Infant Behavior & Development 36 (2013) 349–358

Contents lists available at SciVerse ScienceDirect

Infant Behavior and Development

Priming infants to use color in an individuation task: Does social context matter?

Tracy R. Brower*, Teresa Wilcox

Texas A&M University, United States

ARTICLE INFO

Article history:
Received 26 September 2012
Received in revised form 30 January 2013
Accepted 21 February 2013
Available online 9 April 2013

Keywords:
Infant development
Object individuation
Social context
Priming

ABSTRACT

Infants' learn a great deal about the physical world during the first year of life. There is a growing body of research investigating the conditions under which this is most likely to occur. Most of this research has focused on the type of information that infants are presented. The current research moves the field in a new direction by investigating the extent to which the social context – who presents the information to the infant – influences knowledge acquisition. Infants were first presented with a color-priming event in a non-social context (Experiment 1) or a social context (Experiment 2). These two contexts differed primarily in whether the individual presenting the color-priming events was behind the apparatus and hidden from view or sat next to the infant and was visible, respectively. The extent to which viewing the color priming events increased infants' sensitivity to color differences in a subsequent object individuation task was then assessed. The results revealed that whereas 8.5-month-olds experienced color priming in the non-social context, 7.5-month-olds only experienced color priming within a social context. Furthermore, the 7.5-month-olds evidenced priming only when their own parent, not an unfamiliar adult, was the social partner performing the priming events. This provides new evidence for the significance of infant learning within a social context and the potential role of parents.

From the early days of life, humans are active learners, attempting to make sense of a complex and dynamic array of incoming information. There is now a great deal of evidence that even very young infants possess expectations about how physical objects should move and interact and recognize when these expectations are violated. At the same time, infants' knowledge about the physical world changes substantially during the first year (for reviews see Baillargeon, 1998; Baillargeon, Li, Ng, & Yuan, 2009; Needham & Ormsbee, 2003; Spelke, 1990; Spelke & Kinzler, 2007) and researchers have identified mechanisms by which infants acquire new knowledge (Needham, Barrett, & Peterman, 2002; Wang & Baillargeon, 2008; Wilcox & Woods, 2009).

One particularly intriguing finding is that select experiences can alter the type of information to which infant attend when interpreting physical events (Baillargeon, 2004; Needham et al., 2002; Wang & Baillargeon, 2005; Wilcox & Chapa, 2004; Wilcox, Woods, Chapa, & McCurry, 2007). For example, infants typically do not use color information to track the identity of objects involved in occlusion events until about 11.5 months. The ability to determine whether an object currently in view is the same object or a different object than see before is referred to as object individuation. However, under some conditions younger infants can be primed to attend to color differences. In one color-priming task infants were first shown events in which the color of an object predicted the function in which it engaged: green containers pounded a nail and red containers scooped and poured salt (Fig. 1). Infants were then tested in an object individuation task using a different set

* Corresponding author at: Texas A&M University, Psychology, 4235 TAMU, College Station, TX 77843, United States. Tel.: +1 979 255 6751.
E-mail addresses: gooddaytracy@gmail.com, tracyrebecca@tamu.edu (T.R. Brower).

0163-6383/$ – see front matter
http://dx.doi.org/10.1016/j.infbeh.2013.02.005

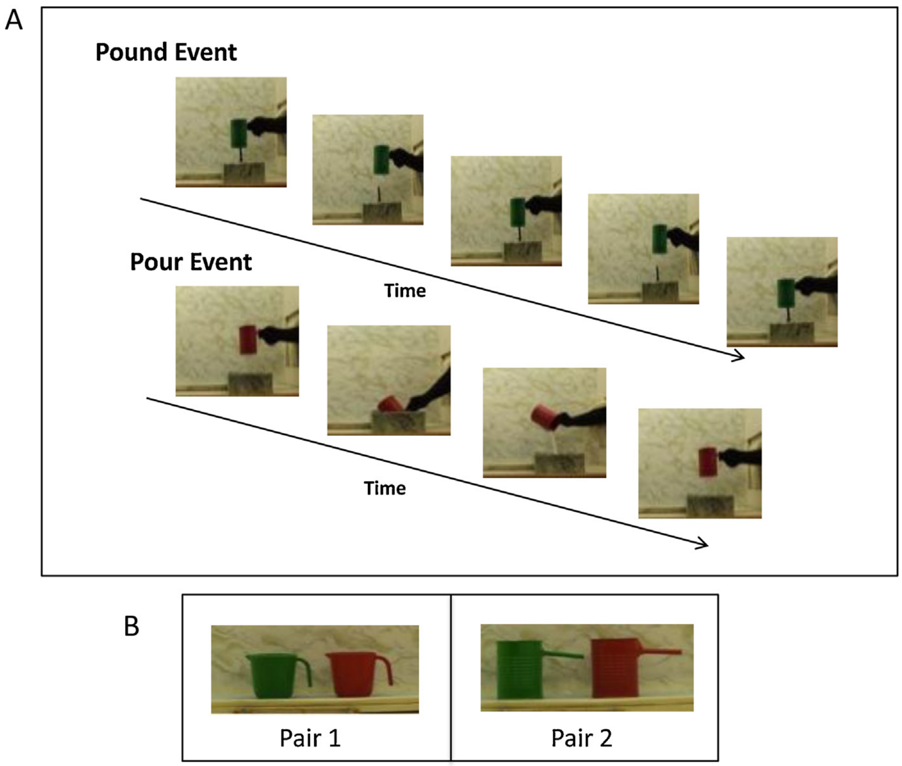

Fig. 1. (A) The pound-pour events of Wilcox and Chapa (2004). The pound event was always seen with the green container and the pour event with the red container. (B) The green and red containers used in the two pairs of pound-pour events. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

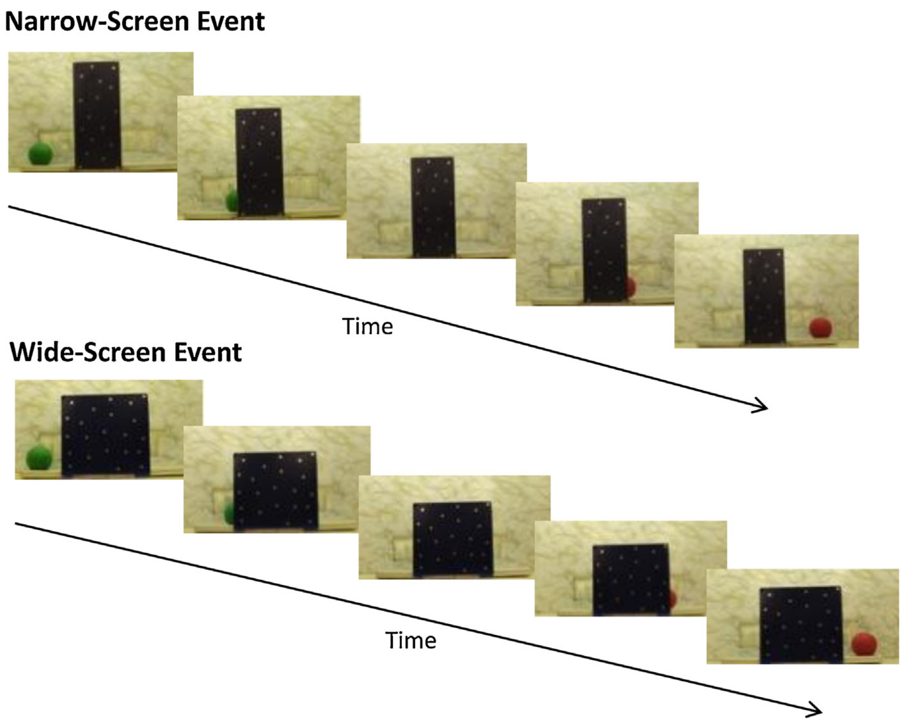

Fig. 2. The test events of Wilcox and Chapa (2004). Longer looking to the narrow-than wide-screen test event is taken as evidence that infants individuated-by-color (i.e., interpreted the test event as involving two objects and recognized that both objects could fit behind the wide but not the narrow screen).

of objects (Fig. 2). After viewing two pairs of pound-pour events, 9.5-month-olds, who do not spontaneously use color in this individuation task, successfully used the color difference to individuate the green and red ball. That is, drawing infants' attention to the predictive value of color in the function events led to increased sensitivity to color in the subsequent occlusion event (Wilcox & Chapa, 2004; Wilcox, Woods, & Chapa, 2008). Wilcox and colleagues have identified additional experiences that can prime infants to attend to color information in individuation tasks (Wilcox et al., 2007), and other researchers have reported priming effects in other physical domains (Wang & Baillargeon, 2005). In all of these studies the nature of the information, or the physical context in which the information was presented, was manipulated. The overarching goal of these types of studies is to identify perceptual and cognitive mechanisms that facilitate change in the way that infants perceive and interpret the physical world.

What has been largely overlooked, however, is that the acquisition of physical knowledge often takes place within a social context. Infants interact daily with other people, including parents, siblings, and caretakers, and exposure to and learning about objects often occur within this context. Although we might assume, on the basis of current pedagogical theory (Csibra & Gergely, 2005), that the nature of these interactions guide what and how infants learn about objects, we know little about the extent to which social factors influence infants' learning about the physical world.

We do know that infants respond differently to familiar and unfamiliar adults. For example, just days after birth infants prefer to look at their mother as compared to a stranger (Pascalis, de Schonen, Morton, & Deruelle, 1995). Within several months after birth infants establish distinct patterns of attention to and engagement with their mother and are more responsive to adults who show familiar as opposed to unfamiliar patterns of engagement (Bigelow & Rochat, 2006; Devouche, 2004; Watson, 1979). In addition, naïve observers can reliably distinguish mother–infant interactions from stranger–infant interactions (Bigelow, Power, Mcquaid, Ward, & Rochat, 2008) on the basis of patterns of interaction. There is also evidence that who presents object information influences the extent to which infants' encode and act on that information. For example, by 12 months infants prefer watching the object-related activity of older children to that of unfamiliar adults (Zmyj, Daum, Prinz, & Aschersleben, 2012). During the second year, the extent to which infants imitate object-related activity is dependent on a number of factors, including whether the presenter is an adult or a peer and whether the presenter is perceived as competent (Ryalls, Gul, & Ryalls, 2000; Zmyj, Buttelmann, Carpenter, & Daum, 2010; Zmyj, Daum, Prinz, Nielsen, & Aschersleben, 2012), However, there does not appear to be an effect of presenter familiarity on object-related activity during the first year (Devouche, 1998, 2004). Together, these findings highlight the importance of social context on attention, learning, and memory in the infant, at least in some contexts.

The present research moves the field forward by exploring the influence of one social factor – who presents the information to the infant – on the efficacy of information uptake during a priming situation. Two experiments were conducted. Experiment 1 examined the age at which infants are first primed by color-function events when those events are viewed in a non-social context. In this experiment an adult produced the priming events from behind the apparatus, as in Wilcox and Chapa (2004). Experiment 2 investigated whether placing the priming events in a social context facilitates color priming in an age group that fails in the non-social context. In addition, we sought to identify whether efficacy of information gathering was influenced by who presented object information. To this end, the individual who presented the priming event was either the infant's parent or an unfamiliar adult. We expected that young infants, who typically prefer caregivers to strangers, would experience greater pedagogical benefits if a parent rather than unfamiliar adult presented the information. However, there is evidence that in a novel environment (e.g., lab setting) older infants perceive an unfamiliar adult as the "expert" and are more likely to seek and use information from the unfamiliar adult than his or her own parent (Stenberg, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005). Hence, we make this prediction with caution.

1. Experiment 1

Previous research indicates that 9.5-month-olds benefit from the priming events displayed in Fig. 1 (Wilcox & Chapa, 2004). That is, viewing the color-function events primes infants to use color information in a subsequent individuation task. To identify the age at which infants first demonstrate color-function priming in this context, 8.5- and 7.5-month-olds were first shown the priming events (Fig. 1) and then tested using the narrow-screen task (Fig. 2). In the narrow-screen task, first reported by Wilcox and Baillargeon (1998a, 1998b), infants are presented with a test event in which different-featured objects (e.g., a green ball and a red ball) emerge successively to opposite sides of a wide or a narrow screen. Only the wide screen is sufficiently wide to hide both objects simultaneously. If infants use the featural difference to signal the presence of two distinct objects, and recognize that both objects can fit behind the wide – but not the narrow-screen, then they should find the narrow – but not the wide-screen test event unexpected. Hence, they should look longer at the narrow – than wide-screen test event. This rationale has been substantiated by data obtained using other paradigms (McCurry, Wilcox, & Woods, 2009; Wilcox & Baillargeon, 1998b; Wilcox & Schweinle, 2002)

1.1. Method

1.1.1. Participants

Twenty 7.5-months-olds, 10 male, 10 female (*M* age = 7 months, 15 days; range = 7 months, 2 days to 7 months, 28 days) and 20 8.5-month-olds, 9 male, 11 female (*M* age = 8 months, 16 days; range = 8 months, 1 day to 8 months, 29 days) participated in Experiment 1. These infants included 34 Caucasian, 5 Hispanic, and 1 black. Seven additional infants were tested but eliminated because they failed to contribute two valid test trials. In each age group 10 infants were pseudo-randomly assigned to the narrow-screen or the wide-screen condition, with an equal number of males and females assigned to each group. In this and the following experiments parents and infants were recruited primarily from commercially produced lists. The study protocol was approved by the IRB. The experimental procedure was explained to the parent and informed consent obtained prior to testing. The parent was offered $5 or a lab t-shirt for participation.

1.1.2. Apparatus and materials

The apparatus and materials were identical to those of Wilcox and Chapa (2004, Experiment 1). Briefly, events were presented in a puppet-stage apparatus that was 213 cm high, 105 cm wide, and 43.5 cm deep. A muslin shade was lowered over the front opening of the stage of the apparatus at the end of each trial. There was a 25.5 cm × 20 cm opening in the right wall through which the experimenter reached (from outside the apparatus) to present the priming events. During the familiarization and test trials the opening was concealed. The platform along which the balls moved during the familiarization and test events was centered on the apparatus floor. Embedded in the center of the platform was a metal bi-level shelf with an upper and lower level shelf. The bi-level, which allowed both objects to be behind the screen simultaneously, was lifted and lowered by means of a handle protruding through the apparatus's back wall, allowing the balls to emerge successively from behind the screen. Two 214 cm × 68 cm muslin-covered frames stood at an angle to either side of the apparatus concealing two observers and isolating infants from the experimental room. In addition to room lighting, a 20-W fluorescent bulb was affixed inside each of the apparatus walls.

Two pairs of containers were used in the priming events (Fig. 1). The containers of each pair were identical in appearance except for color: one was red and the other green. The pound-box and pour-box were 8 cm high, 19.5 cm wide, and 15.75 cm deep with one open side. The pound-box was placed with the open side down and had a black wooden peg protruding upwards. The pour-box was placed with the open side up and was filled with salt (it did not have a peg). During the priming events the appropriate box sat in the front, right corner of the apparatus.

The balls used in the familiarization and test events were 10.25 cm in diameter and painted either green or red. Each ball was mounted on a clear Plexiglas base with a long handle that protruded out the back of the apparatus. Using the handle, an experimenter who was concealed behind the apparatus moved the balls across the platform (the balls were attached to the base and did not roll).

The familiarization screen was 30 cm × 41 cm and yellow. The narrow (15.5 cm × 41 cm) and wide (30 cm × 33 cm) test screens were blue.

1.1.3. Events

Each experimental session included priming, familiarization, and test events. One experimenter wearing a white glove produced all of the events following a precise script. The numbers in parentheses indicate the time taken to produce the actions described.

Narrow-screen condition. Each infant saw two pairs of priming events. Each pair consisted of a pound event and a pour event (Fig. 1). The first pound event began with the experimenter holding the green can above the box with the wooden peg. The experimenter lowered the can to pound the peg two times and raised the can (4 s), then repeated this action (4 s). This 8 s sequence (which we refer to as one cycle) was repeated continuously until the end of the trial. The first pour event began with the experimenter holding the red can above the box with the salt. The experimenter lowered the can to scoop the salt from the box and then raised the can (4 s), tilted the can forward to pour out the salt and then returned the can to its starting position (4 s). This 8 s sequence was repeated continuously until the trial ended. The second pair of priming events was identical to the first except that the green and red cans were replaced with the green and red measuring cups.

Following the priming events, infants saw a familiarization event. At the start of each familiarization trial, the green ball sat at the left end of the platform and the red ball sat on the lower shelf of the bi-level behind the familiarization screen. Once the infant looked at the ball for 1 s, the green ball moved behind the screen until it rested on the upper shelf of the bi-level (3 s). The bi-level was then lifted so that the red ball on the lower shelf could emerge from behind the screen and move to the right end of the platform (3 s). This 6 s sequence was then seen in reverse. The balls moved at a rate of 12 cm/s. The entire 12 s event sequence was repeated continuously until the trial ended.

Finally, infants were presented with a test event (Fig. 2) that was identical to the familiarization event except that the familiarization screen was replaced with the narrow test screen.

Wide-screen condition. The priming, familiarization, and test events were identical to those of the narrow-screen condition except that the wide screen was used in the test trials.

1.1.4. Procedure

During priming trials, infants sat in a Bumbo® seat centered in front of the apparatus with their head 78 cm from the objects on the platform. Parents sat in a small chair beside their infant and were asked to close their eyes and not interact with their infant while the experiment was in progress. During familiarization and test trials, infants sat in parents' lap, with their head again centered 78 cm from the objects on the platform. Parents were still asked to close their eyes and not interact with their infant while the experiment was in progress.

Infants saw four priming trials, each 30 s in duration. Infants saw six familiarization trials, each ending when the infant (a) looked away for 2 consecutive s after having looked at the event for at least 12 cumulative s or (b) looked for 60 cumulative s

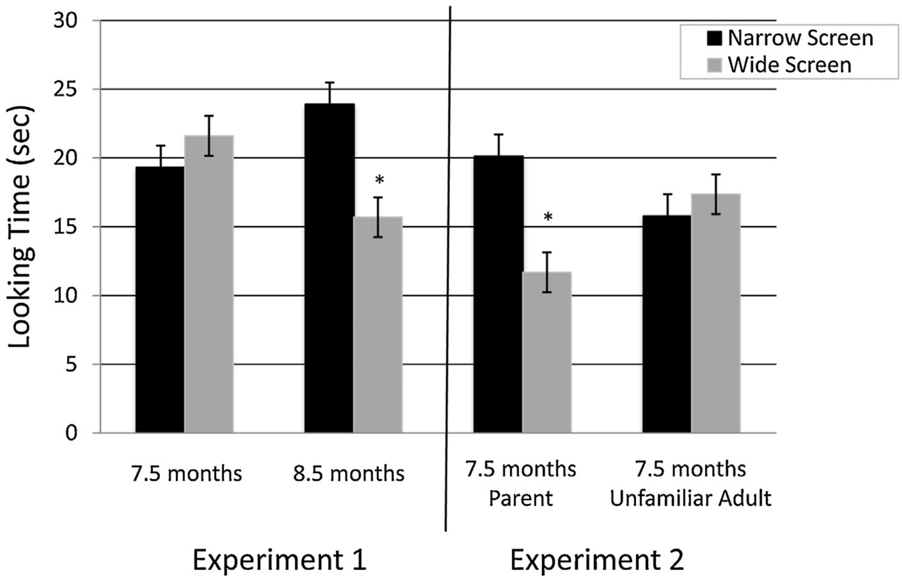

Fig. 3. Mean (*SD*) looking times to the narrow- and wide-screen test events of the infants tested in Experiment 1 (non-social context) and Experiment 2 (social context).

without looking away for 2 consecutive s. Finally, infants saw the test event appropriate for their condition on two successive trials. Test trial termination criteria were the same as for the familiarization trials except that minimum looking time was 6 s. Two observers, who were naïve to the experimental conditions monitored infants looking behavior online through peepholes in the frames to either side of the apparatus. Inter-observer agreement was measured for 38 of the 40 infants and was calculated for each test trial. Agreement averaged 90% per test trial per infant.

Preliminary analyses were conducted for this and the following experiment to test for within-subject effects of trial and between-subject effects of sex. No reliable differences emerged in either experiment so the data are collapsed across these two factors.

1.2. Results

1.2.1. Priming trials

The infants' looking times during the four priming trials were averaged and analyzed by means of an ANOVA with age in months (7.5 or 8.5) and test event (narrow- or wide-screen) as between-subjects factors. The main effects of age ($F(1, 36) = 0.13$, $p = .72$, $\eta_p^2 = .004$) and test event ($F(1, 36) = 1.97$, $p = .17$, $\eta_p^2 = .052$) and the interaction between these two factors ($F(1, 36) = 0.86$, $p = .36$, $\eta_p^2 = .023$) were not significant, indicating that the infants in the four conditions did not differ reliably in their mean looking times during the priming trials (8.5 months narrow-screen, $M = 26.52$, $SD = 3.04$; 8.5 months wide-screen, $M = 23.49$, $SD = 5.01$); 7.5 months narrow-screen, $M = 24.84$, $SD = 4.83$; 7.5 months wide-screen, $M = 24.23$, $SD = 3.18$).

1.2.2. Familiarization trials

The infants' looking times during the six familiarization trials were averaged and analyzed in the same manner as the priming trials. The main effects of age ($F(1, 36) = 0.53$, $p = .47$, $\eta_p^2 = .015$) and test event ($F(1, 36) = 0.34$, $p = .56$, $\eta_p^2 = .009$), and the interaction between these two factors ($F(1, 36) = .025$, $p = .88$, $\eta_p^2 = .001$), were not significant, indicating that the infants in the four conditions did not differ reliably in their mean looking times during the familiarization trials (8.5 months narrow-screen, $M = 33.10$, $SD = 9.94$; 8.5 months wide-screen, $M = 30.62$, $SD = 11.42$); 7.5 months narrow-screen, $M = 30.15$, $SD = 11.86$; 7.5 months wide-screen, $M = 28.73$, $SD = 8.38$).

1.2.3. Test trials

The infants' looking times during the two test trials were averaged and analyzed in the same manner as the priming trials (Fig. 3). The main effects of age ($F(1, 36) = 1.02$, $p = .32$, $\eta_p^2 = .028$) and test event ($F(1, 36) = 2.50$, $p = .12$, $\eta_p^2 = .065$) were not significant. However, the interaction between age and test event was significant ($F(1, 36) = 5.92$, $p = .02$, $\eta_p^2 = .14$). Planned contrasts indicated that the 8.5-month-olds looked reliably longer at the narrow-screen ($M = 23.14$, $SD = 10.03$) than wide-screen ($M = 12.31$, $SD = 5.08$) test event ($t(18) = 3.05$, $p = .007$, Cohen's $d = 1.44$). In contrast, the 7.5-month-olds looked about equally at the narrow-screen ($M = 19.30$, $SD = 10.18$) and wide-screen ($M = 21.60$, $SD = 7.83$) test event ($t(18) = -0.58$, $p = .58$, Cohen's $d = -0.27$).

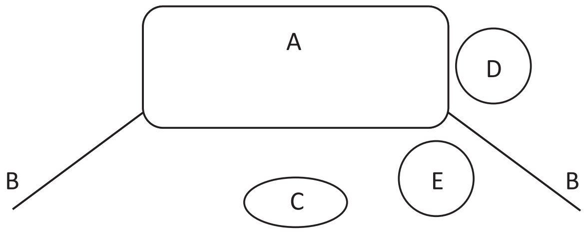

Fig. 4. Experimental set-up for Experiments 1 and 2. (A) Apparatus where the events were performed; (B) screens blocking the infant from the experimental room; (C) location of the infant watching the event; (D) location of the experimenter in Experiment 1; (E) location of the experimenter in Experiment 2.

1.3. Discussion

The 8.5-, but not the 7.5-month-olds, individuated the green and red ball in the test events, revealing that infants first benefit from this priming procedure at 8.5 months. We suspect, however, that 7.5-month-olds might evidence color priming under more supportive conditions. In order for priming to occur, infants' must extract the relation between color and function (e.g., green containers pound and red containers pour). It is this process that leads to increased sensitivity to color differences in subsequent test trials. There is evidence that completion of this process, which is difficult for younger infants, is facilitated when the relation between color and function is made more explicit or when infants are shown more exemplars of the color-function pairings (Wilcox et al., 2007; also see Wilcox, Smith, & Woods, 2011). Experiment 2 was designed to assessed whether placing the priming procedure within a social context would facilitate extraction of the relation between color and function in 7.5-month-olds.

2. Experiment 2

Human infants are sensitive to cues that signal pedagogical situations and appear particularly adept at seeking out and acquiring new information when it is presented in a social context (Gergely, Egyed, & Ildikó, 2007). For example, infants are more likely to imitate actions on objects demonstrated by an adult on-line, and with whom they can potentially interact, than those demonstrated by an adult in a televised recording, making interaction with the actor impossible (Barr & Hayne, 1999; Nielsen, Simcock, & Jenkins, 2008). To create a social context in Experiment 2, the experimenter who produced the priming event sat next to the infant; the adult and infant were able to look at each other and the event during each priming trial.

What is unclear from current research is whether familiarity with an "information presenter" influences infants' learning. On the one hand, one might expect infants to be more sensitive to information presented by a familiar adult, someone they know and with whom they have previously engaged in learning experiences (Seehagen & Herbert, 2012). On the other hand, there is evidence that during the first year familiarity does not influence the likelihood with which infants imitate novel behavior. In addition, there is evidence that in a laboratory setting infants sometimes perceive an unfamiliar adult as the "expert" and are more likely to seek and use information from the unfamiliar adult than his or her own parent (Seehagen & Herbert, 2012; Stenberg, 2009; Walden & Kim, 2005). To assess the influence of presenter familiarity on the efficacy of priming, the infant's parent or an adult unfamiliar to the infant produced the pound-pour events.

2.1. Method

2.1.1. Participants

Forty-three 7.5-months-olds, 20 male, 23 female (*M* age = 7 months, 13 days; range = 7, 0 to 7, 29) participated in Experiment 2. These infants included 32 Caucasian, 9 Hispanic, 1 Black, and 1 Asian/Pacific Islander. Four additional infants were tested but eliminated from the sample because they failed to contribute two valid test trials. Infants were pseudo-randomly assigned to one of four groups, formed by crossing test event (narrow- or wide-screen) and experimenter (parent or unfamiliar adult): parent (*M* age = 7 months, 13 days; range = 7, 0 to 7, 29; narrow screen: 5 male, 6 female; wide screen: 4 male, 7 female); unfamiliar adult (*M* age = 7 months, 13 days; range = 7, 0 to 7, 29; narrow screen: 6 male, 5 female; wide screen: 4 male, 6 female).

2.1.2. Apparatus and materials

The apparatus and materials were identical to those of Experiment 1.

2.1.3. Events and procedure

The familiarization and test events were identical to those of Experiment 1. The priming events were similar with the following modifications. First, rather than sitting behind the apparatus and reaching through an opening in the side wall to produce the priming events, the experimenter sat in a small chair in front of the apparatus (Fig. 4). She was in full view of, and at eye level with, the infant. Second, the individual who presented the priming trials was either the infant's parent or an adult unfamiliar to the infant. In both conditions, the experimenter was female and naïve to the experimental hypotheses. In the parent condition, prior to the test session the infant's parent (i.e., mother) received instruction using a third set of green and red containers on how to produce the pound and pour events. They were told that they could call the infant's name or speak in a way to direct the infant's attention toward the priming events (e.g., "look here" or "watch this") but were asked not to label or describe the objects or the events. During experimenter instruction, the infant was engaged in play with a lab member in another part of the testing room.

In the unfamiliar adult condition, a female adult unfamiliar to the infant was trained to produce the pound and pour events using the same instructional protocol. Seven different females served as an unfamiliar adult and each one tested between 1 and 5 infants ($M = 3$).

An observer watched each experimental session on-line and experimenters who failed to produce the priming events according to instruction and/or who used inappropriate vocalizations were excluded from the sample ($n = 1$). For a subset of participants the priming trials were videotaped. One video camera was positioned to record the adult experimenter as she produced the event and the other to record the infant during the same time period. Two independent naïve observers coded (from the videotapes) the following during each priming trial: (1) the amount of time the experimenter engaged in event production and (2) the number of event cycles the experimenter produced. Data were available for $n = 16$ each condition. Inter-observer agreement was calculated and averaged 99% per priming trial per experimenter. The parents and unfamiliar adults did not differ significantly in the amount of time they spent actively producing the priming event (parents, $M = 28.03$, $SD = 2.68$; unfamiliar adults, $M = 29.11$, $SD = 0.64$; $F(1, 30) = 2.48$, $p = .13$, $\eta_p^2 = .076$) or the number of event cycles completed (parents, $M = 5.72$, $SD = 2.08$; unfamiliar adults, $M = 5.51$, $SD = 0.37$; $F(1, 30) = 0.16$, $p = .70$, $\eta_p^2 = .005$) during each priming trial.

Independent naïve observers measured infants' looking to the priming, familiarization, and test events. Inter-observer agreement was measured for 41 of the 43 infants and averaged 90% per test trial per infant.

2.2. Results

For priming, familiarization, and test data infants' looking times were averaged across trial and analyzed in the same way as in Experiment 1.

2.2.1. Priming trials

The main effects of experimenter ($F(1, 39) = 0.43$, $p = .51$, $\eta_p^2 = .011$) and test event ($F(1, 39) = 1.75$, $p = .19$, $\eta_p^2 = .043$), and the interaction between these two factors ($F(1, 39) = 1.80$, $p = .19$, $\eta_p^2 = .004$), were not significant. The infants in the four conditions did not differ reliably in their mean looking times during the priming trials (parent narrow-screen, $M = 21.54$, $SD = 5.10$ and wide-screen, $M = 21.52$, $SD = 4.50$; unfamiliar adult narrow-screen, $M = 20.71$, $SD = 3.18$ and wide-screen, $M = 23.96$, $SD = 2.61$).

2.2.2. Familiarization trials

The main effects of experimenter ($F(1, 39) = 0.21$, $p = .65$, $\eta_p^2 = .005$) and test event ($F(1, 39) = 3.49$, $p = .07$, $\eta_p^2 = .082$), and the interaction between these two factors ($F(1, 39) = 0.35$, $p = .56$, $\eta_p^2 = .009$), were not significant. The infants in the four conditions did not differ reliably in their mean looking times during the familiarization trials (parent narrow-screen, $M = 35.39$, $SD = 4.79$ and wide-screen, $M = 29.04$, $SD = 11.55$; unfamiliar adult narrow-screen, $M = 32.67$, $SD = 9.11$ and wide-screen, $M = 29.38$, $SD = 6.67$).

2.2.3. Test trials

Five infants had a test trial looking time that was more than two standard deviations above the group mean: two in the parent, narrow screen condition, two in the unfamiliar adult, narrow screen condition, and one in the unfamiliar adult, wide screen condition. To avoid loss of data points, these outliers were truncated to the next highest data point for that trial and group. The main effects of experimenter ($F(1, 37) = 0.017$, $p = .90$, $\eta_p^2 = 0.00$) and test event ($F(1, 37) = 1.87$, $p = .18$, $\eta_p^2 = .048$) were not significant. However, the interaction between experimenter and test event was significant ($F(1, 37) = 4.37$, $p = .04$, $\eta_p^2 = .11$). Planned contrasts indicated that the infants in the parent condition looked reliably longer at the narrow-screen ($M = 20.10$, $SD = 8.38$) than wide-screen ($M = 12.44$, $SD = 3.21$) test event ($t(18) = 2.58$, $p = .019$, Cohen's $d = 1.22$). In contrast, the infants in the unfamiliar adult condition looked about equally at the narrow-screen ($M = 15.76$, $SD = 6.35$) and wide-screen ($M = 17.36$, $SD = 8.56$) test events ($t(19) = -0.49$, $p = .63$, Cohen's $d = -0.22$).

2.2.4. Exploratory analysis of social cues

To explore whether parents and unfamiliar adults differed in their use of social cues that could facilitate infants' information gathering, we utilized the videotapes of a subset of infant-adult dyads who were recorded during the priming trials. (For a variety of reasons, videotapes were not available for all infant-adult dyads.) A total of 20 infants contributed to this data subset, which included five from each of the four conditions (i.e., 10 each with the parent and the unfamiliar adult). All trials began with the presenter looking at the box (nail- or salt-box) and the container (green or red) that she was manipulating on the stage. This established the priming event as the point of reference and served as a cue that the event contained information to which the infant should attend (D'Entremont, Hains, & Muir, 1997; Farroni, Csibra, Simion, & Johnson, 2002;

Farroni, Massaccesi, Pividori, & Johnson, 2004). Recall that experimenters were instructed as to how to produce the event, and were told to limit vocalizations, but they were not instructed in their use of social cues.

There is evidence that when an adult alternates gaze between a referenced object and infant it signals to the infant that this is an object to be shared and facilitates learning about that object (Cleveland, Schug, & Striano, 2007; Striano, Chen, Cleveland, & Bradshaw, 2006). When adults engage in mutual gaze (eye-to-eye contact) with an infant this is also interpreted by infants as a signal to "pay attention" to a referenced object and encourages engagement in pedagogical situations (Csibra & Gergely, 2005; Gergely et al., 2007). Finally, joint attention, which is typically defined as shared attention to a referenced object, promotes attention to and learning about new objects (Cleveland & Striano, 2007; Kopp & Lindenberger, 2011).

To explore alternating gaze, mutual gaze, and joint attention during the priming events, two independent and naïve observers coded, for each priming trial, the amount of time (1) the presenter looked at the infant (after having looked at the priming event), (2) the infant and adult spent in mutual gaze, and (3) the infant and adult spent looking at the referenced priming event simultaneously. In addition, to explore whether infants were more likely to focus attention on an unfamiliar than familiar adult, which could draw attention away from the priming event, the amount of time the infant spent looking at the experimenter during each priming trial was coded. Inter-observer agreement was calculated for each variable coded and averaged 99% across trials.

Each of the four duration measures were averaged across trial and independently subjected to a one-way ANOVA with experimenter as the between-subjects factor. The parents ($M = 10.54$, $SD = 4.75$) spent significantly more time looking at the infant (after having looked at the priming event) than the unfamiliar adults ($M = 6.25$, $SD = 3.95$), $F(1, 18) = 4.83$, $p = .041$, $\eta_p^2 = .21$. The two groups did not differ significantly in the amount of time they spent in mutual gaze; both groups spent relatively little time in mutual gaze (parent: $M = 1.93$, $SD = 0.96$; unfamiliar adult: $M = 1.36$, $SD = 0.58$; $F(1, 18) = 2.50$, $p = .13$, $\eta_p^2 = .12$). In contrast, the unfamiliar adults ($M = 18.37$, $SD = 4.50$) spent significantly more time in joint attention (looking at the referenced event) than the parents ($M = 13.52$, $SD = 4.66$), $F(1, 18) = 5.59$, $p = .03$, $\eta_p^2 = .24$). Finally, the infants in the two groups did not differ significantly in the amount of time they spent looking at the experimenter during the priming trials (parent: $M = 3.24$, $SD = 2.61$; unfamiliar adult: $M = 4.04$, $SD = 2.65$; $F(1, 18) = 0.46$, $p = .50$, $\eta_p^2 = .025$).

2.3. Discussion

The 7.5-month-olds benefitted from the color priming procedure when his or her own parent but not an unfamiliar adult produced the priming events, suggesting that infants are more likely to learn from their parent than an adult who is unfamiliar to them. These results cannot be explained by group differences in the way the adults produced the priming events or in the amount of time infants spent attending to the events.

Exploratory analyses with a sub-sample of infants indicated that the parent, as compared to unfamiliar adult, spent more time looking at the infant after having looked at the priming event. This result suggests that the parent spent more time engaged in bids to "pay attention to what I am showing you". It is possible that parental attention encourages infants to focus more closely on the event, and the information presented in the event, which facilitates extraction of the relation between color and function. However, because of the small sample size we interpret these positive results with caution. In contrast, the infants who saw an unfamiliar as compared to familiar adult produce the priming events spent significantly more time engaged in joint attention during the priming trials. Apparently event sharing, at least in this context, does not facilitate color priming. The charge of future research will be to investigate in more detail and with a larger sample the extent to which parents and unfamiliar adults effectively utilize social cues in these types of situations.

3. Conclusion

Infants learn a great deal about the physical world in the presence of others. Yet relatively little is known about the extent to which the social context influences infants' capacity to gather information about physical objects. The current research investigated whether one social factor, who presents the information to the infant, influences color priming. The results revealed that 7.5-month-olds were more likely to benefit from viewing pound-pour events, and show sensitivity to color information in a subsequent test event, when the events were viewed within a social context. That is, when they could see the person producing the events. At the same time, infants' were not equally sensitive to all social agents. Infants were more successful at gathering and extracting information from the priming event when their parent, as compared to an unfamiliar adult, presented the event to them. In this priming task, it is the linking of object color to function, extracted after viewing multiple exemplars of pound-pour events, that leads to increased sensitivity to color information in subsequent test events (Wilcox & Chapa, 2004; Wilcox et al., 2007). Why is this process facilitated when a parent, as compared to an unfamiliar adult, acts as the "information presenter"?

One possible explanation involves emotional factors. Infants' begin to experience stranger anxiety around 7–8 months of age (Waters, Matas, & Sroufe, 1975). It may be that higher levels of anxiety and arousal prevented the infants in the unfamiliar adult condition from fully benefiting from the priming procedure. In comparison, the infants in the parent condition may have felt more at ease during the priming trials, leaving greater resources available for object processing. Although there was no evidence in our data to suggest that the stranger-as-experimenter group was more anxious or aroused than the parent-as-experimenter group (i.e., the groups did not differ in the amount of time they spent attending to the events, attending to the experimenter, or engaged in mutual gaze), our measures may have not been sufficiently sensitive. The use of more sophisticated behavioral and physiological measures of anxiety and arousal would aid in the testing of this hypothesis.

Another possible explanation for the parent bias observed here focuses on infants' perception of who is a reliable source of information. Young infants may place more weight on information presented by an individual with whom they are familiar, and have previously engaged in learning situations, than someone who is a stranger to them. There is a growing body of research on credulity in young children, which has revealed that not all sources of information are uniformly considered (e.g., Harris, 2007; Heyman & Legare, 2005; Jaswal & Neely, 2006; Nurmsoo & Robinson, 2009). There are a number of factors that influence who young children perceive as a reliable source of information, including past experience with an adult. The current research raises the possibility that even infants perceive some adults as more credible sources of information than others. If so, investigators will need to sort out the factors that influence whether infants are more likely to gather information from one source than another, and the extent to which these factors differ from those observed in young children.

Finally, it is possible that the current findings reflect, at least to some extent, differences in the social cues that parents and unfamiliar adults employ to engage and direct attention when presenting infants with information they perceive as important. Exploratory analysis conducted in Experiment 2 suggested that parents were more likely than unfamiliar adults to use cues to signal the infant to "pay attention, this is important". Although the small sample size leads us to interpret these preliminary data with caution, the fact that these behaviors occurred naturally, without instruction, is compelling.

It will be important to identify whether the parent-advantage observed in the present work generalizes to other contexts. A limited number of studies have investigated the effect of adult familiarity on object-related learning and memory in the infant, and what has been conducted comes from a single context: imitation. Imitation studies suggest that the extent to which infants learn and repeat novel actions on objects is not influenced by adult familiarity. Infants imitate novel object-related behaviors presented by mothers and strangers about equally. In addition, increased experience with an unfamiliar adult does not significantly impact imitation of novel object-related actions (Devouche, 1998, 2004). It is not until the second year that familiarity of the presenter influences imitative behaviors and then other factors, such as whether the unfamiliar presenter is a peer or an adult or whether the unfamiliar presenter is perceived as competent, also come into play. Yet the present studies revealed a clear parent-as-presenter advantage when infants viewed object-related actions in the context of pound and pour events. Because the priming task used in the present research differs in many ways from the imitation studies reviewed above, it is difficult to speculate as to why infants are more likely to benefit from viewing a parent as compared to an unfamiliar adult in one context but not the other. Collectively, however, these studies do reveal that the relationship between the infant and an adult presenter can influence object learning and that the conditions under which this occurs need to be better specified.

In summary, the present research reveals the importance of the relation between the "information presenter" and the infant in pedagogical situations and is the first to report that infants are more sensitive to object-related information presented by their parent than an unfamiliar adult. These findings have implications for knowledge acquisition in other domains, such as language learning and face processing (Melinder, Forbes, Tronick, Fikke, & Gredebäck, 2010; Seehagen & Herbert, 2010). It also lays the foundation for research geared toward identifying the underlying basis for the "parent advantage" observed here. We suspect that there are a number of factors that can influence the extent to which infants learn about physical objects within the social context.

References

Baillargeon, R. (1998). Infants' understanding of the physical world. In M. Sabourin, F. I. M. Craik, & M. Robert (Eds.), *Advances in psychological science: Vol. 1. Cognitive and biological aspects* (pp. 503–529). London: Psychology Press.

Baillargeon, R. (2004). Infants' reasoning about hidden objects: Evidence for event-general and event-specific expectations. *Developmental Science: 7.*, 391–414.

Baillargeon, R., Li, J., Ng, W., & Yuan, S. (2009). A new account of infants' physical reasoning. In A. Woodward, & A. Needham (Eds.), *Learning and the infant mind* (pp. 66–116). New York: Oxford University Press.

Barr, R., & Hayne, H. (1999). Developmental changes in imitation from television during infancy. *Child Development: 70.*, 1067–1081. http://dx.doi.org/10.1111/1467-8624.00079

Bigelow, A. E., Power, M., Mcquaid, N., Ward, A., & Rochat, P. (2008). Distinguishing mother–infant interaction from stranger–infant interaction at 2, 4, and 6 months of age. *Infancy: 13.*, (2), 158–171. http://dx.doi.org/10.1080/15250000701795614

Bigelow, A. E., & Rochat, P. (2006). Two-month-old infants' sensitivity to social contingency in mother–infant and stranger–infant interaction. *Infancy: 9.*, (3), 313–325. http://dx.doi.org/10.1207/s15327078in0903_3

Cleveland, A., Schug, M., & Striano, T. (2007). Joint attention and object learning in 5- and 7-month-old infants. *Infant and Child Development: 16.*, (3), 295–306. http://dx.doi.org/10.1002/icd.508

Cleveland, A., & Striano, T. (2007). The effects of joint attention on object processing in 4- and 9-month-old infants. *Infant Behavior & Development: 30.*, (3), 499–504. http://dx.doi.org/10.1016/j.infbeh.2006.10.009

Csibra, G., & Gergely, G. (2005). Social learning and social cognition: The case for pedagogy. In M. H. Johnson, & Y. Munakata (Eds.), *Processes of change in the brain and cognitive development, attention and performance XXI*. Oxford: Oxford University Press.

D'Entremont, B., Hains, S. M. J., & Muir, D. W. (1997). A demonstration of gaze following in 3- to 6-month-olds. *Infant Behavior and Development: 20.*, (4), 569–572. http://dx.doi.org/10.1016/S0163-6383(97)90048-5

Devouche, E. (1998). Imitation across changes in object affordances and social context in 9-month-old infants. *Developmental Science: 1.*, (1), 65–70. http://dx.doi.org/10.1111/1467-7687.00014

Devouche, E. (2004). Mother versus stranger: A triadic situation of imitation at the end of the first year of life. *Infant and Child Development: 13.*, (1), 35–48. http://dx.doi.org/10.1002/icd.334

Farroni, T., Csibra, G., Simion, F., & Johnson, M. (2002). Eye contact detection in humans from birth. *Proceedings of the National Academy of Sciences: 99.*, 9602–9605. http://dx.doi.org/10.1073/pnas.152159999

Farroni, T., Massaccesi, S., Pividori, D., & Johnson, M. H. (2004). Gaze following in newborns. *Infancy: 5.*, (1), 39–60. http://dx.doi.org/10.1207/s15327078in0501_2

Gergely, G., Egyed, K., & Ildikó, K. (2007). On pedagogy. *Developmental Science: 10.*, (1), 139–146.

Harris, P. L. (2007). Trust. *Developmental Science: 10.*, 135–138.

Heyman, G. D., & Legare, C. H. (2005). Children's evaluation of sources of information about traits. *Developmental Psychology: 41.*, 636–647. http://dx.doi.org/10.1037/0012-1649.41.4.636

Jaswal, V. K., & Neely, L. A. (2006). Adults don't always know best: Preschoolers use past reliability over age when learning new words. *Psychological Science: 17.*, 757–758. http://dx.doi.org/10.1111/j.1467-7687.2007.00575.x

Kopp, F., & Lindenberger, U. (2011). Effects of joint attention on long-term memory in 9-month-old infants: An event-related potentials study. *Developmental Science: 14.*, (4), 660–672. http://dx.doi.org/10.1111/j.1467-7687.2010.01010.x

McCurry, S., Wilcox, T., & Woods, R. (2009). Beyond the search barrier: New evidence for object individuation in young infants. *Infant Behavior & Development: 32.*, 429–436.

Melinder, A., Forbes, D., Tronick, E., Fikke, L., & Gredebäck, G. (2010). The development of the still-face effect: Mothers do matter. *Infant Behavior & Development: 33.*, (4), 472–481. http://dx.doi.org/10.1016/j.infbeh.2010.05.003

Needham, A., Barrett, T., & Peterman, K. (2002). A pick-me-up for infants' exploratory skills: Early simulated experiences reaching for objects using 'sticky mittens' enhances young infants' object exploration skills. *Infant Behavior & Development: 25.*, 279–295.

Needham, A., & Ormsbee, S. M. (2003). The development of object segregation during the first year of life. In R. Kimchi, M. Behrmann, & M. C. Olson (Eds.), *Perceptual organization: Behavioral and neural perspectives* (pp. 205–232). Mahwah, NJ: Erlbaum.

Nielsen, M., Simcock, G., & Jenkins, L. (2008). The effect of social engagement on 24-month-olds' imitation from live and televised models. *Developmental Science: 11.*, (5), 722–731. http://dx.doi.org/10.1111/j.1467-7687.2008.00722.x

Nurmsoo, E., & Robinson, E. J. (2009). Children's trust in previously inaccurate informants who were well or poorly informed: When past errors can be excused. *Child Development: 80.*, 23–27.

Pascalis, O., de Schonen, S., Morton, J., & Deruelle, C. (1995). Mother's face recognition by neonates: A replication and an extension. *Infant Behavior & Development: 18.*, (1), 79–85. http://dx.doi.org/10.1016/0163-6383(95)90009-8

Ryalls, B. O., Gul, R. E., & Ryalls, K. R. (2000). Infant imitation of peer and adult models: Evidence for a peer model advantage. *Merrill-Palmer Quarterly: 46.*, (1), 188–202. Retrieved from:. http://libezproxy.tamu.edu:2048/login?url=http://search.proquest.com/docview/619459637?accountid=7082

Seehagen, S., & Herbert, J. S. (2010). The role of demonstrator familiarity and language cues on infant imitation from television. *Infant Behavior & Development: 33.*, (2), 168–175. http://dx.doi.org/10.1016/j.infbeh.2009.12.008

Seehagen, S., & Herbert, J. (2012). Selective imitation in 6-month-olds: The role of the social and physical context. *Infant Behavior & Development: 35.*, 509–512.

Spelke, E. S. (1990). Principles of object perception. *Cognitive Science: 14.*, 29–56.

Spelke, E. S., & Kinzler, K. D. (2007). Core knowledge. *Developmental Science: 10.*, 9–96.

Stenberg, G. (2009). Selectivity in infant social referencing. *Infancy: 14.*, (4), 457–473. http://dx.doi.org/10.1080/15250000902994115

Stenberg, G., & Hagekull, B. (2007). Infant looking behavior in ambiguous situations: Social referencing or attachment behavior? *Infancy: 11.*, 111–129.

Striano, T., Chen, X., Cleveland, A., & Bradshaw, S. (2006). Joint attention social cues influence infant learning. *European Journal of Developmental Psychology: 3.*, (3), 289–299. http://dx.doi.org/10.1080/17405620600879779

Walden, T., & Kim, G. (2005). Infants social looking toward mothers and strangers. *International Journal of Behavioral Development: 29.*, (5), 356–360. http://dx.doi.org/10.1080/01650250500166824

Wang, S., & Baillargeon, R. (2005). Inducing infants to detect a physical violation in a single trial. *Psychological Science*, 542–549.

Wang, S., & Baillargeon, R. (2008). Detecting impossible changes in infancy: A three-system account. *Trends in Cognitive Sciences: 12.*, 17–23.

Waters, E., Matas, L., & Sroufe, L. (1975). Infants' reactions to an approaching stranger: Description, validation, and functional significance of wariness. *Child Development: 46.*, 348–356.

Watson, J. S. (1979). Perception of contingency as a determinant of social responsiveness. In E. B. Thomas (Ed.), *Origins of the infant's social responsiveness* (pp. 33–64). Hillsdale, NJ: Erlbaum.

Wilcox, T., & Baillargeon, R. (1998a). Object individuation in infancy: The use of featural information in reasoning about occlusion events. *Cognitive Psychology: 37.*, 97–155.

Wilcox, T., & Baillargeon, R. (1998b). Object individuation in young infants: Further evidence with an event monitoring task. *Developmental Science: 1.*, 127–142.

Wilcox, T., & Chapa, C. (2004). Priming infants to attend to color and pattern information in an individuation task. *Cognition: 90.*, 265–302.

Wilcox, T., & Schweinle, A. (2002). Object individuation and event mapping: Developmental changes in infants' use of featural information. *Developmental Science: 5.*, (1), 132–150.

Wilcox, T., Smith, T., & Woods, R. (2011). Priming infants to use pattern information in an object individuation task: The role of comparison. *Developmental Psychology: 47.*, (3), 886–897.

Wilcox, T., & Woods, R. (2009). Experience primes infants to individuate objects: Illuminating learning mechanisms. In A. Needham, & A. Woodward (Eds.), *Learning and the infant mind* (pp. 117–143). NY: Oxford University Press.

Wilcox, T., Woods, R., & Chapa, C. (2008). Color-function categories that prime infants to use color information in an object individuation task. *Cognitive Psychology: 57.*, 220–261.

Wilcox, T., Woods, R., Chapa, C., & McCurry, S. (2007). Multisensory exploration and object individuation in infants. *Developmental Psychology: 43.*, 479–495.

Zmyj, N., Buttelmann, D., Carpenter, M., & Daum, M. M. (2010). The reliability of a model influences 14-month-olds' imitation. *Journal of Experimental Child Psychology: 106.*, (4), 208–220. http://dx.doi.org/10.1016/j.jecp.2010.03.002

Zmyj, N., Daum, M. M., Prinz, W., & Aschersleben, G. (2012). Infants' attentional preference for object-related actions of older children compared to object-related actions of peers and adults. *Infant Behavior & Development: 35.*, (3), 533–542. http://dx.doi.org/10.1016/j.infbeh.2012.03.003

Zmyj, N., Daum, M. M., Prinz, W., Nielsen, M., & Aschersleben, G. (2012). Fourteen-month-olds' imitation of differently aged models. *Infant and Child Development: 21.*, (3), 250–266. http://dx.doi.org/10.1002/icd.750