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Nine-month-old infants generalize object labels, but not object preferences across individuals

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Abstract

As with all culturally relevant human behaviours, words are meaningful because they are shared by the members of a community. This research investigates whether 9-month-old infants understand this fundamental fact about language. Experiment 1 examined whether infants who are trained on, and subsequently habituated to, a new word-referent link expect the link to be consistent across a second speaker. Experiment 2 examined whether 9-month-old infants distinguish between behaviours that are shared across individuals (i.e., words) from those that are not (i.e., object preferences). The present findings indicate that infants as young as 9 months of age expect new word-referent links, but not object preferences, to be consistent across individuals. Thus, by 9 months, infants have identified at least one of the aspects of human behaviour that is shared across individuals within a community. The implications for children's acquisition of language and culture are discussed.

Keywords

shared knowledge; conventionality; culture; pedagogy; infant cognition; action perception; language development

Introduction

A defining feature of the human species is the fundamental role that culture plays in shaping our interactions with one another. Culturally relevant behaviours include the linguistic and social conventions that pervade nearly every facet of our lives and have meaning because they are shared by the members of our social group (Hofstede, 2001). To illustrate, consider the way in which communication breaks down when individuals from different linguistic communities attempt to communicate. Evidence suggests that children generate shared forms of behaviour early in development (for a review see Tomasello, Carpenter, Call, Behne, & Moll, 2005). By 12 months, infants produce their first words (e.g., Fenson et al., 1994; Huttenlocher & Smiley, 1987) and other conventional actions (e.g., Bakeman & Adamson, 1986; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Messinger & Fogel, 1998). Interestingly, children's learning systems might be geared towards information that is likely to be shared by their own community (Henderson, Sabbagh, Woodward, & Saby, 2009; Kinzler, Dupoux, & Spelke, 2007; Kinzler, Shutts, DeJesus, & Spelke, 2009). Despite knowing that infants engage in shared forms of behaviour within the first year of

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their lives after birth, little is known about whether young infants understand these behaviours as shared forms. The present research investigates whether 9-month-old infants understand the shared nature of words and if so, whether they appreciate that words are shared across individuals while other forms of human behaviour are not.

Evidence demonstrating that children produce shared forms of human behaviour by their first birthday (for a review see Tomasello et al., 2005) has led to a growing interest in the processes and mechanisms through which children acquire such behaviours (e.g., Csibra & Gergely, in press, 2009; Gergely, Egyed, & Kiraly, 2007; Tomasello et al., 2005). An emerging theme in this research is the critical role that infants' participation in communicative exchanges with the members of their social world is hypothesized to play in the acquisition of culturally relevant forms of human behaviour. Tomasello and colleagues (Tomasello, 1999; Tomasello et al., 2005) argue that communicative episodes involving joint attention in which an adult and an infant are jointly focused (and aware of this shared focus) on some common element of the context are the primary forces driving the transmission of shared knowledge. Csibra and colleagues similarly argue that communicative exchanges are critical for cultural transmission. They posit that infants are naturally sensitive to a number of ostensive communicative signals that are provided by speakers (e.g., eye gaze, infant-directed speech) and that the presence of these cues cues leads infants to assume that the information presented is generalizeable and culturally universal (see Csibra & Gergely, 2009; Gergely et al., 2007).

Evidence documenting infants' engagement in joint attention episodes (e.g., Gredebäck, Fikke, & Melinder, 2010) and sensitivity to ostensive signals (for a review see Csibra, 2010) offers mounting empirical support for the notion that human communicative episodes play a critical role in the transmission and acquisition of shared knowledge. However, ostensive communicative contexts present a challenge for cultural learners because not every piece of information introduced during such contexts is culturally universal. Consider an infant who observes his mother scream "look, a mouse!" while pointing at an animal that is unfamiliar to him. To fully comprehend his mother's actions, the infant must appreciate that her actions are meaningful at two levels. At the personal level, the infant must understand that his mother's behaviour is guided by her attention (e.g., she is referring to something she can see) and driven by an underlying intention (e.g., she is warning him of the approaching animal). He must also identify how his mother feels about the animal and understand that other individuals might not feel the same way. Identifying his mother's feelings towards the animal would help him predict her future actions (e.g., whether she is likely to allow him to have a pet mouse). The infant must also understand that there are aspects of the event, which are meaningful because they will be shared by the other members of his social group. In particular, he must appreciate that the word "mouse" is not an idiosyncratic term that only his mother knows, but is also known by the broader linguistic community. Thus, because shared behaviours are accompanied by information that is unique to the individual producing the behaviour, identifying the shared forms of human behaviour is not a straightforward problem to solve.

Recent evidence suggests that infants understand quite a bit about the personal aspects of human behaviour (for reviews see Luo & Baillargeon, 2010; Woodward, Sommerville, Gerson, Henderson, & Buresh, 2009; Woodward, 2009). By 9 months, infants appreciate that: 1) human action is generally goal-directed and driven by one's underlying intentions (e.g., Sommerville & Woodward, 2005; Woodward, 1998), 2) perceptual access and attention are important elements guiding human action (e.g., Luo, 2010; Luo & Johnson, 2009; Onishi & Baillargeon, 2005; Phillips, Wellman, & Spelke, 2002), and 3) human action is driven by preferences towards one object over another (Luo & Baillargeon, 2005; Luo & Johnson, 2009; Sommerville & Crane, 2009). These studies did not investigate whether

infants generalized information across different individuals, nor did they examine infants' understanding of shared forms of human behaviour.

To date, the evidence surrounding young children's understanding of shared forms of human action has focused on whether children appreciate that linguistic labels are shared across speakers (Buresh & Woodward, 2007; Graham, Stock, & Henderson, 2006; Henderson & Graham, 2005). The first direct investigation of this question was conducted by Henderson and Graham (2005) in which 24-month-olds were taught a new word-referent link and were asked to select the referent of the word in a subsequent comprehension test. Infants who were asked the comprehension test question by a speaker who was not present when the word-referent link was taught were just as likely to select the target object as were infants who were asked the comprehension test question by the same speaker who taught them the link. These findings suggest that 24-month-olds expect word meanings to be consistent across speakers of the same linguistic community (see Graham et al., 2006 for results with 19-month-olds; see also Woodward, Markman, & Fitzsimmons, 1994).

Buresh and Woodward (2007) recruited a visual habituation paradigm to examine whether younger infants will generalize linguistic labels across speakers. Thirteen- and 9-month-old infants were repeatedly shown an event in which a speaker provided a novel label (i.e., modi) while looking at and grasping one of two novel objects. After infants were habituated to that event, the sides on which the toys were located were switched and infants were shown test trials in which a speaker provided the word while holding either the same object or the other object that she had not previously interacted with. Half of the infants saw the same speaker perform the test events; the remaining infants saw a different speaker perform the test events. Infants at both ages looked longer when the same speaker violated the word-object association. However, only the 13-month-olds looked longer when the word-object association was violated by a different speaker. These findings suggest an understanding of the shared nature of words is present by 13 months, but may be absent before that age.

Buresh and Woodward's (2007) findings raise interesting questions surrounding the factors that might play a role in the development of an understanding of shared forms of human behaviour. One possibility is that infants might only come to understand that words are shared as they begin to produce words, or make further gains in their receptive vocabulary. If this were the case, it is reasonable that an understanding of the shared nature of words would develop between 9- and 13-months since this is a time in which infants show the first signs of reliable production of words and experience substantial receptive vocabulary growth (Fenson et al., 1994). However, it is also possible that 9-month-olds' failure to evidence an understanding of the shared nature of words might have stemmed from other factors, such as high task demands (Buresh & Woodward, 2007). For instance, Buresh and Woodward's habituation paradigm might not have offered infants enough experience with the new word-referent link for them to generalize it across speakers; a notion supported by their finding that including labels in the habituation events seemed to weaken 9-month-olds' responses even when the same speaker was present. Considering this, it seems reasonable that infants under one year of age would require more support in tasks that require them to integrate new words with a person's referential actions.

We address this possibility in Experiment 1 by investigating whether 9-month-olds would demonstrate an understanding of the shared nature of words when they are provided with additional training on a new word-referent link in a context rich with ostensive cues. To do this, infants participated in three additional training rounds in which an experimenter used infant directed speech, alternated her gaze between the infant and the object, and provided the word-referent link four times (resulting in twelve additional exposures to the link) before participating in Buresh and Woodward's habituation paradigm. Following the findings from

our first experiment, Experiment 2 investigated whether 9-month-olds appreciate that words are special in that they are shared across speakers, while other information such as object preferences are not. If infants have begun to distinguish between the shared and non-shared forms of human behaviour before their first birthday, then providing 9-month-olds with additional training in a rich communicative context might help them to generalize word-referent links across individuals, but should not lead them to generalize non-conventional forms, such as expressions of preference. If, however, infants initially assume that any information provided in a communicative context rich with ostensive cues is generalizable, infants might extend both words and preferences across individuals. The findings of the experiments reported here provide novel insights about how infants begin to differentiate between the person-specific and person-general aspects of human behaviour and thus, inform current understanding of the processes through which children acquire culturally universal knowledge.

Experiment 1

Method

Participants—Forty full-term infants (*mean age* = 9 months, 6 days, range = 8 months, 7 days to 10 months, 18 days) who were exposed to English more than 70% of the time were recruited from a database of families managed by a large university in the Eastern United States. Families had responded to advertisements stating that they were interested in volunteering for infant development studies. Thirty-six infants were classified as Non-Hispanic and of the following races: White ($n = 23$), Black ($n = 6$), Asian ($n = 2$), and more than one race ($n = 5$). Two infants were Hispanic and White, and demographic data from the remaining two infants were not available. Twenty infants participated in the Same Actor condition (12 males, 8 females; *mean age* = 9 months, 7 days) and twenty infants participated in the Switch Actor condition (8 males, 12 females; *mean age* = 9 months, 5 days). Seven additional infants began the experiment, but were removed from the final sample due to experimenter error ($n = 2$) or because they became too distressed to complete the procedure ($n = 5$). Infants received a small toy and a certificate for participating.

Parents completed the long version of the MacArthur Vocabulary Inventory: Words and Gestures (Fenson et al., 1994), which provides a measure of the number of words understood and produced and gestures produced by infants 7- to 18-months-old. The MCDI was used to: 1) ensure that infants in the two conditions did not differ on vocabulary size or gesture production and 2) investigate whether infants' language development is related to their pattern of looking during test trials. The conditions did not differ in infants' word comprehension ($t(31) = 1.38$, $p > .10$, $d = 0.50$, $r = 0.24$), word production ($t(31) = 1.20$, $p > .20$, $d = 0.43$, $r = 0.21$), or gesture production ($t(31) < 1$, $d = 0.25$, $r = 0.12$) scores (see Table 1). Possible associations between infants' MCDI scores and their looking on the test trials are addressed in the results section.

Materials and Procedure

Training—During this phase, the infant sat on his or her parent's lap at a table across from the experimenter and were shown two novel objects (see Figure 1). One of these objects (the target) was linked with a novel word (i.e., modi) and the other object (the distractor) was shown to the infant but not labeled. There were a total of three training rounds. In each round the experimenter picked up the target object and labeled it four times (e.g., "Look a modi. This is called a modi. Look at the modi. Yup, that's a modi."). The experimenter then picked up and drew attention to the distractor object (e.g. "Look at this. This one's pretty cool. It's colourful. Yup, that's neat."). The experimenter left the room and re-entered the room after five seconds marking the beginning of the next training round.

After the final training round, a second experimenter entered the room and the two experimenters played a game of peek-a-boo with the infant in order to allow him or her to become familiar with each of them individually and side-by-side. This familiarization was particularly important for infants in the Switch Actor condition, who would see both experimenters during the course of the habituation procedure (see below).

Habituation-dishabituation—The parent and infant were then escorted into the habituation room. The infant was seated on his or her parent's lap approximately 69 cm away from a small table-top stage on which the habituation and test events were presented. The two objects from training were placed on the table 20 cm apart and 5 cm from the front of the stage. The experimenter who had administered training served as the habituation actor and was seated on a bench behind the table at a distance of 64 cm from each object (see Figure 1). Infants were habituated to an event in which the actor provided the novel label ("Hi. A modi."), retrieved the target object, and while looking at the object in her hand, provided the label a second time ("A modi."). The actor maintained this final position until the infant looked away to end the trial. At the end of each trial the screen was raised to hide the stage from infants' view while the actor set up for the next trial.

Infants were shown the habituation event until their total looking on three consecutive trials fell below half of the total amount of time they looked on the first three trials or until 14 trials had elapsed. After this criterion was reached infants watched one more trial of the habituation event (i.e., baseline). Then, while the screen was raised and the stage was out of the infant's view, the positions of the target and distractor objects were reversed. In the Switch Actor condition, the first experimenter exited the stage and the second experimenter took his or her place. In the Same Actor condition, the first experimenter remained in place. To familiarize infants to the set-up for the test trials, infants watched one trial in which the actor looked at infants and said, "Hi. Where's the modi?" Infants then watched six test events in which the actor provided the same label as in habituation and alternated picking up either the same object (old-object test trials) or the other object (new-object test trials).

The following factors were fully counterbalanced across infants in each condition: target object, test trials (i.e., old-object trial first vs. new-object trial first), and gender of the experimenter who presented the training (and habituation) and test events. Infants who watched the male actor during training and habituation, watched the female at test, and vice versa.

Throughout the habituation, familiarization and test phases, infants' looking on each trial was timed beginning from when the actor stopped moving until the end of the trial, which occurred when the infant looked away for two seconds or when 120 seconds had elapsed. Infants' looking was coded online using a coding program (Casstevens, 2007) by an observer who was unaware of the condition to which the infant had been assigned and could not see any of the events. To assess reliability, the test trials for all infants were coded offline by a second coder using digitized recordings. Coders were counted as in agreement if they judged the same look away to have ended the trial. In both conditions, coders were in agreement on 93% of the test trials. We also assessed whether the directions of the disagreements reflected bias with respect to the hypothesized findings. Each disagreement was classified based on the direction of the disagreement and the test trial type on which it occurred. Fisher's exact tests revealed that the distribution of disagreements was unsystematic across test event types ($p > 0.5$, two-tailed).

Results and Discussion

Infants' average looking times during the habituation, familiarization, and test trials are summarized in Table 2. Initial analyses confirmed that infants in both conditions showed

comparable levels of attention during the habituation and familiarization trials. A 6 (habituation trial: first, second, third, third to last, second to last, last) × 2 (condition: Same Actor, Switch Actor) mixed-design analysis of variance (ANOVA) revealed a significant main effect of habituation trial indicating a general decline in infants' attention across the six habituation trials, $F(5, 190) = 19.05$, $p < .001$, $\eta_{partial}^2 = .33$. There were no other reliable effects. The conditions did not differ in the average number of trials in which infants habituated, $t(38) < 1$, $d = 0.04$, $r = 0.02$. Infants in the Same Actor condition habituated in an average of 7.7 trials ($SE = 0.6$) and infants in the Switch Actor condition habituated in an average of 7.6 trials ($SE = 0.6$). The conditions did not differ in infants' attention on the familiarization trial, $t(38) = 1.67$, $p = .10$, $d = 0.54$, $r = 0.26$.

The focal analyses tested whether infants responded by looking longer when the label was applied to the distractor object (new-object trials) as compared to the target object (old-object trials) and whether this response differed across conditions. Preliminary analyses revealed no significant effects of infant gender, the object that was the habituation goal, or the experimenter on infants' average looking on the different test trials. Therefore, subsequent analyses were collapsed across these dimensions. We conducted a 2 (test trial type: old-object, new-object) × 2 (first test trial: old-object, new-object) × 2 (condition: Same Actor, Switch Actor) mixed-design ANOVA with test trial type as the within-subject factor1. The ANOVA revealed a significant main effect of condition, $F(1, 36) = 8.21$, $p = .007$, $\eta_{partial}^2 = .19$, reflecting longer overall looking times for infants in the Switch Actor condition ($M = 7.52$, $SE = 0.65$) than Same Actor condition ($M = 4.89$, $SE = 0.65$). There was also a significant main effect of test trial type, $F(1, 36) = 5.58$, $p = .024$, $\eta_{partial}^2 = .13$, reflecting longer overall looking times during the new-object test trials ($M = 6.72$, $SE = 0.59$) than the old-object test trials ($M = 5.69$, $SE = 0.41$). This main effect was qualified by a significant two-way interaction between first test trial and test trial type, $F(1, 36) = 5.39$, $p = .026$, $\eta_{partial}^2 = .13$.2 This interaction reflects the fact that infants' preference for new-object over old-object trials was greater for those infants who received new-object trials first. Thus, these analyses indicate a tendency for infants across conditions to look longer on new-object than old-object trials.

To test whether this tendency was reliable in both conditions, we conducted two 2 (test trial type: old-object, new-object) × 2 (first test trial: old-object, new-object) mixed-design ANOVAs with test trial type as the within-subject factor for each condition. The ANOVA for the Same Actor condition revealed a significant main effect of test trial type, $F(1, 18) = 9.01$, $p = .008$, $\eta_{partial}^2 = .33$, reflecting overall looking times during the new-object test trials. There were no other reliable effects. The ANOVA for the Switch Actor condition revealed no reliable effects, however the interaction between test trial type and first test trial was approaching significance, $F(1, 18) = 4.26$, $p = .054$ $\eta_{partial}^2 = .19$, suggesting a tendency for infants in the Switch Actor condition to look longer on the new-object test trials when a new-object test trial was the first test trial.

Analyses at the individual level confirmed these results. Seventeen of 20 infants in the Same Actor condition looked longer on the new-object test trials than on the old-object test trials, $p = .003$ (paired sign test). In the Switch Actor condition, 12 of the 20 infants looked longer on the new-object test trials than on the old-object test trials, $p = 0.5$ (paired sign test). These analyses indicate that although infants in the Same Actor condition looked reliably longer on new-object than old-object trials, as a group, infants in the Switch Actor condition did not.

[1]Including test pair in the ANOVA revealed general trends of decreasing attention across test pairs. Infants' relative preference for new-object versus old-object events in each condition did not not differ as a function of test pair. Thus, we collapsed across test pair in all analyses.

[2]The analyses were repeated excluding the four infants (two per condition) who did not habituate. Since the findings were the same, we report the analyses using all of the infants.

In the next set of analyses, we investigated whether, despite the group level findings, there were individual differences in infants' responses in the Switch Actor condition. The results of our focal analyses revealed that infants in the Switch Actor condition looked significantly longer across all of the test trials than did infants in the Same Actor condition. This suggests that infants in the Switch Actor condition might not have had sufficient time to register both the new presenter and the new positions of the toys prior to the onset of test trials. Their longer looking overall during test trials suggests that they had not had time to process these new elements of the scene, and this may have disrupted their attention to the objects and the presenter's actions on them. To investigate this possibility we coded infants' looking to the three critical regions (i.e., presenter and each of the two objects) during the familiarization trial. A second coder coded 25% of the clips for reliability (% agreement = 89%, kappa = 0.82). This coding revealed that all infants attended to the speaker during familiarization. However, some infants in the Same Actor condition ($n = 5$) and the Switch Actor condition ($n = 8$) did not attend to both of the objects during familiarization. Because infants who did not attend to both of the objects might not have had a sufficient amount of time to acclimate to the change in their locations prior to the test trials, we reanalyzed the test trials excluding these infants. The findings of the Same Actor condition remained the same; 12 of the 15 infants who looked at all three of the critical areas during the familiarization trial looked longer on the new test trials than they did on the old test trials, $p = .035$ (paired sign test). Interestingly, the findings differed for the Switch Actor condition; 10 of the 12 infants who looked at all three critical regions during familiarization looked longer on the new test trials than they did on the old test trials, $p = .039$ (paired sign test). Thus, 9-month-olds generalized new linguistic forms across speakers, but only if they had attended to *both* of the objects during familiarization.

In the final set of analyses, we explored whether infants' looking towards the different test trial types was related to their language abilities (as assessed by the MCDI). Bivariate correlations were conducted for each condition to explore possible associations between infants' looking towards the old- and new-object test trials and the number of words that parents reported their infants understood, produced, and the number of gestures produced at the time of testing. No significant correlations were revealed in either condition. Thus, infants' tendency to look longer towards a violation of a new word-referent link (either by the same or a different speaker) was not related to any of the obtained measures of infants' language development.

In sum, the findings from the Experiment 1 were mixed. Although the overall trend was for infants to look longer on new-object than old-object trials, only infants in the Same Actor condition showed a reliable preference for new-object trials when analyzed separately. Infants in the Switch Actor condition did not show a reliable pattern of response as a group. However, follow-up coding and analyses suggested that infants in this condition who were attentive to the change in object positions during the familiarization trial responded as did infants in the Same Actor condition, by looking longer on new-object than on old-object trials. This finding raises the interesting possibility that providing infants with additional exposure to a word-referent link in a context rich with ostensive cues might guide infants to generalize the link across individuals in the same linguistic community, if we provided them with additional time to acclimate to the presence of the new presenter and the reversed object positions prior to the test trials. In Experiment 2 we tested this possibility by investigating whether providing infants with an additional familiarization trial, which introduced them to the reversed toy positions prior to the introduction of the second presenter, would support systematic responding in the Switch Actor condition.

Experiment 2

To investigate whether infants would generalize a new word-referent link across individuals, one group of infants participated in the same sequence of events as did infants in the Switch Actor condition of Experiment 1 with one difference: there was an additional familiarization trial after the habituation criterion was reached. For this trial, the locations of the toys were switched, but the habituation experimenter remained. After this familiarization trial, there was a second familiarization trial with the new experimenter present. The test events proceeded in the same manner as in Experiment 1.

Experiment 2 also investigated whether additional training would guide infants to generalize any piece of verbal information that accompanies a goal-directed action across speakers (even when it is inappropriate to do so). Buresh and Woodward (2007) found that 9-month-olds do not generalize goal-directed actions that are accompanied by a verbal statement of preference (i.e., “ooh, mm”) across individuals. However, additional exposure to a person’s verbal statements of preference in a communicative context fortified with ostensive cues might lead infants to generalize this information across individuals as well. Indeed, as reviewed above, it has been hypothesized that ostensive cues support infants’ generalization of socially provided information (Csibra, 2010; Csibra & Gergely, 2009; Gergely et al., 2007). To evaluate this possibility, we tested a second group of infants with events in which an experimenter expressed a verbal preference for one of two objects in three additional training rounds before participating in the habituation paradigm. Of interest was whether infants would expect a second experimenter to act in the same way towards the same object. If infants generalize object labels across individuals, but not verbal expressions of preference, this would suggest that 9-month-old infants have begun to delimit which aspects of human behaviour are shared and which aspects are not.

Method

Participants—Forty full-term infants (*mean age* = 9 months, 9 days, range = 8 months, 6 days to 10 months, 12 days) who were exposed to English at least 70% of the time participated in this experiment and were recruited in the same way as in Experiment 1. Thirty-one infants were classified as Non-Hispanic and of the following races: White (n = 23), Black (n = 5), Asian (n = 2), and more than one race (n = 1). Four infants were Hispanic and White. There were four Hispanic infants whose race was unknown. One infant was of an unknown race and ethnicity. Twenty infants participated in the Word condition (10 females; *mean age* = 9 months, 9 days) and 20 infants participated in the Preference condition (9 females, 11 males; *mean age* = 9 months, 6 days). Eight additional infants began the experiment, but were not included in the final sample for the following reasons: inability to complete the procedure due to distress (n = 5), presenter error (n = 2), and external interference during test trials (n = 1).

Parents also completed the long version of the MCDI: Words and Gestures (Fenson et al., 1994). Infants in the two conditions did not differ in word comprehension ($t(24) = 1.21$, $p > .20$, $d = 0.46$, $r = 0.22$), word production ($t(24) < 1$, $d = 0.10$, $r = 0.05$), or gesture production ($t(24) < 1$, $d = 0.17$, $r = 0.08$) scores (see Table 1).3 Possible associations between infants’ MCDI scores and their looking on the test trials are addressed in the results section.

[3]One infant in the Word Condition was an outlier in word comprehension (181 words). MCDI data from this infant is not included in Table 1. The results did not differ with this infant’s data included.

Materials and Procedure

Training—Infants in the Word condition participated in three rounds of training on a new word-referent link as described in Experiment 1. Infants in the Preference condition participated in three rounds of training in which an experimenter demonstrated an object preference for one of the objects. The experimenter's physical actions were the same as in the Word condition, however the actor's verbalizations and affect differed slightly. Specifically, the experimenter picked up the target object and verbalized a preference for the object in four different ways (e.g., "Ooh, I like that. This is the one I really like. This is my favourite. Yup, I like that one."). The experimenter also provided several non-verbal cues of preference, which included positive facial expressions (smiling at the target object) and vocal tone. The experimenter then drew attention to the other object in the same way as in Experiment 1. However, to contrast with the nonverbal cues for the 'favourite' object, the experimenter maintained a neutral facial affect and vocal tone while attending to and talking about the other object (e.g., "Look at this. This one's pretty cool. It's colourful. Yup, that's neat."). After referring to the distractor object the experimenter left the room for approximately 5 seconds and after returning to the room, began the next training round (as in Experiment 1). As in Experiment 1, after training the second experimenter entered the room for a brief peek-a-boo game to ensure that infants were familiar with each experimenter.

Habituation-dishabituation—The parent and infant were then escorted into the habituation room, which was set-up as in Experiment 1. Infants in the Word condition viewed the same habituation and test events as described in Experiment 1. Infants in the Preference condition were habituated to an event in which the training experimenter looked at the target object, emoted positively ("Hi. Ooh."), retrieved the target object, and emoted positively again ("Mmm") while maintaining focus on the object. Looking time was coded and the habituation criterion established in the same manner as in Experiment 1.

After reaching the habituation criterion and watching the baseline event, the screen was raised and the locations of the objects were reversed (as in Experiment 1). Two familiarization trials followed: the first was presented by the experimenter who had presented the habituation events and the second was presented by the other experimenter. On each familiarization trial the experimenter faced the infant and asked either "Where is the modi?" (Word condition) or "Where did it go?" (Preference condition). After the second familiarization trial, the second experimenter presented the six test trials. For infants in the Word condition the test trials were exactly the same as in the Switch Actor condition in Experiment 1. For the test events in the Preference condition, the test experimenter looked at, emoted positively ("Hi. Ooh. Mmm."), and retrieved either the same object (old-object trials) or the distractor object (new-object trials). Infants' looking time was coded and reliability coded the same way as in Experiment 1. The original coder and the reliability coder agreed on 90% of the test trials. The distribution of disagreements was unsystematic across the two types of test trials (Fisher's Exact Test, $p > 0.40$, two-tailed).

Results and Discussion

Infants' average looking times are summarized in Table 2. The first series of analyses confirmed that infants in the two conditions showed comparable levels of attention during the habituation and familiarization trials. A 6 (habituation trial: first, second, third, third to last, second to last, last) × 2 (condition: Same Actor, Switch Actor) mixed-design ANOVA revealed a significant main effect of habituation trial indicating a general decline in infants' attention across habituation trials, $F(5, 190) = 27.49$, $p < .001$, $\eta_{partial}^2 = .42$. There were no other reliable effects. There were no condition differences in the average number of habituation trials, $t(38) < 1$, $d = 0.09$, $r = 0.05$. Infants in the Word condition habituated in an

average of 8.5 trials (SE = 0.7) and infants in the Preference condition habituated in an average of 8.2 trials (SE = 0.5). The conditions did not differ in infants' attention on either the first or the second familiarization trial, $t(38) < 1$, $d = 0.23$, $r = 0.11$, and $t(38) = 1.82$, $p = .08$, $d = 0.59$, $r = 0.28$, respectively.

The questions of interest were whether infants would succeed in generalizing words across experimenters in the Word condition and whether infants in the Preference condition would generalize the first experimenter's object preference information to the second experimenter. Preliminary analyses revealed no significant effects of infant gender, target object, or experimenter on infants' average looking on the test trials. Therefore, our subsequent analyses collapsed across these dimensions. A 2 (test trial type: old-object, new-object) × 2 (first test trial: old-object, new-object) × 2 (condition: Word, Preference) mixed-design ANOVA with test trial type as the within-subject factor showed a significant two-way interaction between the type of test trial and first test trial, $F(1, 36) = 5.92$, $p = .02$, $\eta_{partial}^2 = .14$, and, most importantly, a significant two-way interaction between condition and test trial type, $F(1, 36) = 4.48$, $p = .04$, $\eta_{partial}^2 = .11$. No other effects were significant.[4,5]

To further explore our findings we conducted a 2 (test trial type: old-object, new-object) × 2 (first test trial: old-object, new-object) follow-up ANOVA for each condition. The ANOVA for the Word condition revealed a significant main effect of test trial type, $F(1, 18) = 1.30$, $p = .005$, $\eta_{partial}^2 = .36$ and no other reliable effects. Infants in the Word condition looked significantly longer on the new-object test trials than they did the old-object test trials. The ANOVA for the Preference condition revealed no significant effects. Thus, these analyses suggest that 9-month-old infants extend object labels, but not object preferences, across speakers.

Analyses at the individual level supported these results. Fifteen of 20 infants in the Word condition looked longer on the new-object test trials than they did on the old-object test trials, $p = .02$ (paired sign test). In contrast, 12 of the 20 infants in the Preference condition looked longer on the new-object test trials than they did on the old-object test trials, $p = 0.5$ (paired sign test).

Bivariate correlations for each condition were conducted to explore possible associations between infants' looking towards the different test trial types and their MCDI scores on word comprehension and word and gesture production. No significant correlations were revealed in either condition. Thus, infants' tendency to look longer towards a violation in a previously established word-object (or preference-object) association was not related to any of the obtained measures of their language development.

The findings of Experiment 2 confirm and extend the findings of our first experiment. When offered additional time to process the aspects of the scene that changed between habituation and test, infants who were trained on a new word-referent link in a communicative context rich in ostensive cues extended the link across speakers. In Experiment 1, it was only the infants who had the opportunity to attend to all three areas of interest during the familiarization trial who generalized the word-referent link across speakers. In Experiment 2, we provided infants with more time to process the test trial set-up by adding a second familiarization trial. Indeed, offline coding revealed that every infant in this experiment

[4]Including test pair in the ANOVA revealed trends of decreasing attention across test pairs. Infants' relative preference for new-object versus old-object events in each condition did not not differ as a function of test pair. Thus, we collapsed across test pair in all analyses.

[5]The analyses were repeated excluding the two infants who did not habituate. Since the pattern of findings was the same, we report the analyses using all of the infants.

attended to all three areas of interest (e.g., the experimenter, target object, distractor object) in at least one of the familiarization trials.

Our findings also suggest that 9-month-olds' tendency to generalize word-referent links is selective for behaviours that are conventional in nature. When infants were shown an actor who expressed a preference for one of two objects and received extra training on that preference, they did not expect a new person to do the same. These findings contrast with those of a large body of studies using quite similar methods which have shown that when the same actor is present throughout the experiment, infants robustly infer that her actions on test trials will reflect the goals and preferences she expressed during habituation trials (Brandone & Wellman, 2009; Buresh & Woodward, 2007; Luo, 2010; Luo & Johnson, 2009; Luo & Baillargeon, 2005, 2007; Sommerville & Crane, 2009; Song & Baillargeon, 2005; Woodward, 2003). Together these findings suggest that, by 9 months infants have identified linguistic labels as one form of human behaviour that extends across individuals.

General Discussion

These studies investigate whether 9-month-old infants appreciate the shared nature of linguistic labels. Our findings indicate that they do, so long as they are given sufficient opportunity to encode the relevant information. Although infants as a group failed to respond systematically in the Switch Actor condition in Experiment 1, the infants who had attended to all of the relevant aspects of the familiarization event generalized the word-referent link from one speaker to another. Experiment 2 confirmed this finding at a group level suggesting that, when they are trained on a new word-referent link in a communicative context and the task demands are sufficiently reduced, infants 9 months of age extend linguistic labels across speakers. These findings provide the first evidence that infants as young as 9 months old appreciate the shared nature of linguistic labels. The findings of our second experiment suggest that providing additional training in a communicative context rich with ostensive cues and reducing task demands does not lead infants to simply extend every new piece of information, such as a verbal expression of preference, that accompanies a goal-directed action across individuals. The preference findings extend the findings of previous work, which has primarily focused on the extent to which infants understand that human action is driven by one's goals, attention, and preferences (for reviews see Luo & Baillargeon, 2010; Woodward, 2009; Woodward et al., 2009). Together, our findings suggest that infants have begun to distinguish culturally universal forms of human behaviour from other forms of human behaviour before their first birthdays.

Until now, evidence has suggested that infants come to appreciate the conventional nature of words in the second year of their life (e.g., Buresh & Woodward, 2007; Graham et al., 2006; Koenig & Echols, 2003). Although previous work has demonstrated that infants *engage* in shared forms of behaviour prior to their first birthday (e.g., Bakeman & Adamson, 1986; Bates et al., 1979; Fenson et al., 1994; Huttenlocher & Smiley, 1987; Messinger & Fogel, 1998), our findings provide the first evidence that the first year of an infant's life represents an important developmental window in which an *understanding* of shared forms of human behaviour begins to emerge. Future work investigating the origins of an understanding of the shared nature of culturally relevant behaviours should be designed to study infants in the first postnatal year.

Methodologically, our findings demonstrate the importance of providing support for infants' encoding of the relevant information in social events. In Experiment 1, infants who attended to all three critical regions of interest during the familiarization trial showed a different pattern of looking on the test trials from the infants who did not. In Experiment 2, including an additional familiarization trial ensured that all infants attended to the critical regions of

the display, which supported systematic responding at a group level. These findings highlight the fact that social events are complex and infants may fail to implement social knowledge because of the demands of attending to and encoding the relevant information. Further, our results point to the importance of assessing not only infants' global responses in looking time studies, but also their fine-grained patterns of attention to the critical aspects of the experimental events.

Our findings support the role that communicative exchanges might play in infants' ability to identify generalizable and culturally universal forms of human behaviour, in this case, linguistic labels (Csibra & Gergely, in press, 2009; Gergely et al., 2007; Tomasello, 1999; Tomasello et al., 2005). Consistent with the view that infants capitalize on ostensive communicative signals provided by speakers (e.g., eye gaze, infant-directed speech) to identify shared forms of behaviour, our findings, compared with those of Buresh and Woodward (2007) suggest that providing initial famliarization with labels in an ostensive interaction supported infants' extension of linguistic labels across individuals.

Our findings also indicate that infants at this age have begun to distinguish these behaviours from aspects of behaviour that are not shared. Infants treated expressions of preference differently than they did a word-referent link, even though both pieces of information were accompanied by the same rich ostensive cues and even though infants were equally attentive to them. While it is unclear whether infants were tracking the experimenter's preference, other research does indcate that same-aged infants do appreciate that expressions of preference are person-specific (e.g., Buresh & Woodward, 2007; for results with older infants see Graham et al., 2006; Henderson & Graham, 2005). Further, our finding that infants failed to generalize in the preference condition contrasts with their systematic responses in studies using very similar events but without changing the actor (e.g., Brandone & Wellman, 2009; Buresh & Woodward, 2007; Luo, 2010; Luo & Johnson, 2009; Luo & Baillargeon, 2005, 2007; Song & Baillargeon, 2005; Woodward, 2003). There is much more to be learned about infants' understanding of others' preferences, including the extent to which infants expect that individuals will maintain preferences over time and across contexts (Sommerville & Crane, 2009), the conditions under which infants will assume that different people will share the same preferences (Gergely et al., 2007), and whether the valence of a person's evaluative expression influences infants' tendency to generalize information to new people or situations (Vaish, Carpenter, & Tomasello, 2009).

How might infants come to identify the shared status of words and differentiate them from non-shared aspects of intentional action? One possibility is that this discovery is supported by an early emerging sensitivity to human language (Sabbagh & Henderson, 2007). Some support for this possibility comes from evidence suggesting that infants who are just days old are sensitive to the special status of human speech compared to other forms of stimuli (for reviews see Gervain & Mehler, 2009; Gervain & Werker, 2008). For instance, neonates discriminate between speech and non-speech stimuli (Ramus, Hauser, Miller, Morris, & Mehler, 2000) and show a clear preference for speech over non-speech sounds (Vouloumanos & Werker, 2007). By 3 months of age, speech sounds enhance infants' attention to and categorization of visual stimuli (Ferry, Hespos, & Waxman, 2010). By the end of the first year, spoken labels support categorization selectively (e.g., Waxman & Markow, 1995; Fulkerson & Haaf, 2003; Fulkerson & Waxman, 2007) and are the prefered referential form for objects (MacKenzie, Graham, & Curtin, 2010), as compared to other kinds of vocalizations or linguistic sounds. Early sensitivities to and selective learning about linguistic forms may contribute to the insight that these forms are meaningful across individuals.

It seems likely that general purpose learning mechanisms, for example, the ability to detect distributional regularities in the social evironment, contribute to this aspect of language learning (see Buresh & Woodward, 2007). Consider what our hypothetical infant might think if he later observed his father utter the same word (i.e., 'mouse') upon viewing the same animal as previously seen by his mother, but exhibit a completely different emotional reaction. The infant might link the word 'mouse' with the animal and assume others would do the same, but might not link a particular emotional reaction to the animal. Over time he might realize that people generally use the same terms to refer things in the environment, but do not generally exhibit the same feelings about those things. By monitoring whether different individuals act in similar or dissimilar ways given similar contexts, infants might come to identify the classes of human behaviour that are shared and those that are not. Given the extensive evidence suggesting that distributional information plays an important role in many aspects of language development (e.g., Saffran, Newport, & Aslin, 1996; Smith & Yu, 2008), future work will investigate the role of distributional information in the ontogeny of infants' understanding of conventional linguistic forms.

Infants' rapidly developing socio-cognitive skills might also shape their ability to identify conventional forms of human behaviour. A significant body of evidence suggests that by 9 months, infants can make sense out of simple goal-directed actions such as an individual reaching for an object (for reviews see Woodward, 2009; Woodward et al., 2009). However, a conventional action, such as someone looking at and labeling an object, requires an analysis of action goals at a level beyond the individual completing the action. Upon encountering an individual carrying out a conventional action, infants might first attempt to use their developing understanding of intentions and analyze the action at the individual level. However, when the meaning of the action is not readily transparent at the individual level, infants might then be forced to look for meaning at the group level. If this were to be the case, infants could be able to identify the actions that should be extended across individuals before possessing a mature understanding of the conventional action itself.

Our findings demonstrate that 9-month-olds generalize words across individuals, but do not disclose what they know about this conventional form of human behaviour beyond its shared nature. It remains unclear whether 9-month-olds possess a conceptual understanding of words as conventional communicative symbols in the same way that older infants do (Akhtar & Tomasello, 1996; Baldwin, 1993; Tomasello & Akhtar, 1995; Tomasello & Barton, 1994; Graham et al., 2006; Henderson & Graham, 2005). A full-fledged understanding of words requires understanding not only that people tend to use the same words when labeling objects, but also that: 1) people use words with the intention of communicating information about a specific referent (Akhtar & Tomasello, 1996; Baldwin, 1993; Tomasello & Akhtar, 1995; Tomasello & Barton, 1994) and 2) different word forms contrast in meaning (Clark, 1993, 2007; Diesendruck & Markson, 2001). Although these aspects of linguistic knowledge have been documented in older infants (for a review see Koenig & Woodward, 2006), there has been little research on this knowledge in infants under one year of age (but see Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006; Martin, Onishi, & Vouloumanos, 2012).

The ability to identify conventional forms of human behaviour suggests an important first step in infants' cultural development. However, a fundamental characteristic of culturally relevant behaviours such as linguistic conventions is that their meanings are *only* shared by particular groups of individuals. Considering this, another crucial step in children's acquisition of culture is the ability to identify to whom the convention applies. Our findings suggest that 9-month-olds would generalize the word 'mouse' across multiple individuals, however they do not speak to whether infants this young would appreciate that the word should only be generalized to members of the English-speaking community. Some aspects

of this understanding may be present in preschool-aged children (e.g., Diesendruck, 2005; Diesendruck & Markson, 2001; Henderson et al., 2009; Sabbagh & Baldwin, 2001). It remains unclear whether infants appreciate the conventional scope of linguistic labels and other shared behaviours.

In conclusion, the current findings provide the first evidence that by the time infants are 9 months of age they have identified the fact that linguistic labels are a shared form of human behaviour. The findings also demonstrate that infants this young differentiate words from other kinds of verbal information that accompanies goal-directed action. Thus, by 9 months, infants have begun to map out the critical distinction between culturally universal and person-specific aspects of human behaviour. This basic understanding likely lays the foundation for future language learning and cultural development more broadly.

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References

Akhtar N, Tomasello M. Two-year-olds learn words for absent objects and actions. British Journal of Developmental Psychology. 1996; 14:79–93.

Baldwin DA. Infants' ability to consult the speaker for clues to word reference. Journal of Child Language. 1993; 20:395–418. [PubMed: 8376476]

Bakeman R, Adamson LB. Infants' conventionalized acts: Gestures and words with mothers and peers. Infant Behavior and Development. 1986; 9:215–230.

Bates, E.; Benigni, L.; Bretherton, I.; Camaioni, L.; Volterra, V. The emergence of symbols: Cognition and communication in infancy. New York: Academic Press; 1979.

Brandone AC, Wellman HM. You can't always get what you want: Infants understand failed goal-directed actions. Psychological Science. 2009; 20:85–91. [PubMed: 19037904]

Buresh JS, Woodward AL. Infants track action goals within and across agents. Cognition. 2007; 104:287–314. [PubMed: 16930577]

Casstevens, RM. jHab: Java Habituation Software (Version 1.0.2) [Computer Software]. Chevy Chase, MD; 2007.

Clark, EV. The lexicon in acquisition. Cambridge: Cambridge University Press; 1993.

Clark EV. Conventionality and contrast in language and language acquisition. New Directions for Child and Adolescent Development. 2007; 115:11–23. [PubMed: 17441544]

Csibra G. Recognizing communicative intentions in infancy. Mind & Language. 2010; 25:141–168.

Csibra G, Gergely G. Natural pedagogy as evolutionary adaptation. Philosophical Transactions of the Royal Society B. (in press).

Csibra G, Gergely G. Natural pedagogy. Trends in Cognitive Sciences. 2009; 13:148–153. [PubMed: 19285912]

Diesendruck G. The principles of conventionality and contrast in word learning: An empirical examination. Developmental Psychology. 2005; 41:451–463. [PubMed: 15910154]

Diesendruck G, Markson L. Children's avoidance of lexical overlap: A pragmatic account. Developmental Psychology. 2001; 37:630–641. [PubMed: 11552759]

Fenson L, Dale PS, Reznick JS, Bates E, Thal DJ, Pethick SJ. Variability in early communicative development. Monographs of the Society for Research in Child Development. 1994; 59(5):v–173.

Ferry AL, Hespos SJ, Waxman SR. Categorization in 3- and 4-month-old infants. Child Development. 2010; 81:472–479. [PubMed: 20438453]

Fulkerson AL, Haaf RA. The influence of labels, non-labeling sounds, and source of auditory input on 9- and 15-month-olds' object categorization. Infancy. 2003; 4:349–369.

Fulkerson AL, Waxman SR. Words (but not tones) facilitate object categorization: Evidence from 6- and 12-month-olds. Cognition. 2007; 150:218–228. [PubMed: 17064677]

Graham SA, Stock H, Henderson AME. Nineteen-month-olds' understanding of the conventionality of object labels versus desires. Infancy. 2006; 9:341–350.

Gergely G, Egyed K, Kiraly I. On pedagogy. Developmental Science. 2007; 10:139–146. [PubMed: 17181712]

Gervain J, Mehler J. Speech perception and language acquisition in the first year of life. Annual Reviews of Psychology. 2009; 61:191–218.

Gervain J, Werker J. How infant speech perception contributes to language acquisition. Language and Linguistics Compass. 2008; 2:1149–1170.

Gredebäck G, Fikke L, Melinder A. The development of joint visual attention: a longitudinal study of gaze following during interactions with mothers and strangers. Developmental Science. 2010; 13:839–848. [PubMed: 20977555]

Henderson AME, Graham SA. Two-year-olds' appreciation of the shared nature of novel object labels. Journal of Cognition and Development. 2005; 6:381–402.

Henderson, AME.; Sabbagh, MA.; Saby, J.; Woodward, AL. Retrieval cues do not help preschoolers remember the name of an object from a foreign country. Poster presented at the Society for Research in Child Development; Denver, Colorado. 2009.

Hofstede, G. Culture's consequences: Comparing values, behaviors, institutions and organizations across nations. 2nd Ed.. Thousand Oaks: Sage Publications; 2001.

Huttenlocher J, Smiley P. Early word meanings: The case of object names. Cognitive Psychology. 1987; 19:63–89.

Kinzler KD, Dupoux E, Spelke ES. The native language of social cognition. The Proceedings of the National Academy of Sciences of the United States of America. 2007; 104:12577–12580.

Kinzler KD, Shutts K, DeJesus J, Spelke ES. Accent trumps race in children's social preferences. Social Cognition. 2009; 27:623–634. [PubMed: 21603154]

Koenig MA, Echols CE. Infants' understanding of false labeling events: The referential roles of words and the speakers who use them. Cognition. 2003; 87:179–208. [PubMed: 12684199]

Koenig, MA.; Woodward, AL. Word learning. In: Gaskell, MG., editor. The Oxford Handbook of Psycholinguistics. Oxford: Oxford University Press; 2006.

Luo Y. Do 8-month-old infants consider situational constraints when interpreting others' gaze as goal-directed action? Infancy. 2010; 15:392–419.

Luo Y, Baillargeon R. Can a self-propelled box have a goal? Psychological reasoning in 5-month-old infants. Psychological Science. 2005; 16:601–608. [PubMed: 16102062]

Luo Y, Baillargeon R. Do 12.5-month-old infants consider what objects others can see when interpreting their actions? Cognition. 2007; 105:489–512. [PubMed: 17182023]

Luo Y, Baillargeon R. Toward a mentalistic account of early psychological reasoning. Current Directions in Psychological Science. 2010; 19:301–307. [PubMed: 21660130]

Luo Y, Johnson SC. Recognizing the role of perception in action at 6 months. Developmental Science. 2009; 12:142–149. [PubMed: 19120422]

Mackenzie H, Graham SA, Curtin S. Twelve-month-olds privilege words over other linguistic sounds in an associative learning task. Developmental Science. 2010; 14:249–255. [PubMed: 22213898]

Martin A, Onishi KH, Vouloumanos A. Understanding the abstract role of speech in communication at 12 months. Cognition. 2012; 123:50–60. [PubMed: 22209584]

Messinger DS, Fogel A. Give and take: The development of conventional infant gestures. Merrill-Palmer Quarterly. 1998; 44:566–590.

Onishi KH, Baillargeon R. Do 15-month-old infants understand false beliefs? Science. 2005; 308:255–258. [PubMed: 15821091]

Phillips AT, Wellman HM, Spelke ES. Infants' ability to connect gaze and emotional expression to intentional action. Cognition. 2002; 85:53–78. [PubMed: 12086713]

Pruden SM, Hirsh-Pasek K, Golinkoff RM, Hennon E. The birth of words: Ten-month-olds learn words through perceptual salience. Child Development. 2006; 77:266–280. [PubMed: 16611171]

Ramus F, Hauser MD, Miller C, Morris D, Mehler J. Language discrimination by human newborns and by cotton-top tamarin monkeys. Science. 2000; 288:349–351. [PubMed: 10764650]

Sabbagh MA, Baldwin DA. Learning words from knowledgeable versus ignorant speakers: Links between preschoolers' theory of mind and semantic development. Child Development. 2001; 72:1054–1070. [PubMed: 11480934]

Sabbagh MA, Henderson AME. How an appreciation of conventionality shapes early word learning. New Directions for Child and Adolescent Development. 2007; 115:25–37. [PubMed: 17441545]

Saffran JR, Newport EL, Aslin RN. Word segmentation: The role of distributional cues. Journal of Memory and Language. 1996; 35:606–621.

Smith L, Yu C. Infants rapidly learn word-referent mappings via cross-situational statistics. Cognition. 2008; 106:1558–1568. [PubMed: 17692305]

Sommerville JA, Crane CC. Ten-month-old infants use prior infomration to identify an actor's goal. Developmental Science. 2009; 12:314–325. [PubMed: 19143804]

Sommerville J, Woodward AL. Pulling out the intentional structure of action: The relation between action processing and action production in infancy. Cognition. 2005; 95:1–30. [PubMed: 15629472]

Song H, Baillargeon R. Can 9.5-month-old infants attribute to an agent a disposition to perform an action on objects? Acta Psychologia. 2005; 124:79–105.

Tomasello, M. The cultural origins of human cognition. Cambridge, MA: Harvard University Press; 1999.

Tomasello M, Akhtar N. Two-year-olds use pragmatic cues to differentiate reference to objects and actions. Cognitive Development. 1995; 10:201–224.

Tomasello M, Barton M. Learning words in non-ostensive contexts. Developmental Psychology. 1994; 30:639–650.

Tomasello M, Carpenter M, Call J, Behne T, Moll H. Understanding and sharing intentions: The origins of cultural cognition. Behavioural and Brain Sciences. 2005; 28:675–691.

Vaish A, Carpenter M, Tomasello M. Sympathy through affective perspective taking and its relation to prosocial behavior in toddlers. Developmental Psychology. 2009; 45:534–543. [PubMed: 19271837]

Vouloumanos A, Werker JF. Listening to language at birth: Evidence for a bias for speech in neonates. Developmental Science. 2007; 10:159–171. [PubMed: 17286838]

Waxman SR, Markow DB. Words as invitations to form categories: Evidence from 12- to 13-month-old infants. Cognitive Psychology. 1995; 29:257–302. [PubMed: 8556847]

Woodward AL. Infants selectively encode the goal object of an actor's reach. Cognition. 1998; 69:1–34. [PubMed: 9871370]

Woodward AL. Infants' developing understanding of the link between looker and object. Developmental Science. 2003; 6:297–311.

Woodward AL. Infants' grasp of others' intentions. Current Directions in Psychological Science. 2009; 18:53–57.

Woodward AL, Markman EM, Fitzsimmons CM. Rapid word learning in 13- and 18-month-olds. Developmental Psychology. 1994; 30:553–566.

Woodward AL, Sommerville JA, Gerson S, Henderson AME, Buresh J. The emergence of intention attribution in infancy. The psychology of learning and motivation. 2009; 51:187–222.

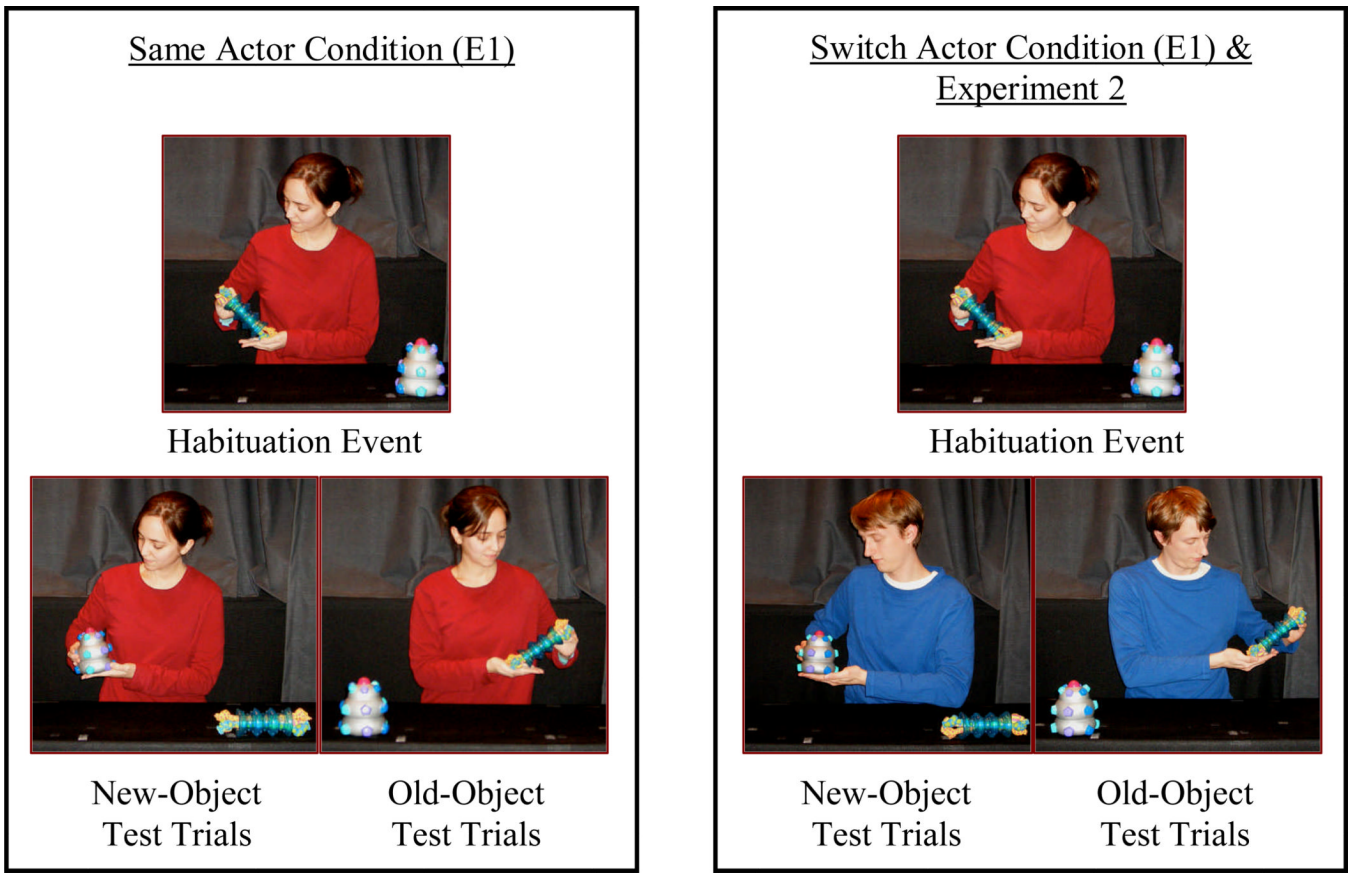

Figure 1.
Habituation and Test Events Experiments 1 and 2.

Table 1

Average and range of vocabulary comprehension, production, and total gesture scores for each condition in both experiments.

Condition	Vocabulary				Gestures	
	Comprehension		Production		Total	
	Mean	Range	Mean	Range	Mean	Range
Experiment 1						
Same Actor - Word	26.94 (5.17)	0–79	0.56 (0.29)	0–4	11 (1.27)	3–20
Switch Actor - Word	17.59 (4.42)	0–66	1.29 (0.53)	0–8	9.82 (1.15)	3–19
Experiment 2						
Word (Switch Actor)	32.73 (8.35)	0–91	0.35 (0.27)	0–3	12.60 (1.45)	4–23
Preference (Switch Actor)	20.91 (4.59)	0–39	0.64 (0.24)	0–2	11.64 (1.92)	0–20

Note. Mean standard errors are provided in parentheses.

Table 2

Average looking times during the habituation, baseline, familiarization, and test trials for each condition in both experiments.

	Habituation trials			Familiarization		Test trials	
Condition	**First 3**	**Last 3**	**Baseline**	**1**	**2**	**Old**	**New**
Experiment 1							
Same Actor - Word	15.7 (1.9)	5.8 (0.7)	5.4 (1.0)	11.0 (2.1)	n/a	5.0 (0.6)	6.6* (0.7)
Switch Actor - Word	12.2 (1.6)	6.9 (0.6)	3.4 (0.6)	20.2 (5.2)	n/a	5.6 (0.6)	5.2 (0.7)
Experiment 2							
Word (Switch Actor)	13.0 (1.2)	4.3 (0.5)	2.7 (0.5)	8.3 (1.2	13.6 (2.3)	6.0 (0.7)	7.4* (1.0)
Preference (Switch Actor)	12.5 (1.9)	5.0 (0.8)	3.7 (0.7)	10.0 (2.2)	22.5 (4.3)	6.6 (1.0)	6.0 (0.6)

Note. Mean standard errors are provided in parentheses.

*Different from the other test event, $p < .05$.