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Toddler learning from video: Effect of matched pedagogical cues

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ABSTRACT

Toddlers learn about their social world by following visual and verbal cues from adults, but they have difficulty transferring what they see in one context to another (e.g., from a screen to real life). Therefore, it is important to understand how the use of matched pedagogical cues, specifically adult eye gaze and language, influence toddlers' imitation from live and digital presentations. Fifteen- and 18-month-old toddlers (N = 123) were randomly assigned to one of four experimental conditions or a baseline control condition. The four experimental conditions differed as a function of the interactive cues (audience gaze with interactive language or object gaze with non-interactive language) and presentation type (live or video). Results indicate that toddlers' successfully imitate a task when eye gaze was directed at the object or at the audience and equally well when the task was demonstrated live or via video. All four experimental conditions performed significantly better than the baseline control, indicating learned behavior. Additionally, results demonstrate that girls attended more to the demonstrations and outperformed the boys on the imitation task. In sum, this study demonstrates that young toddlers can learn from video when the models use matched eye gaze and verbal cues, providing additional evidence for ways in which the transfer deficit effect can be ameliorated.

1. Introduction

In the late 1990's, television programs and DVDs directed towards infants and toddlers emerged (Anderson & Pempek, 2005) and reports demonstrate that children under age 2 are consistently watching nearly 2 h of screen media per day (Barr, Danziger, Hilliard, Andolina, & Ruskis, 2010; Rideout & Hamel, 2006; Rideout, 2013). Despite the amount of time with screen media, many studies have demonstrated that very young children still learn better and more quickly from a live demonstration than a video presentation (see Barr, 2013 for review). This concept was originally termed the video deficit (Anderson & Pempek, 2005). It was recently reframed as the transfer deficit effect (Barr, 2010) as a result of the research demonstrating the challenges young children face when transferring learning from one context to another (e.g., 2D to 3D) rather than strictly from a screen to a real life experience.

Given the near half-century of research that has demonstrated successful learning from educational preschool television programming (e.g., Fisch & Truglio, 2001), research has begun to evaluate which features can support infant and toddler learning from screen presentations. To date, researchers have demonstrated that social factors including character famil-

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iarity (Calvert, Richards, & Kent, 2014; Gola, Richards, Lauricella, & Calvert, 2013; Lauricella, Gola, & Calvert, 2011), social contingency (Krcmar, 2010; Troseth, Saylor, & Archer, 2006), and observation of other's social interaction (O'Doherty et al., 2011) can help infants and toddlers overcome the transfer deficit. The intent of this study is to assess the effect of interactive eye gaze and language, social features that are common in children's educational television programs (e.g., *Dora the Explorer*), on toddlers learning from a video presentation.

1.1. Infant and toddler development

One of the key ways in which infants and toddlers learn about the world around them is through social interaction with adults (Vygotsky, 1978), both verbally and through interactive cues like gaze following and pointing. While language is a key feature of social interaction and plays a powerful role in child linguistic and verbal skills (e.g., Hart & Risley, 2003), other social cues also play an influential role in development and learning. It has been well documented that by 12 months of age, infants can successfully follow an adult's eye gaze (e.g., Brooks & Meltzoff, 2005; Gredeback, Theuring, Hauf, & Kenward, 2009) and engage in joint attention (Carpenter, Nagell, & Tomasello, Butterworth, & Moore, 1998), key social cues that help direct a child's attention and support learning. Beginning in the first year of life, children learn through imitation and are good at imitating actions performed by others, even with novel objects (Barr, Dowden, & Hayne, 1996; Carpenter et al., 1998). Furthermore, research demonstrates that infants are more likely to imitate behaviors when the model uses ostensive cues, including eye gaze and child-directed speech (e.g., Brugger, Lariviere, Mumme, & Bushnell, 2007; Nielsen, 2006). The ability to perceive and utilize these social cues continues to develop during the toddler years and has a strong impact on learning from events in the real world; however, we have yet to examine how these social cues influence learning when material is presented in 2D video form.

1.2. Learning from television

While infants are quite capable of learning from social situations in the real world, there is considerable evidence that learning information from a 2D screen presentation (e.g., television) may be significantly more challenging than a live presentation, particularly for children under age 4 years (see Anderson & Pempek, 2005; Barr, 2010, 2013). More specifically, imitation of behaviors demonstrated on television is poorer for children between the ages of 12- and 42-months compared to when the actions are demonstrated live (Barr & Hayne, 1999; Dickerson, Gerhardstein, Zack, & Barr, 2013; Hayne, Herbert, & Simcock, 2003). Over the years, this transfer deficit (Barr, 2010) has been demonstrated in a range of learning tasks and a variety of contexts (e.g., Barr & Hayne, 1999; Lauricella, Pempek, Barr, & Calvert, 2010; Meltzoff, Kuhl, Movellan, & Sejnowski, 2009; Simcock & DeLoache, 2006; Zack, Barr, Gerhardstein, Dickerson, & Meltzoff, 2009), providing concern that infants and toddlers could not learn from video experiences.

Recently researchers have documented that developmental constraints on information processing contribute to the transfer deficit from media during very early childhood (for review see, Barr, 2013; Hipp et al., in press; Kirkorian, Pempek, & Choi, in press; Fisch, 2000). By the preschool years, however, children have consistently demonstrated their ability to learn from educational television programs (e.g., Anderson et al., 2000; Fisch & Truglio, 2001). A number of factors contribute to strong and consistent effects of educational media learning in preschoolers. First, content developers consider preschool development across multiple cognitive domains including attentional processing, memory capacity (both short-term and long-term), and language when developing content (Anderson, 2013; Linebarger, Brey, Fenstermacher, & Barr, in press). Second, preschoolers have accumulated extensive daily exposure to the formal features of television (e.g., scene changes involving cuts and pans; Alwitt, Anderson, Lorch, & Levin, 1980; Calvert, Huston, Watkins, & Wright, 1982.). Third, producers have systematically implemented educational curricula into preschool content (Linebarger et al., in press). These same parameters have not yet been systematically investigated for infant and toddler media.

Despite the questions remaining about *why* young children face a deficit in learning from screen media, researchers have begun to examine specific features and instances in which this transfer deficit effect can be ameliorated. Recent research demonstrates that factors related to the presentation of the media content, such as repetition (Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007), language prompts (Barr & Wyss, 2008; Barr, 2010; Seehagen & Herbert, 2010), use of closed-circuit television (Troseth, 2003a), and the meaningfulness or the social contingency of the character (Calvert et al., 2014; Gola et al., 2013; Krcmar, 2010; Lauricella et al., 2011; Troseth et al., 2006) can improve young children's learning from video. Furthermore, factors related to the child, specifically age (Barr & Hayne, 1999) and experience using television as a source of information (Troseth, 2003b) also play a role in children's successful learning from a video. While each of these instances provides a glimpse into the opportunity for children to learn from screen media, many of these features are not feasible for mass TV production (e.g., Krcmar, 2010; Troseth et al., 2006; Troseth, 2003a).

For more than 40 years, researchers have studied preschool-directed television programs and consistently find that preschool-aged children can learn from quality educational media content (e.g., Anderson et al., 2000; Fisch & Truglio, 2001). Recently, programming for preschoolers and younger children has begun to use interactive techniques in which the characters look directly out at the audience and use language that invites the audience to participate with the characters (e.g., *Blue's Clues*, *Dora the Explorer*, *Super Why*, *Daniel Tiger's Neighborhood*). Programs like *Blues' Clues*, in which the main character utilizes these interactive techniques, have a positive impact on preschooler's cognitive development, including performance on pattern perception, creative thinking, and general problem solving skills (Anderson et al., 2000). Further, children learn best when they actively responded to prompts provided in this type of program (Calvert, Strong, Jacobs, & Conger, 2007). These studies indicate that factors related to the production of television programs, including the behaviors of the main characters, can be crucial for how well preschool children learn from them. A content analysis of infant-directed programming examining language promoting strategies also demonstrated that similar strategies are present in programs developed for infants and toddlers but not as frequently as for preschool programs (Vaala et al., 2010; Linebarger et al., in press).

1.3. The current study

The purpose of the current study was to examine the effect of matched pedagogical cues on toddlers' learning from video. Relying on techniques used in children's programming, we experimentally tested the effect of audience gaze with interactive language and object gaze with non-interactive language on 15- and 18-month old toddlers learning from video. Given that infants and toddlers frequently struggle to learn from a screen representation (Anderson & Pempek, 2005), we hypothesized (H1a) that toddlers would learn best from live demonstrations by scoring significantly higher on the imitation task than toddlers in the baseline condition, and (H1b) that toddlers would learn better from a live demonstration than a video demonstration. Because infants can follow eye gaze (e.g., Meltzoff & Brooks, 2007; Meltzoff & Brooks, 2014) and because interactive features in current preschool programming are associated with better learning outcomes (e.g., Anderson et al., 2000; Calvert et al., 2007), we hypothesized (H2) that toddler imitation would be better from the audience gaze video condition than the object gaze video condition. Finally, as others have seen improvements in this particular imitation task with age (e.g., Barr & Hayne, 1999), we hypothesized (H3) that older toddlers (18-month-olds) would perform better than younger toddlers (15-month-olds) in all conditions.

2. Method

2.1. Participants

One hundred and twenty-three toddlers participated in this study. Sixty-one 18-month-olds (31 male) and 62 15-month olds (32 male) were randomly assigned by age and sex into one of five conditions. Conditions varied as a function of presentation (live vs. video) and as a function of interactivity (audience gaze with interactive language vs. object gaze with non-interactive language). We refer to the four experimental conditions as: Audience Gaze Live, Audience Gaze Video, Object Gaze Live, Object Gaze Video, and have a fifth non-experimental condition which we refer to as a Baseline Control in which participants did not see a demonstration of the task (See 2.2. for more details on the conditions). Overall the sample was relatively homogeneous in ethnicity and socioeconomic status. Eighty percent of the infants were Caucasian, 8% were mixed ethnicities, 5% African American, 6% Asian, and less than 1% Hispanic. Socioeconomic status was indexed by parental education. Most parents (87%) had a graduate degree, 12% had a college degree, and less than 2% had only a high school degree; mean SES was 82.31 (SD = 11.45).

2.2. Materials and experimental conditions

The stimuli used involved construction of a *red rattle*, identical to the one used by Simcock and DeLoache (2006), which consisted of a red wooden stick (12.5 cm long) with a plug on the end which fitted into a blue plastic ball with a hole cut in the top (4 cm in diameter), and a red wooden bead (1.5 cm in diameter). Two videos in which the same female adult performed the demonstration were created. In the Object Gaze Video condition, the televised adult looked at the pieces of the rattle and narrated her behavior during one continuous shot using the pronoun "I". The televised adult said, "I'm making a rattle. I put the ball in the jar. Now I put the stick on the jar. See a rattle. Shake. Shake. Shake." The televised adult looked down at the objects while performing the demonstration except when it was time to shake the rattle. At this point the televised adult looked sideways and shook the rattle up high near her head as she looked at it (see Fig. 1). The televised adult did not look at the camera directly (audience) at any point during the demonstration. To start the second demonstration, the televised adult said, "I'll do that again." There was a brief 1-s fade to black and then the first demonstration was repeated in its entirety.

In the Audience Gaze Video condition, the televised adult put together the same rattle as in the Object Gaze Video condition. However, she looked directly at the camera (audience) throughout the demonstration and used identical language with the exception of using the pronoun "you" instead of "I". The televised adult looked straight ahead (at the audience) and said, "Let's make a rattle. You put the ball in the jar. Now, you put the stick on the jar. See a rattle. Shake. Shake. Shake." The televised adult looked down at the object while performing each specific action (e.g., putting the ball in the jar) but looked at the audience after each action and looked at the audience when she shook the rattle (see Fig. 1). Once again, there was a brief 1-s fade to black and then the first demonstration was repeated in its' entirety.

The live conditions (Audience Gaze Live and Object Gaze Live) were identical to the video conditions with the exception that the demonstration was performed by the experimenter live in front of the infant rather than prerecorded on a video. After the first demonstration, the experimenter took the rattle apart behind her back and placed the three pieces in front of

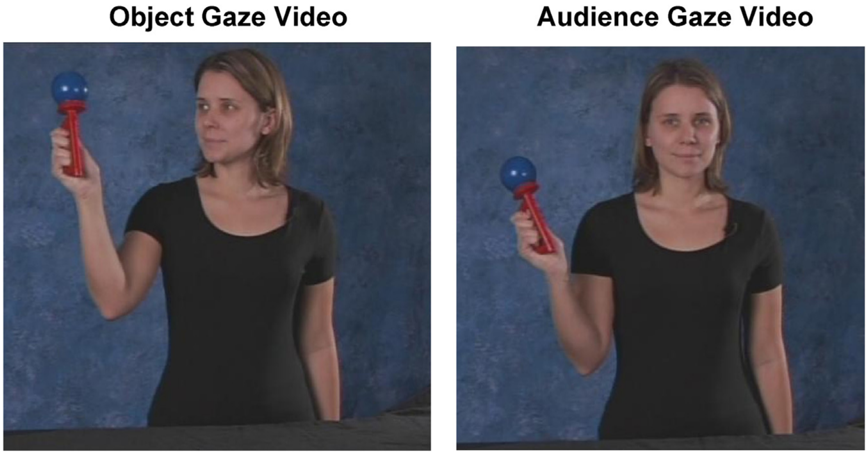

Fig. 1. Screen shots of Audience Gaze Video and Object Gaze Video during demonstration of the third imitation behavior.

her and repeated the demonstration. The demonstration was repeated twice for all infants. There was also a baseline control condition that did not view a demonstration.

2.3. Procedure

All participants were tested in their homes at a time that the parent reported the child was alert and active. All parents completed an informed consent and a short parent questionnaire while the experimenters played with the infant until the infant was comfortable with them. Parents remained in the room for the entire procedure and were told to interact with their child but not to direct the toddler to the target actions. The demonstration and test were videotaped for later coding.

Toddlers sat in their parent's lap and were exposed either to a live or a video demonstration. Infants were tested immediately after viewing by the experimenter at the visit. The female actor in the video was never the experimenter for children in the video conditions. For toddlers in the four experimental conditions, the experimenter put the three pieces of the rattle in front of the participant and said, "You just saw how to make a rattle. Can you show me how to make a rattle?" To assess the spontaneous production of the target actions, the experimenter put the three pieces of the rattle in front of the participant in the baseline control condition and said, "These are the things you use to make a rattle. Can you show me how to make a rattle?" All participants were given 60 s to reproduce the target actions.

2.4. Coding and reliability

2.4.1. Looking time

Looking time was coded from videotaped sessions using a computer timer. The coder pressed a key to mark the beginning and end of the demonstration and pressed another key when toddlers looked at or away from the demonstration. The overall percent looking was subsequently calculated (e.g., Wright et al., 1984). Data were not recorded for six toddlers due to technical errors. Twenty percent of videotapes were coded by two observers, yielding an intraclass reliability correlation above 0.95.

2.4.2. Imitation scores

Scoring began as soon as the participant touched any of the pieces of the rattle. An imitation score was calculated by totaling the total number of target actions that each participant imitated during the videotaped test session (range 0–3). Twenty-one percent of tests were coded by 2 observers, yielding a 92% agreement and kappa = 0.84.

3. Results

3.1. Looking time

Looking time was high for all experimental conditions ($M = 94.52$, $SD = 8.33$). A 4 condition (Audience Gaze Live, Object Gaze Live, Audience Gaze Video, Object Gaze Video) × 2 age (18 months, 15 months) × 2 sex (male, female) ANOVA conducted with percent looking time as the dependent variable yielded a sex by condition interaction, $F(3, 77) = 4.81$, $p = 0.004$ partial $\eta^2 = 0.16$. To analyze the interaction between sex and condition, separate one-way ANOVAs were conducted with looking time as the dependent variable and condition as the independent variable for each sex. When the ANOVA was conducted only for boys, there was a significant main effect of condition, $F(3, 38) = 5.81$, $p = 0.002$ partial $\eta^2 = 0.31$. Tukeys Post hoc *t*-tests indicated that boys looked significantly less during the Audience Gaze Video ($M = 85.97$, $SD = 13.73$) than to any of the other three demonstrations (Audience Gaze Live ($M = 89.12$, $SD = 6.01$, $p = 0.02$), Object Gaze Live ($M = 97.24$, $SD = 2.86$,

$p = 0.01$), Object Gaze Video ($M = 97.75$, $SD = 2.48$, $p = 0.04$). When the ANOVA was conducted with only girls, looking time did not differ by condition ($p > 0.05$). Percent attention was not correlated with imitation scores so it was not included in further analysis.

3.2. Imitation scores

Imitation is operationally defined as group performance that is significantly above baseline based on observation of a model (see Barr & Hayne, 2000). To test for H1, a 5 condition (Audience Gaze Live, Object Gaze Live, Audience Gaze Video, Object Gaze Video, Baseline Control) × 2 age (18 months, 15 months) × 2 sex (male, female) analysis of variance (ANOVA) was conducted with total imitation score as the dependent variable. See Table 1 for imitation scores by condition, age, and gender. The overall ANOVA yielded a significant main effect of condition, $F(4, 103) = 10.75$, $p < 0.001$, partial $\eta^2 = 0.30$, and sex, $F(1, 103) = 8.44$, $p = 0.004$, partial $\eta^2 = 0.08$. There were no significant interactions between the independent variables, ($p > 0.05$). First, we established that the experimental groups performed above baseline by conducting a post-hoc Dunnett's *t*-test which compares the experimental groups against the baseline control. The Dunnett's post-hoc analysis revealed that all four experimental conditions performed significantly better than the baseline control ($p < 0.001$ for all four tests). These results support H1a that toddlers who viewed the live condition would perform significantly better than the baseline control as well as demonstrating that toddlers in the video condition also performed significantly better than baseline control. After establishing that performance did exceed baseline which indicated learned imitation rather than chance performance, we conducted additional follow-up tests. Pairwise comparisons across the 4 experimental conditions did not reveal any between condition differences ($p > 0.05$ correcting for multiple comparisons). Pairwise comparisons indicated that girls ($M = 1.98$, $SD = 0.95$) scored significantly higher than boys ($M = 1.57$, $SD = 0.89$) ($p < 0.01$).

Table 1
Total imitation scores by condition, age, and gender.

Condition		15 months Mean (SD)	18 months Mean (SD)	Total Mean (SD)
Baseline	Male (N = 12)	0.67 (.52)	0.67 (.82)	0.67 (.65)
	Female (N = 12)	1.5 (.84)	0.5 (.55)	1 (.85)
	Total (N = 24)	1.08 (.79)	0.58 (.67)	0.83 (.76)
Object Gaze Live	Male (N = 13)	1.71 (.76)	1.83 (.75)	1.77 (.73)
	Female (N = 12)	2 (1.10)	2.5 (.55)	2.25 (.87)
	Total (N = 25)	1.85 (.90)	2.17 (.72)	2 (.82)
Audience Gaze Live	Male (N = 13)	1.57 (.79)	2.17 (.98)	1.85 (.90)
	Female (N = 11)	2.17 (.75)	2.67 (.52)	2.42 (.67)
	Total (N = 24)	1.85 (.80)	2.42 (.79)	2.12 (.83)
Object Gaze Video	Male (N = 13)	2 (.89)	1.86 (.90)	1.92 (.86)
	Female (N = 13)	1.83 (1.17)	2.17 (.75)	2 (.95)
	Total (N = 26)	1.92 (1.0)	2 (.82)	1.96 (.89)
Audience Gaze Video	Male (N = 12)	1.17 (.41)	2 (.89)	1.58 (.79)
	Female (N = 12)	2.17 (.75)	2.33 (.82)	2.25 (.75)
	Total (N = 24)	1.67 (.78)	2.17 (.84)	1.92 (.83)

Follow-up planned ANOVAs were conducted to test our predictions that performance would differ as a function of presentation medium (live or video) or presentation type (audience or object directed). To test H1b, a separate 2 condition (Audience Gaze Live, Audience Gaze Video) × 2 age (18 months, 15 months), ×2 sex (male, female) ANOVA was conducted. The overall ANOVA yielded a significant main effect of sex, $F(1, 40) = 7.05$, $p = 0.01$, partial $\eta^2 = 0.15$, and age $F(1, 40) = 5.20$, $p = 0.03$, partial $\eta^2 = 0.12$, with older children and girls performing better than younger children and boys. There was no difference in performance based on condition and no significant interactions between the independent variables, ($p > 0.05$). This finding does not support our hypothesis (H1b) that toddlers would perform significantly better in the live condition compared to the video condition when eye gaze is focused on the audience, but does support our hypothesis that older toddlers would perform better than younger toddlers (H3). Furthermore, performance was better overall for girls than boys.

To test H1b, a separate 2 condition (Object Gaze Live, Object Gaze Video) × 2 age (18 months, 15 months), ×sex (male, female) ANOVA was conducted. The overall model was not significant, $F(7, 43) = 0.583$, $p = 0.58$ and did not yield any significant main effects or interactions (all p values >0.10). This finding does not support our hypothesis (H1b) that toddlers would perform significantly better in the live condition compared to the video condition when eye gaze is focused on the object, nor does it support our hypothesis of age differences (H3).

To test our hypothesis that toddlers learn better from a video when eye gaze is focused on the audience compared to the object (H2), a separate 2 condition (Object Gaze Video, Audience Gaze Video) × 2 age (18 months, 15 months), ×2 sex (male, female) ANOVA was conducted. The overall model was not significant, $F(7, 42) = 1.16$, $p = 0.35$ and did not yield any significant main effects or interactions (all p values >0.10). This finding suggests that children learned equally well from a video in which the eye gaze is on the audience as when it is on the object and does not support our hypothesis that children would learn better when video demonstrations were audience-directed and included interactive language cues (H2).

4. Discussion

The purpose of this study was to assess toddler learning from video and the effect of matched pedagogical cues on learning. Previous research has indicated that under some conditions, toddlers in this age range show a transfer deficit (Barr & Hayne, 1999; Barr et al., 2007), but under other conditions do not (Barr & Hayne, 1999; Exp. 2a; Meltzoff, 1998). In the present experiment, the ostensive gaze and language cues were systematically manipulated to focus on either the audience or the object; toddlers learned equally well from both live and video conditions when both types of cues were used. In fact, children in all four experimental conditions performed significantly better than children in the baseline condition, demonstrating that all children learned from the exposure. Furthermore, none of the experimental conditions differed from each other, even live versus video. These findings suggest that specific features like match pedagogical cues appear to support infant learning from video. In this study we also report unexpected sex differences in attention and learning, with girls attending to a higher percentage of the demonstrations and outperforming boys on the imitation task.

This study adds to the growing body of research that demonstrates that under certain circumstances, infants and toddlers can in fact learn from a screen presentation (e.g., Barr & Hayne, 1999; Barr & Wyss, 2008; Barr et al., 2007; Calvert et al., 2014; Gola et al., 2013; Lauricella et al., 2011); it also demonstrates that toddlers can learn equally well from a live and screen presentation with matched language and gaze cues. Given previous research, we discuss the ways in which the matching of pedagogical cues may have influenced toddler learning.

4.1. Social cues

Although both interactive features (audience gaze) and non-interactive features (object gaze) were successful techniques to teach young children, they may do so in different ways. As we have seen with preschool-aged children, interactive features and audience eye gaze can be a helpful tool to increase the child's attention and engagement with the screen-based content (e.g., Anderson et al., 2000; Calvert et al., 2007). With infants, ostensive eye gaze cues supports their imitation from a live model (e.g., Brugger et al., 2007) and 2.5 year-old toddlers learned language equally well when observing a videotaped social interaction as a live third-party conversation (O'Doherty et al., 2011). In the current study, children imitated equally well in the audience gaze conditions, both when it was live and when it was on a video, suggesting that the interactive cues may have helped to increase infant engagement and involvement with the video in ways similar to those that occur with older preschool-aged children (Calvert et al., 2007). It is important to note, however, that looking time was higher for girls and for older toddlers in the interactive (Audience Gaze) conditions, which is consistent with prior research documenting both sex-related and age-related changes in processing eye gaze (e.g., Bayliss, di Pellegrino, & Tipper, 2005).

In contrast, toddlers in the non-interactive (Object Gaze) conditions may have been equally as successful for different reasons. While this condition did not engage the child in an interactive-like manner, the object gaze and accompanying language cues may have supported the young children in their processing of the key information needed to master the task. Fisch (2004) discusses the importance of minimizing the cognitive load required of children to process mediated content. In the Object Gaze conditions, the eye gaze cues directed the child's attention to the rattle during the key points necessary to complete the task. Also toddlers only had to follow one change in eye gaze direction during the demonstration and listen to the experimenter narrating what she was doing. With the character's full attention on the object, which is highly pedagogically salient to the child, the demonstration may have directed the child's attention directly to where it needed to be to learn the task, potentially minimizing the cognitive demands placed on the child's working memory, resulting in improved imitation of the task. Further studies using eye-tracking methodology would be useful to untangle these potential explanations.

The natural combination of matched pedagogical cues in this experiment may have supported toddler learning. In both real world interactions and many television presentations, the character cues are closely aligned and together support infant processing of language and information (see Vaala et al., 2010). Research conducted by Striano, Chen, Cleveland, and Bradshaw (2006) demonstrated that 12-month-old infants learn equally well from interactive and non-interactive live experiences. In this study, researchers manipulated the experimenter's level of joint attention between a toy and the infant. In one condition, the experimenter engaged in joint attention with the child by speaking to the infant about the toy and looking at the toy. In the second condition, the experimenter focused their attention only on the object and on the ceiling, never on the child. The results suggest that in a real world experience, infants learn by both of these types of matched pedagogical cues (Striano et al., 2006). This supports the results of the current study, which demonstrates that by 15- or 18-months infants are able to process information from matched pedagogical cues even when presented with the information in a screen format.

In previous imitation research with infants and toddlers in which a video deficit was found, the demonstrations were performed with minimal verbal description (e.g., Barr & Hayne, 1999; Barr & Wyss, 2008; Barr et al., 2007; Hayne et al., 2003) and generally minimal social cues. When verbal communication was included in the demonstration videos or at the time of the test, participants demonstrated improved performance. For example, Hayne and Herbert (2004) found that a verbal prompt at the time of test enhanced retrieval by 18- to 30-month-olds. Similarly, Seehagen and Herbert (2010) found that scripts derived from naturalistic maternal speech facilitated learning from television by 15-month-olds. Therefore, it may be that the combination of matched eye gaze and the use of rich language cues in all demonstrations in the present study as well as at the test, supported participants in their learning from the experiences. Future research is needed to fully understand *why* children were able to learn from these types of video presentations.

4.2. Repetition

In this study, with just two repetitions (most previous research relies on 3 repetitions), toddlers as young as 15-months successfully imitated a task presented on video at levels equal to that of a live presentation. This finding supports other research that has demonstrated that repetition of a video presentation can increase infant imitation from a screen to significantly above the baseline control, thus demonstrating learning (Barr et al., 2007; Muentener, Price, Garcia, & Barr, 2004). Importantly, beyond simply finding that imitation scores were significantly above baseline performance after watching a video demonstration, we found no difference between scores when the child watched a video or a live demonstration in this study. Therefore, with this particular video stimulus, repetition of the experience a mere two times resulted in equal learning in live and video conditions.

4.3. Sex differences

In this study there was an overall sex difference with girls outperforming boys on the imitation task and girls attending more to the audience gaze video presentation. Previous research has not reported sex differences in imitation performance (e.g., Barr & Hayne, 1999; Brooks & Meltzoff, 2002; Hayne & Herbert, 2004).

Prior research has demonstrated that females are generally better than males at following eye gaze (Bayliss et al., 2005) and facial expression processing (McClure, 2000). Given that eye gaze was a crucial part of all four experimental conditions and not relevant for the baseline condition, it is likely that the ability to follow eye gaze played a substantial role in toddlers' success on this task. Additionally, research indicates that infant girls are more attentive to faces than boys who, in turn, are more attentive to objects (Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000). Therefore, it may be that young boys and girls attend to different cues when watching a demonstration. That is, as suggested by Baron-Cohen's theory on sex differences (e.g., Baron-Cohen, Knickmeyer, & Belmonte, 2005), girls in this study may focus more on social interactive qualities like eye gaze whereas the boys may focus more on the objects themselves. This visual preference may partly explain why attention was lower for boys in the Audience Gaze Video condition compared to the other experimental conditions. Additional empirical research is needed to determine exactly why girls and boys demonstrated differences in attention to these stimuli.

4.4. Limitations and conclusions

This study is not without limitations. First, it is possible that the matched pedagogical cues of eye gaze and language together supported children's learning from the demonstration. While it might make sense that the combination of language and eye gaze cues could be isolated to determine which if either was more effective independently, this matched experience of cues is what happens traditionally in live and televised interaction. Given the findings that the combination of both cues decreased the video deficit that had been observed in prior studies (e.g., Hayne et al., 2003), additional empirical research is warranted to determine the independent effects of changes in pedagogical cues. Eye tracking technology might also isolate how girls and boys differ in their processing of eye gaze cues during the demonstration phase. Second, this study did not capture verbal scores for all children and thus cannot determine how language skills may have influenced attention to the programs. Future research should ensure that language scores are assessed at time of testing. Third, repetition supports learning from a screen (Barr et al., 2007). In this study all demonstrations were repeated twice; it is possible that differences in performance would have been observed had the demonstration only been presented once. This approach should be examined in future research.

In conclusion, this study provides evidence that factors related to both the character on the screen and characteristics of the child may play a role in toddler's successful imitation from a video presentation. For toddlers, eye gaze and language that provide a sense of audience participation between a television character and the audience, and eye gaze and language that helps direct the child's attention to the objects on a screen may both be successful techniques that improve toddlers' imitation from videos.

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