character condition did not perform significantly better on the seriation task when compared to the unfamliarized character condition. Lauricella et al. (2011) demonstrated that toddlers who viewed the meaningful character Elmo seriated better than those who viewed the unfamiliar DoDo perform the same task. The most likely explanation for this discrepancy in findings is that DoDo is not Elmo, as the *Sesame Street* character is a ubiquitous presence in U.S. children's lives across multiple settings. His brand appears even on the food that many children eat and the clothes that they wear (Rideout et al., 2003). Three months of exposure to DoDo may have simply been insufficient to result in the overall popularity of Elmo, thereby diminishing the learning difference between the familiar and unfamiliar conditions of the current study.

While past studies have demonstrated that toys and encouragement in the home result in later learning (Bogatz & Ball, 1971), examination of toddlers' play with the character in the current familiarization condition provides information about what is happening behind the scenes that leads to later learning. In particular, we were able to observe toddler behaviors that may indicate a meaningful relationship had developed between the toddlers and DoDo, thereby separating familiarization per se from the strength of the child's meaningful parasocial relationship with the character. Specifically, toy play in which toddlers took care of DoDo predicted later seriation scores. These prosocial nurturing behaviors are an indicator of an emotional relationship with a character in which toddlers treat that character as a real person. Because toddlers were playing in ways that involved prosocial care taking behaviors that are often motivated by emotional feelings for others (Batson et al., 2010), the data reported here provide evidence that toddlers who formed a social and emotional parasocial relationship with DoDo, as demonstrated during play sessions, were later better able to learn from the character.

Calling the character by name during play sessions, however, was not significantly correlated with toddlers' subsequent seriation scores. Perhaps saying somebody's name is not an indicator of having a parasocial rela-

tionship with them. Indeed, research using parental questionnaires and factor analysis to assess the parasocial relationship between children ages six months to eight years and their favorite media character found that the question examining whether children called their favorite character by name did not load on the personhood factor. Instead, items such as treating the character as a friend, trusting the character, and believing the character has wants and needs comprised the personhood factor (Bond & Calvert, 2013). Thus, it seems that calling the character by name was not an accurate measure of a parasocial relationship, nor a positive predictor of toddlers' learning from the character. These findings are also consistent with prior research in which naming the character was not a significant covariate when used as a predictor of seriation scores (Lauricella et al., 2011).

Toddlers' smiling during play sessions was also unrelated to their best seriation scores. Because there were difficulties in getting a clear view of faces during toy play, the role of smiling in promoting positive affect toward the character cannot be ruled out as a way to increase performance on later cognitive tasks. Parents' promotion of prosocial nurturant behaviors with the character was also unrelated to toddlers' prosocial nurturing behavior scores or seriation scores. Thus, it appears that the establishment of meaningful relationships with characters is deeply rooted in the child's (not the parent's) nurturing play behaviors that we measured.

Although the DoDo character directly addressed toddlers using parasocial interaction techniques while demonstrating the seriation task in both the familiarized and unfamiliarized video exposure conditions, it was the prior exposure to the character in which children could play with DoDo and view him as a character on other videos in their homes that made a difference for their later learning; that is, the strength of the parasocial relationship that toddlers formed with the character, not the use of parasocial interaction techniques in the seriation videos, improved their learning from videos. This interpretation of the data is supported by a prior study in which the use of parasocial interaction techniques by a familiar and unfamiliar character did not lead to comparable learning from the character; instead, the meaningfulness of the character led to differential learning outcomes (Lauricella et al., 2011). Although the DoDo familiarization videos were noninteractive, they still demonstrated prosocial behaviors through social modeling (e.g., DoDo taking care of his toy bear). The data suggest that in this study, toddlers may have learned some of the behaviors that would lead to parasocial relationship development through observational learning of videos about DoDo performing prosocial behaviors, that is, social cognitive theory (Bandura, 1986).

Past research has shown that toddlers have difficulty transferring from two- to three-dimensional tasks across a variety of media, including books, videos, computers, and pictures (Barr, 2010). Toddlers' play with the DoDo toys may have also helped toddlers transfer the character's two-dimensional

seriation demonstration to the three-dimensional seriation cups. That is, combining two-dimensional viewing experiences with three-dimensional toy play may help toddlers make this transition, thereby improving transfer skills.

The parent behaviors during the play sessions were also examined in relation to their toddlers' play and to the toddlers' later seriation scores. Data from previous studies emphasize the important role that parents and adults can play in young children's learning from video. For example, infants were more responsive while viewing infant-directed videos when their parents asked more questions and provided more labels and descriptions during the viewing (Barr, Zack, Garcia, & Muentener, 2008), Similarly, preschoolers learned more prosocial messages after viewing the prosocial television program *Mister Rogers' Neighborhood* when adults in the viewing situation labeled the key program content (Friedrich & Stein, 1975). Three year olds also only learned verbs from video if they participated in live social interaction with an adult (Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009). Although parents were instructed not to interact with their toddlers while watching the seriation video in the current study, the parental behaviors that we coded for during play sessions did not play a significant role in influencing their toddlers' learning of seriation skills from DoDo. Future research should examine if there are other kinds of parental behaviors that we did not measure that might promote beneficial seriation outcomes.

One limitation of the current study is that the unfamiliarized character condition did not receive three months of exposure to character-based videos and a related character puppet as the participants in the familiarized meaningful character condition did. Such a design would have better controlled for possible parent involvement effects that may have occurred while watching the familiarization videos and playing with the character across the three months. Future research should address this limitation to better control for the effects of parental involvement in toddlers' learning experiences. Another direction for future research is to attempt to create meaningful relationships between toddlers and a range of media characters, including electronic toys that can respond contingently to young children's actions and convey personal information about the child during their interactions. Finally, it would be useful to disentangle character-based toy exposure from character-based video exposure in relation to the toddlers' parasocial relationships with a character.

Although the three groups were similar on prior exposure to videos or television content, the toddlers in the familiarized meaningful character group had lower language scores at age 21 months than the toddlers in the other two groups. It is possible that the parents in the familiar character group were more comfortable with the experimenters and, thus, were more honest when checking the words that their child said. Language scores,

however, were unrelated to seriation scores in this study. Furthermore, almost all of the toddlers in the control group had nesting cups, but only 69% of those in the other conditions owned nesting cups. Therefore, the control group had more opportunities to practice seriation skills before participating in the study than was true of the other conditions. This issue was addressed by using cup ownership as a covariate in the seriation analysis.

At a policy level, our data suggest that characters as toys in children's homes can play an important role in bridging the gap between the two-dimensional experience of screen presentations and the three-dimensional worlds in which children play, perhaps addressing the transfer issue that young children often face (see Barr, 2010). Although there are arguments that toy media characters promote commercialism (Linn, 2004) and even obesity (Institute of Medicine, 2006), media characters can also promote learning of educational STEM content, an area in which U.S. children lag behind children in other developed nations (U.S. Department of Education, 2011a). Toy media characters also help pay for the high cost of making children's television programs (Cahn, Kalagian, & Lyon, 2008). This study, then, finds a space where media characters can play a constructive role for child outcomes.

In conclusion, the current study examined toddlers' learning of an early mathematical concept from an onscreen character that they did not initially know. This experimental design provided control over factors unaccounted for in past research, such as potential exposure to the character in retail spaces and on television and DVDs. As expected, toddlers who had the DoDo toys and videos in their home for three months prior to viewing the seriation video, but not those who only viewed the video of DoDo performing the seriation task, learned how to sequence the cups significantly better than those in a control group who did not see a demonstration. Emotionally based prosocial nurturing behaviors that took place during play revealed that the strength of parasocial relationships between the toddlers and DoDo positively predicted their subsequent seriation performance. The data document the important role of parasocial relationships with media characters for toddlers' learning of early mathematical skills that are a foundation for their future academic success (Kroesbergen & Van Luit, 2003).

NOTES

1. One child was replaced because of excessive fussiness during testing.
2. Only one toddler lined up her cups instead of nesting them, however, and the highest of her two scores (the nesting score) was used in the seriation analyses.
3. Although the third play session occurred after seriation testing, this order was followed to keep the procedure for seriation assessment constant across all three conditions.

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