Infants' Attribution of Agent and Recipient Roles to Animate and Inanimate Objects In a Causal Event

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Abstract

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Research on the perception of causality suggests that infants' ability to perceive causal events develops during the first year of life (Oakes, 2003). However, few studies have investigated whether infants associate the role of an agent with animate beings and the role of a recipient with inanimate objects in a causal event. Using an infant-controlled habituation procedure, the aims of the present two experiments were to examine whether (a) infants are able to detect a role-reversal in a causal event featuring animals and furniture items and (b) infants are able to detect an incongruent role-reversal in which an inanimate object plays the role of an agent. Results of Experiment 1 revealed that 16-month-old infants who had habituated to causal events involving animal agents and furniture recipients looked longer at the test trial, in which the roles were reversed relative to the habituation events, than at the test trial, in which the roles were maintained. Results from Experiment 2 revealed that when infants were habituated to category-congruent causal events, 19-, but not 13-, month-old infants looked longer at the test event featuring an incongruent role-reversal than at the test event featuring a congruent role-reversal. Overall, these results indicate that infants are able to perceive a role-reversal between animals and furniture, and that by 19 months of age, infants are able to associate agent-recipient roles with the appropriate category. These results shed light on infants' developing knowledge of causal events as well as their conceptualization of animates and inanimates.

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Infants' Attribution of Agent and Recipient Roles to Animate and Inanimate Objects in a Causal Event

The ability to distinguish between animate and inanimate entities is considered one of the most fundamental achievements in cognitive development (Gelman & Opfer, 2002; Gelman & Spelke, 1981). The category of animate beings consist of people, animals, and insects, whereas the category of inanimate objects include artefacts, such as vehicles, toys and furniture (Rakison & Poulin-Dubois, 2001). The centrality of the animate-inanimate (A/I) distinction is supported by developmental research that indicates that by preschool years, the A/I distinction is well established (Gelman & Opfer, 2002). For example, preschoolers attribute biological processes to humans but not to objects (Gelman & Opfer, 2002), use animacy cues to interpret words (Backscheider, Gelman, Martinez, & Kowieski, 1999; Gelman & Koenig, 2001) and infer correctly how animate and inanimate objects move (Massey & Gelman, 1988). The foundational nature of the A/I distinction is also evident by its neurophysiological correlates (Caramazza & Shelton, 1998; Gainotti, 2000; Garrard et al., 2001), and its cross-cultural uniformity (Atran, 1999).

The animate-inanimate distinction holds important advantages for human cognition (Arterberry & Bornstein, 2002). The recognition of an object as being animate or inanimate enables the formation of different inferences and causal explanations (Gelman & Opfer, 2002). For example, animate beings possess biological (e.g., self-initiated movement) and psychological properties (e.g., goal-directed), while inanimate objects do not. As well, knowledge of animate and inanimate categories enhances memory by facilitating the retrieval of category-related information (Arterberry &

Bornstein, 2002). Finally, the A/I distinction represents categorization abilities that have been suggested to underlie conceptual development (for an elaboration of this argument see Bornstein, 1985). Given the fundamental nature and importance of the A/I distinction to human cognition, and that this distinction is in place by preschool years, it is of empirical and theoretical interest to explore how and when this knowledge develops in infancy.

Several studies have indicated that the foundations for the A/I distinction are in place early in life. For example, infants as young as 2 months of age smile and coo when faced with a responsive adult, but not when faced with a toy monkey (Brazelton, Koslowski, & Main, 1974; Trevarthen, 1977). Similarly, 3-month-old infants will reserve their smiles for a person and rarely for objects that vary in similarity to an abstract, smiling face (Ellsworth, Muir, & Hains, 1993). Infants between the ages of 5- and 8-weeks-old also imitate actions of people but not similar activities performed by mechanical objects (Legerstee, 1991). Furthermore, pre-reaching infants show a differential response to people versus objects (Tronick, 1989), whereby infants try to communicate with people but act instrumentally toward objects. Taken together, these findings suggest that infants, from a very early age, respond differently to people and objects. However, it remains to be determined whether such a distinction reflects broad categories of animates and inanimates that include animals and artefacts. Moreover, little is known about the types of cues infants use to differentiate animate beings from inanimate objects.

Some of the perceptual cues that infants could use to determine whether an entity is animate or inanimate include featural cues (e.g., presence or absence of a face, presence of wheels versus legs), dynamic cues (e.g., self-propulsion, goal-directed movement), and other cues that may be difficult to assess, such as tactile and olfactory information (for a review, see Gelman & Opfer, 2002). For example, an animal has a certain featural configuration and can engage in self-generated motion. It has been suggested that infants are able to distinguish animate beings from inanimate objects by attending to the motion cues characteristic of these different category members.

There are many reasons for positing that dynamic cues might hold a special status in the emergence of the A/I distinction. First of all, researchers have demonstrated that motion is prime in infant perception (Haith, 1966). Specifically, newborn infants have a preference for a moving stimulus over a comparable stimulus that is stationary (Kellman & Banks, 1998). Similarly, infants aged 3 to 6 months look longer at a point-light display depicting a walking individual than a standing individual (Bertenthal, Profitt, Cutting, 1984; Fox & McDaniel, 1982). Secondly, there is neurological evidence to suggest that visual perception of biological (e.g., non rigid motion) and non-biological motions (e.g., rigid motion) are subserved by different neural networks (Grèzes et al., 2001; Grossman et al., 2000; Grossman & Blake, 2001). Specifically, it appears that the perception of biological motion is associated with the activation of the posterior portion of the superior temporal sulcus and the left intraparietal cortex, whereas perception of non-biological motion is associated with the activation of areas posterior to those elicited by biological motions (Grèzes et al., 2001). The dedication of specific areas of the brain to the processing of biological and non-biological motions suggests that visual perception of these motion kinds is domain-specific. From an evolutionary perspective, this proposal is plausible given that human survival depends on the ability to identify, interpret, and predict the actions of others. Thirdly, preschool-aged children are able to link motion cues to their understanding of life. Of particular interest is the finding that preschoolers explain the motion of animals and objects differently, whereby they are more likely to attribute self-initiated movement and changes of place to animals than to objects, despite wide variations in the surface characteristics of the objects within each group (Massey & Gelman, 1988). The recognition that motion cues is a salient aspect of the A/I distinction is an important first step, however the different patterns of motions that give rise to this distinction remain to be identified.

The importance of motion in the conceptualization of animate and inanimate entities was recently highlighted by Mandler (1992a, 1992b, 2000, 2004) in an influential theory of conceptual development. According to Mandler, infants develop concepts of animate beings and inanimate objects, during their first year of life, via an innate process of *perceptual analysis* in which motion cues are recoded into basic building blocks and abstract representations called *image schemas*. In particular, Mandler argued that an infant's concept of an animate being consists of image schemas of different animate motion characteristics, such as self-propulsion, non-linear motion trajectory, contact at a distance, contingency of motion without physical contact, and role of agent in causal interactions. In contrast, the concept of an inanimate object consists of image schemas representing movement caused by an external agent, linear motion trajectory, contingent motion with contact, and the role of the recipient in causal interactions. Taken together, these image schemas form the basis by which knowledge of motion characteristics lead to an A-I distinction.

A similar typology of motion cues was recently outlined by Rakison and Poulin-Dubois (2001), with the addition of some other attributes, such as purpose of action (goal-directed vs. without aim) and influence of mental states (intentional vs. accidental). After a comprehensive review of the literature, they concluded that although infants are able to discriminate between many animate and inanimate motion cues, support for infants' association between motion cues and broad categories, such as animals and artefacts, is scarce and typically limited to a contrast between people and objects. For example, in one of the first experiments to examine infants' abilities to associate motion cues with people and artefacts, 9- and 13-month-old infants failed to habituate to a live ball set in motion by a hidden human agent but readily habituated when the human agent was shown to push the ball (Poulin-Dubois & Shultz, 1988, 1990). As well, 7-month-old infants who habituated to events in which a large box and a person moved with or without contact, looked longer at displays in which the box started to move without contact (Spelke, Phillips, & Woodward, 1995). In another study, 9- and 12-month-old infants considered the apparently self-initiated movement of a humanoid robot to be incongruous when compared to a condition in which the same robot was stationary, as evidenced by the increase in negative affect. In contrast, there was no such increase in negative affect in response to the self-motion of a female stranger when infants were previously presented with a stationary person (Poulin-Dubois, Lepage, & Ferland, 1996). Thus, it appears that infants as young as 7 months of age associate self-motion with people and caused motion with inanimate objects.

Recently, several studies have directly tested the hypothesis that infants are able to associate motion cues, such as motion trajectory (linear vs. non-linear), pattern of interaction (contingent vs. non-contingent), and form of causal action (action at a distance vs. action from contact), with broad categories of objects, such as animals and artefacts. First, Baker, Demke, and Poulin-Dubois (under review) examined whether 12-, 16- and 20-month-old infants were able to associate animate beings and inanimate objects with different motion trajectories. Results revealed that by 12 months of age, infants were able to associate a non-linear motion trajectory with animals and a linear motion trajectory with vehicles, suggesting that infants have connected the motion characteristic of trajectory with their conceptualization of the categories of animals and vehicles by the end of their first year. Further evidence that infants understand the relation between different motion patterns and object kinds came from a series of experiments conducted by Kosugi and Fujita (2001), in which they investigated infants' understanding of animates' and inanimates' pattern of interaction (contingent vs. noncontingent). Following the habituation to launching events featuring people and objects, results revealed that 8-, but not 4-month-old, infants regarded the no-contact test event between a person and an object to be anomalous when compared to a similar test event in which there was contact, suggesting that infants appreciate that contact is necessary to set in motion inanimate objects. Furthermore, Legerstee and her colleagues (2000) recently investigated 6-month-old infants' ability to understand that people talk to persons but act instrumentally toward objects. Results revealed that infants who were habituated to a person talking to an occluder looked longer at the test event in which an object was behind the occluder, and infants who were previously habituated to a person swiping at the occluder looked longer at the test event in which a person was behind the occluder. In contrast, no differences in looking time was observed between these two test events for infants in the control condition, in which they were habituated to either the person or object alone. On the basis of these results, Legerstee and her colleagues concluded that 6-month-old infants appreciate that people can communicate with other persons and can therefore cause actions at a distance, whereas objects can only be manipulated and require contact to move. Taken together, there is some evidence to indicate that infants associate animate beings and inanimate objects with some category-congruent motion cues, such as motion trajectory, pattern of interaction, and form of causal action. However, little research have examined infants' ability to discriminate animates from inanimates on the basis of their role in a causal event, that is, whether infants expect animate entities to act as agents in a causal event and inanimate entities to act as recipients of a causal action.

In the first step to test the hypothesis that infants associate the role of an agent with an animate being and the role of a recipient with an inanimate object in a causal event, several studies have investigated whether infants perceive causality (Cohen & Amsel, 1998; Leslie, 1984; Oakes, 1994). One way in which researchers have studied the development of infants' causal perception is by looking at Michottian-like launching events, in which one object hits a second stationary object, causing the stationary object to move (Leslie, 1984; Oakes & Cohen, 1990). Typically, temporal and spatial components of the events are manipulated to assess infants' perception of causality. Infants who have habituated to a causal event show dishabituation when presented with non-causal events during the test phase (i.e., second object begins to move before the first object contacts it), suggesting that infants view causal and non-causal events differently and that causality is perceived only when objects collide. Using this type of procedure, several studies have indicated that infants have developed causal perception of inanimate objects by the end of their first year (Baillargeon, 1995; Oakes 1994; Oakes & Cohen, 1990). Specifically, infants perceive the causality of launching events involving simple stimuli (e.g., colored squares) at 6 to 7 months of age, and more complex stimuli by 10 months of age.

It is important to note that causal reasoning does not simply require the processing of the difference between causal and noncausal events. Rather, it also involves the recognition that the two objects in a causal event have different roles: one is the agent and the other is the recipient. In one of the first studies to test the development of agent-recipient distinction in causal events, 10- to 12-month-old infants were habituated to a causal and a noncausal event in which one of two objects was associated with a type of event (e.g., object A was always the agent in the causal event and object B was the recipient, whereas the reverse was true in the noncausal event) (Cohen & Oakes, 1993). Following the habituation phase, the infants were tested with an event in which the roles were switched (e.g., object A is now the agent in the noncausal event as opposed to the causal event). Results revealed that infants dishabituated to the role switch only when the agent was associated with a new type of event (e.g., from a causal to a noncausal event). These findings suggest that infants have linked the identity of the agent, but not the recipient, with whether or not the event was causal. However, the simple linking between an object and type of event does not inform us about infants' understanding of the agent and recipient roles in a causal sequence. A more compelling approach to understanding agent-recipient distinction in infancy would be to look at a reversal of roles in a causal event as opposed to a noncausal event. A reversal of roles in a causal event involves changes in the agent-recipient roles, whereas a reversal of roles in a noncausal event does not. Research on the development of causal perception indicates that infants are sensitive to the agent-recipient roles in events; however, this perception of causality does not emerge fully developed. Rather, 6-month-old infants recognize the agent-recipient distinction only in events that involve simple objects, such as red and green bricks (Leslie & Keeble, 1987). This distinction is later extended, at 14 months of age, to objects in events that are more complex and multi-featured (Cohen, Amsel, Redford, & Cassasola, 1998). Only later, at 18 months of age, are infants able to associate labels with actions in the events (Cohen & Amsel, 1998).

The fact that infants are able to discriminate a change of agent and recipient roles in causal events during the first year of life does not entail that they are able to correctly associate the role of agents with animate beings and the role of recipients with inanimate objects in causal events (Rakison & Poulin-Dubois, 2001). To our knowledge, only one study has directly examined infants' understanding of causal roles played by animates and inanimates (Golinkoff & Kerr, 1978). In this study, infants between the ages of 15 and 18 months were habituated to one of two causal events that were filmed using live actors and a real piece of furniture. All infants were presented with a fixed number of trials. In one causal event, a man (agent) walked, with hands slightly lifted, toward another facing man (recipient), pushed him, and then stopped. The recipient took two steps backwards with his hands slightly raised. In the other causal event, a similar causal interaction took place but between a human agent and a real wooden chair, which was pulled off-camera by invisible strings attached to its forward legs. Following habituation to one of these events, the infants were presented with a role-reversal test event, in which the agent and recipient roles from the habituation phase were switched, thus producing a congruent role-reversal in the man-man condition and an incongruent role-reversal (inanimate agent) in the man-chair condition. Using a heart rate measure as the dependent variable, infants' responses to the incongruent role-reversal test trial (chair agent – man recipient) were compared to infants' responses to congruent role-reversal (man agent – man recipient) test trial. It was predicted that if infants were sensitive to the animate-as-agent restriction, then infants would look longer at the incongruent than at the congruent role-reversal test event. Results indicated that infants responded similarly to the incongruent role-reversal test event and to the congruent role-reversal test event, suggesting that infants did not detect a violation of an inanimate object acting as an agent. However, given the nonsignificant findings and the small sample size ($N = 10$), evidence of infants' understanding of the causal roles animates and inanimates play remains inconclusive.

Using an infant-controlled habituation procedure, the goal of the present series of experiments was two-fold: to determine whether young infants are able to detect a reversal of agent and recipient roles across causal events and whether they are able to associate the role of an agent with an animate entity in a causal sequence. The infant-controlled habituation procedure is commonly used to test the cognitive abilities of infants as young as 3 months (e.g., Baillargeon, 1995) and have a number of features which make it attractive to use in the assessment of infants' perceptual and cognitive abilities, including the tailored length of each testing session (see also Kellman & Arterberry, 1998) and the limited demands in terms of active participation by the infant (Mandler & Bauer, 1988; Oakes, Madole, & Cohen, 1991). Because most studies examining the A/I distinction have focused on the person vs. object distinction, the present study used animals to represent animate beings to clarify whether infants associate the role of an agent in a causal event with the broad category of animate beings. Specifically, animals (e.g., horse, sheep), like people, can move without an external force and can cause another entity (e.g., pig, chair) to move.

Experiment 1

The purpose of Experiment 1 was to examine whether 16-month-old infants were able to perceive a role-reversal across causal events involving animals and furniture items. At this age, infants should have little difficulty perceiving a role-reversal within one single complex causal event (Cohen et al., 1998). It was hypothesized that if infants could detect a role-reversal across events, they would look significantly longer at the test trial in which the roles of the animal and furniture were reversed compared to the habituation phase than at the test trial in which the roles of the animal and furniture were the same as in the habituation phase.

Method

Participants

The final sample consisted of 24 16-month-old infants (14 boys, 10 girls; M = 16.11 months, range = 15.57 to 16.59 months). An additional 7 infants (3 males, 4 females) participated in the study but were excluded from the final analysis on the basis of not meeting the habituation criterion (n = 4), fussiness (n = 1), and experimenter error (n = 2). On the basis of parental report, all infants had a minimum 36-week gestation period, and had no vision or hearing impairments. All infants were recruited from birthlists provided by a government health services agency.

Stimuli

The experimental stimuli were computer-animated films that were created using Director 6.0© for Macintosh© and exported into QuickTime™ movies. In order to counterbalance for direction of movement, a total of 4 habituation movies and 8 test movies were created for each of the two conditions. Each movie consisted of four repetitions of a particular event, with each event lasting 8 s for a total of 32 s for the entire movie. Between the repetitions of each event, a solid green curtain appeared to lower and then ascend. The background of each event consisted of a brown floor against a light blue background. In each event, a familiar animal or furniture agent (e.g., horse, table) appeared stationary on one side of the screen for a brief period of time before it moved across the computer screen and contacted either another stationary animal or piece of furniture recipient, causing it to move. The events were created to be as realistic as possible: the legs of the animals moved in accordance with biological motion characteristics and the furniture moved across the screen in a sliding motion. No auditory information accompanied the causal events. The movies were created using pictures of animals and furniture scanned from children's books and edited using the Adobe Photoshop 2.0© computer software.

A novel film was presented to infants in the pretest and post-test events to evaluate their fatigue. This pre/post-test film consisted of a computer-generated geometrical shape that had moving wing-like appendages. It appeared on the left side of the screen, moved across the screen, and exited on the right side of the screen. The length of these events were identical to those of the experimental events described above. Another QuickTime™ movie was used as an attention-getter to reorient the infant's gaze to the computer monitor between trials. The attention-getter consisted of a green circular disc that appeared to continually expand and recede against a black background. This pulsing action was accompanied by a rhythmic chiming bell.

Design

Infants were randomly assigned to one of two groups (See Table 1 for experimental design). During the habituation phase, infants saw two different movies. In each movie, an animal agent (e.g., horse) caused a furniture recipient (e.g., chair) to move. The pairs varied across the two groups: horse-chair and sheep-table for one group and horse-table and sheep-chair for the other group. Within each group, half of the infants saw the table and the other half saw the chair as the agent in the test phase. Events in the habituation phase were presented in pseudo-random order with the following constraints: The first four trials and the last four trials alternated between the two types of events. In the intervening eight trials, a given event was presented no more than two times in a row. Following habituation, the infants in each group saw one of two test event groups. In the congruent test event, the roles of the animal and furniture were the same as in the habituation phase. In the incongruent test event, the roles of the animal and furniture were reversed compared to the habituation phase. The order and the direction of movement of these test events were counterbalanced across children (See Figure 1 for sample movie frames from habituation and test events).

Apparatus

The infant was seated in a child seat that was attached to a table and the parent was seated directly behind the infant. Events were presented on a color Apple© Multiple Scan 720 Display computer monitor (40.6 cm on the diagonal), which was placed at eyelevel at a distance of 1.07 m from the infants on a table. The testing area behind the computer monitor was surrounded, on three sides, by a black wooden partition to highlight the visual stimuli being presented and to obscure any background distracters. Behind an 11 cm diameter hole in the partition was a Sony© EVO-120 video camera that transmitted an image of the infant's face to a a Sony© Trinitron Colour Video monitor (19.7 cm on the diagonal), which enabled the experimenter to unobtrusively monitor the infant's gaze and to code the infant's visual fixation by pressing keys on a keyboard (See Figure 2 for diagram of testing apparatus). The computer program Habit© (version 7.8) was used to present the computer-animated QuickTime™ movies on the monitor, to record infants' fixation time, and to determine when the infant had met the criterion for habituation.

Procedure

The participants were first brought to a reception area where the parents read and signed the consent form, and completed a demographic questionnaire (see Appendix A and Appendix B). The experimenter played with the infants in order to accustom them to the new environment and to the presence of a new person before testing began. Then, the infant and parent were brought to the testing room where the infant sat in a child seat and the parent sat directly behind the infant. Parents were instructed not to interact with their child during the testing session, except to smile if the infants turned towards them.

The testing session began when the experimentor activated the attention-getter in order to draw the infant's attention to the computer screen. As soon as the infant's gaze was oriented toward the screen, the experimentor pressed a key to begin the presentation of the first event and to begin recording the infant's looking time. The attention-getter was reactivated either when the infant continuously looked away from the screen for longer than 1 second or when the event reached a maximum duration of 32 seconds. To continue the presentation of the films and the recording of infants' looking time, the experimentor re-pressed the key.

Using an infant-controlled habituation procedure, infants were presented with 4 blocks of trials: 1 pre-test trial, a maximum of 16 habituation trials, 2 test trials, and 1 post-test trial. The sum of the looking time across the first four habituation trials determined the habituation baseline. An infant was deemed to have reached the criterion of habituation when the total looking time on any 4 consecutive trials was less than 50% of the baseline. Therefore, the minimum number of trials in the habituation was five and the maximum number of trials was 16. Immediately following habituation, infants were presented with two test trials, followed by the post-test trial.

Coding

To obtain a measure of reliability, a second experimentor randomly selected 25% of infants (n = 6) to code their visual fixations. The coding was conducted by reviewing video recordings of the infant's testing session. Using the Pearson product-moment correlations, the mean inter-observer reliability was r = .99 (range = .99 to 1.00).

Results and Discussion

Preliminary analyses revealed no effects of gender or test group, so the data reported are collapsed across males and females, and across agent-recipient pairings (horse-chair and sheep table pairings; horse-table and sheep-chair pairings). Analyses were conducted using an alpha level of .05, and all post hoc analyses were conducted using the Bonferroni correction technique (Tabachnick & Fidell, 1996). Data screening was performed prior to main statistical analyses and assumptions of normality and homogeneity of variance were met. No outliers were identified.

Habituation Analyses

To assess whether infants had habituated to the events presented during the habituation phase, infants' looking times at the beginning and at the end of the habituation phase were analyzed using a paired sample *t*-test. The first and last habituation blocks consist of the average looking times of the first and last four trials of the habituation phase, respectively. The analysis revealed that infants looked significantly longer at the first habituation block ($M = 17.18$ s, $SD = 6.92$ s) than at the last habituation block ($M = 6.92$ s, $SD = 2.96$ s), $t(23) = 11.79, p < .05$, indicating that infants habituated to the events presented during the habituation phase.

Main Analyses

To determine whether infants detected a role-reversal across events, an analysis of variance was performed to compare looking times across three types of trials (last habituation block, congruent event, and incongruent event). If infants were able to detect a role-reversal in an event, then they should look longer at the incongruent test event, in which the role of the animal and furniture were reversed compared to the habituation phase, than at the congruent test event, in which the role of the animal and furniture have been maintained. The analysis revealed a significant main effect of trial $F(2, 44) = 11.88$, $p < .01$. Pairwise comparisons indicated that infants, overall, looked longer at the incongruent test trial ($M = 14.37$ s, $SD = 10.50$ s) than at the congruent test trial ($M = 7.12$ s, $SD = 5.07$ s) and at the last block of habituation trials ($M = 7.10$ s, $SD = 2.96$ s), whereas no such differences existed between the congruent test event and the last block of habituation trials. This pattern of finding indicates that infants detected a role-reversal and that they are able to abstract the role played by different objects across events.

Fatigue Analyses

To determine whether infants were fatigued or disinterested at the end of the experiment, their looking times at the last block of habituation trials and the post-test trial was compared using a paired sample *t*-test. If infants were not fatigued by the end of the experiment, it was expected that they would look longer at the post-test trial than the last block of habituation trials, given that it was relatively novel when compared to the previously repeated events. The analysis revealed that infants' looking times at the last block of habituation trials and post-test trial ($M = 8.45$ s, $SD = 7.08$ s) did not significantly differ, $t(23) = 1.84$, n.s. Although this may suggest that their looking times during the test events may have been influenced by fatigue, these results may be better accounted for by the fact that infants may have perceived the experimental events as being more interesting than the pre-test or post-test events. Therefore, in order to assess whether infants found the experimental events to be more interesting than the control event, their looking times at the pre-test trial and the first block of habituation trials were compared using a paired sample *t*-test. If infants perceived the experimental events to be more interesting than the pre-test event, they were expected to look longer at the first block of habituation trials than at the pre-test trial. Results revealed that infants looked significantly longer at the events during the first block of habituation trials (M = 17.18 s, SD = 6.92 s) than at the pre-test event (M = 13.45 s, SD = 8.42 s), $t(23) = 2.41$, $p < .05$. Overall, this pattern of result suggests that infants found the first block of habituation trials to be more captivating than the control pre-test trial, and that fatigue may not have played an important role in their performance on the test trials.

Chance Analyses

In order to examine if children's performance was different from chance, a novelty preference score was calculated by dividing the amount of time infants looked at the incongruent test trial by the sum of their looking time across the two test trials. If a group of infants had a mean novelty preference that was significantly greater than chance (50%), then infants were said to have succeeded on the task (Quinn, 1999; Quinn & Johnson, 1997). Results indicated that 16-month-olds' mean novelty preference score (M = 64%) exceeded chance $t(23) = 3.42$, $p < .01$. Consistent with the previous analysis, this suggests that 16-month-old infants, as a group, were capable of detecting a role-reversal between animals and furniture across events. Finally, whether or not a given infant succeeded on the task was assessed by comparing each infant's novelty preference score to a criterion that is based on chance and the standard deviation of the group mean preference score (see Arterberry & Bornstein, 2002, for details). By comparing an infants' novelty preference score to this criterion, it is possible to assess how far above chance the novelty preference score has to be to reflect a true detection of a role-reversal rather than chance fluctuation. Following the procedure outlined by Arterberry and

Bornstein, the criterion for this group of 16-month-old infants was 60%. Using this criterion, the proportion of infants whose novelty preference score was above chance was 67%. These results are consistent with those reported in other categorization studies in which the percentage of infants classified as passing the task typically ranged from 45% to 65% (Arterberry & Bornstein, 2002). Overall, these results suggest that 16-month-old infants were capable of recognizing when the animals and furniture switched agent and recipient roles across events.

Although the current findings suggest that infants have detected a reversal of agent-recipient roles across events, a follow-up study is needed in order to clarify whether infants responded to a role-switch between an animal and furniture in the incongruent test event or whether they responded to the anomaly of the role switch involving an inanimate object (table, chair) act as agent. As a result, Experiment 2 will control for role-reversal during the test phase by holding it constant across test events while manipulating the plausibility of the role-reversal. More specifically, a role-reversal between agent-recipient pairing from the habituation phase will result in an incongruent role-reversal and a congruent role-reversal during the test phase.

Experiment 2

In light of the results of Experiment 1, the goal of Experiment 2 was to examine 13- and 19-month-old infants' abilities to associate the role of agent with animals and the role of recipient with furniture items in a causal event while controlling for role-reversal between the agent and recipient during the test events. As a result, both test events featured an agent-recipient role-reversal but differed with respect to the plausibility of the agent-recipient role in real life (furniture agent-animal recipient vs. animal agent-animal recipient). First, it was hypothesized that both 13- and 19-month-old infants would look longer at both test trials than at the last block of habituation trials, indicating that infants detected a role-reversal. Secondly, 19-month-old infants were expected to look longer at the incongruent test event (furniture agent – animal recipient) than at the congruent test event (animal agent – animal recipient), indicating that they associated the role of agent with animals in a causal event.

To enhance the ecological validity of the causal events, a number of changes were made to events used in Experiment 2. First, auditory cues were added during the causal sequence in order to highlight the causal interaction between the agent and recipient during the causal events. Secondly, a repetition of the agent-recipient interaction was added within each film to draw infants' attention to the causal component of the event. That is, infants saw the agent approaching the recipient and causing it to move twice during an event, for a total of 8 repetitions during a particular trial. Thirdly, to highlight the self-initiated movement of the agent, the causal event began with the agent on-screen as opposed to off-screen, as seen in Experiment 1.

Method

Participants

The final sample consisted of 49 infants. Of these infants, there were twenty-four 13-month-olds (12 boys, 12 girls; $M = 12.92$ months, $SD = 0.59$) and twenty-five 19-month-olds (14 boys, 11 girls; $M = 19.60$ months, $SD = 0.55$). On the basis of parental report, all infants had a minimum 34-week gestation period, and had no vision or hearing impairments. All infants were recruited from birthlists provided by a government health services agency.

An additional ten 13-month-old infants (4 males, 6 females) participated in the study but were excluded from the final analysis on the basis of not meeting the habituation criterion (*n* = 3), parental interference (*n* = 3), fussiness (*n* = 1), and experimenter error (*n* = 3). Also, an additional 7 (3 males, 4 females) 19-month-old infants were excluded from the final sample on the basis of not meeting the habituation criterion (*n* = 1), parental interference (*n* = 2), fussiness (*n* = 2), and technical difficulties (*n* = 2).

Stimuli, design, and apparatus

The experimental stimuli, design, and apparatus remained the same as in the previous experiment except for the following changes. In order to create a congruent and incongruent role-reversal during the test phase, the same animal agent was maintained for both causal events during the habituation phase. As a result, a total of 4 QuickTime™ habituation and 4 test movies were created for each of the two conditions. Each movie consisted of four repetitions of a particular event, which depicted the causal interaction between an agent and recipient twice. Each event lasted 8 s for a total of 32 s for the entire movie. To highlight the self-initiated movement of the agent in each event, a familiar animal or furniture agent (e.g., horse, table) appeared stationary on one side of the screen for a brief period of time before it moved across the computer screen and contacted either another stationary animal or piece of furniture recipient, causing it to move. This causal interaction occurred twice in a given event, for a total of 8 times in a movie. Direction of action on screen was counterbalanced across events. To enhance the realism of the causal events, the contact between the agent and recipient was highlighted by a sound cue to resemble a muffled "bump".

Infants were randomly assigned to either the condition in which a horse was the agent or a sheep was the agent (See Table 2 for experimental design). During the habituation phase, infants saw two different movies. In one movie, an animal agent (e.g., horse) caused a different animal recipient (e.g., sheep) to move. In another movie, the same animal agent caused a furniture recipient to move. Events were presented in pseudo-random order with the following constraints: The first four trials and the last four trials alternated between the two types of events. In the intervening eight trials, a given event was presented no more than two times in a row. Following habituation, infants in each condition saw two types of role-reversal test events in which the role of the agent and recipient from the same habituation event were reversed. In the congruent event, the roles of the two animals were reversed in comparison to the habituation phase (animal B agent- animal A recipient). In the incongruent event, the roles of the animal and furniture were not only reversed in comparison to the habituation phase (furniture agent – animal recipient) but also featured an anomalous entity acting as agent. The order and the direction of movement of these test events were counterbalanced (See Figure 3 for sample movie frames from habituation and test events).

In the testing room, 13-month-old infants sat approximately 76 cm away from the computer monitor whereas 19-month-old infants sat 1.07 m away from the computer monitor. The distance from the computer monitor was reduced for the younger age group to account for their visual acuity.

Procedure

The procedure was identical to that of the previous experiment.

Coding

To obtain a measure of reliability, a second experimenter randomly selected 25% of infants (n = 6) from each age group to code their visual fixations. The coding was conducted by reviewing video recordings of the infant's testing session. Using the Pearson product-moment correlations, the mean inter-observer reliability was $r = .99$ (range = .94 to 1.00) for 13-month-olds and r = 1.00 (range = .99 to 1.00) for 19-month-olds.

Results and Discussion

Preliminary analyses revealed no effects for gender or type of animal agent, so the data reported were collapsed across males and females, and across category exemplars (horse or sheep as agents) in the causal events. Analyses were conducted using an alpha level of .05, and all post hoc analyses were conducted using the Bonferroni correction technique (Tabachnick & Fidell, 1996). Data screening was performed prior to main statistical analyses and assumptions of normality and homogeneity of variance were met. No outliers were identified.

Habituation Analyses

To assess whether infants had habituated to the events presented during the habituation phase, infants' looking times at the beginning and at the end of the habituation phase were analyzed as a function of age, using a 2 (Trial: first habituation block, last habituation block) by 2 (Age: 13 months, 19 months) mixed-model analysis of variance (ANOVA), with trial as a within-subjects factor and age as a between-subjects factor. The first and last habituation blocks consisted of the average looking times of the first and last four trials of the habituation phase, respectively. The analyses revealed a significant main effect for Trial, $F(1, 47) = 581.10$, $p < .05$, whereby infants looked longer at the first habituation block ($M = 23.89$ s, $SD = 6.39$ s) than at the last habituation block ($M = 10.32$ s, $SD = 3.01$ s). There was also a significant main effect of Age, $F(1, 47) = 5.40$, $p < .05$, whereby 19-month-old infants looked longer at both habituation trials ($M = 18.50$ s, $SD = 4.19$ s) than the 13-month-old infants ($M = 15.58$ s, $SD = 4.83$ s). There was no significant Trial by Age interaction, $F(1, 47) = 1.38$, n.s. Together, these findings indicate that 13- and 19-month-old infants habituated to the events presented during the habituation phase, and that 19-month-old infants looked longer at the events than 13-month-olds.

Main Analyses

To determine whether infants detected the violation between the expected role of animals and furniture in causal event, a 3 (Trial: last habituation block, congruent event, incongruent event) by 2 (Age: 13 months, 19 months) mixed-model ANOVA, with trial as the repeated-subjects factor, was conducted. If infants considered the furniture acting as agent in the causal event to be anomalous, then they were expected to look longer at the incongruent test event than at the congruent test event. This analysis revealed a significant main effect of Trial $F(2, 94) = 3.94, p < .05$, and age $F(1, 47) = 4.49, p < .05$. Pairwise comparisons indicated that infants, overall, looked longer at the incongruent test trial ($M = 14.05$ s, $SD = 9.91$ s) than at the last block of habituation trials ($M = 10.22$ s, $SD = 3.03$ s). Also, 19-month-old infants looked longer across all the trials ($M = 13.85$ s, $SD = 7.62$ s) than 13-month-old infants ($M = 10.48$ s, $SD = 6.34$ s). As illustrated in Figure 5, there was also a significant Trial by Age interaction $F(2, 94) = 3.12, p = .05$. As predicted, post hoc analyses revealed that the significant interaction was due to 19-month-old infants looking longer at the incongruent test trial ($M = 17.58$ s, $SD = 9.95$ s) than at the congruent test trial ($M = 12.62$ s, $SD = 10.14$ s) and the last block of habituation events ($M = 11.35$ s, $SD = 2.78$ s), whereas no such differences were found between the different types of trials for 13-month-old infants (last habituation block: $M = 9.10$ s, $SD = 2.91$ s; congruent: $M = 8.37$ s, $SD = 1.90$ s; incongruent: $M = 10.43$ s, $SD = 8.64$ s). These results suggest that 19- but not 13-month-old infants detected a violation of the association between the role of agent and object kind that occurred in the incongruent test event.

Fatigue Analyses

To assess whether infants were fatigued or disinterested at the end of the experiment, their looking times at the last block of habituation trials and at the post-test trial were compared as a function of their age. A 2 (Trial: last habituation block, post-test) by 2 (Age: 13 months, 19 months) mixed-model ANOVA, with Trial as a repeated-subjects factor, was conducted. The analysis revealed no significant main effect for Trial, $F(1, 47) = .44$, n.s., indicating that infants' looking times at the last block of habituation trials and post-test trial ($M = 10.51$ s, $SD = 8.50$ s) did not significantly differ. This suggests that their looking times during the tests events may have been influenced by fatigue. There was no significant main effect of Age, $F(1, 47) = 2.38$, n.s. nor was there a significant interaction, $F(1, 47) = 1.84$, n.s. However, these results may be better accounted for by the fact that infants may have perceived the experimental events as being more interesting than the pre-test or post-test events. Therefore, to assess whether infants found the experimental events to be more interesting than the control event, their looking times at the pre-test trial and the first block of habituation trials were compared. A 2 (Trial: pre-test trial, first habituation block) by 2 (Age: 13 months, 19 months) mixed-model ANOVA was conducted, with trial as a within-subjects factor. Results revealed that there was a significant main effect of Trial $F(1, 47) = 71.18, p < .05$, whereby infants looked longer at the events during the first block of habituation trials ($M = 23.88$ s, $SD = 6.39$ s) than at the pre-test event ($M = 13.24$ s, $SD = 8.61$ s). A Trial by Age interaction was also significant $F(1, 47) = 4.86, p < .05$. Post-hoc analyses revealed that the interaction was due to 19-month-old infants looking longer at the first block of habituation trials (*M* = 25.64 s, *SD* = 5.60 s) than 13-month-olds infants (*M* = 22.06 s, *SD* = 6.75 s), while there were no differences between the two age groups at the pre-test trial (13 months: *M* = 14.23 s, *SD* = 7.81 s; 19 months: *M* = 12.28 s, *SD* = 9.37 s, respectively). The main effect of Age was not significant, $F(1, 47) = .22$, n.s. Overall, this pattern of result suggests that infants found the first block of habituation trials to be more captivating than the control pre-test trial, and that fatigue may not have played an important role in their performance on the test trials.

Chance Analyses

In order to examine if children's performance was different from chance, a novelty preference score was calculated by dividing the amount of time infants looked at the incongruent test trial by the sum of their looking time across the two test trials. Results indicated that 19-month-olds' mean novelty preference score (*M* = 61%) exceeded chance $t(23) = 2.67, p < .05$, while 13-month-olds' mean novelty preference score (*M* = 46%) did not, $t(23) = .91, p = .37$, ns. Consistent with the main analysis, the finding suggests that only 19-month-old infants, as a group, were capable of differentiating animates from inanimates on the basis of causal role. Finally, whether or not a given infant succeeded on the task was assessed by comparing individual infants' novelty preference score to a criterion based on chance and the standard deviation of the group mean preference score (see Arterberry & Bornstein, 2002, for a review). Following the procedure outlined by Arterberry & Bornstein, the criterion for 13- and 19-month-old infants were .61 and .60, respectively. Using this criterion, the proportion of infants whose novelty preference score was above chance was 28% and 50% for 13- and

19-month-old infants, respectively, suggesting that only half of the older infants' preference for novelty was above chance. This pattern of finding indicates that the ability to detect an incongruent role-reversal involving an inanimate agent (e.g., table) may represent an emerging ability, whereby, with increasing age, a greater proportion of infants were successfully able to associate the role of agent with the appropriate object kind. These results are consistent with those reported in other categorization studies (Arterberry & Bornstein, 2002). Overall, these results suggest that 19-month-old infants, as a group, were capable of recognizing when the agent role in the causal event was played by the inappropriate category of objects.

General Discussion

The development of the ability to distinguish between animate beings and inanimate objects has been the subject of much inquiry in cognitive developmental research (Gelman & Opfer, 2002; Legerstee, 1992; Poulin-Dubois, 1999; Rakison & Poulin-Dubois, 2001). Recently, the developmental origins of this conceptual knowledge in infancy have become the focus of research and of some theoretical proposals. One prominent theoretical view posits that motion cues are the building blocks for the emergence of A/I distinction in infancy (Mandler, 1992; Rakison & Poulin-Dubois, 2001). Although there is some evidence that infants can associate motion cues, such as onset of motion, motion trajectory, pattern of interaction, and form of causal action with different object kinds (Baker, Demke, & Poulin-Dubois, in preparation; Kosugi & Fujita, 2001; Legerstee, Barna, & DiAdamo, 2000; Poulin-Dubois, Lepage, & Ferland, 1996), research investigating infants' understanding of the roles played by animate beings and inanimate objects in causal events is scarce. Using an infant-controlled habituation paradigm, the purpose of the present experiments was twofold: (1) to examine infants' abilities to perceive a role-reversal between animals and furniture in a causal event and (2) to assess infants' abilities to attribute the roles of agent and recipient to animals and artefacts in a causal event.

In general, the results of the present study suggest that infants can detect a reversal of agent-recipient roles across events by 16 months of age and infants' abilities to correctly associate the role of an agent with animals in a causal event by 19 months. The results of Experiment 1 revealed that 16 months-old infants can detect a change of category member (a furniture item) in the role of agent, as shown by their longer looking time to an event featuring a novel category member (a furniture item) in the role of the agent than to a test event featuring a familiar category member (an animal). This result suggests that infants are able to detect a role-reversal between animals and furniture across events, which replicates and extends research by Cohen and his colleague's (1998), indicating that, by 14-months of age, infants are sensitive to changes in agent-recipient roles within an event that involve complex and multi-featured objects.

The results of Experiment 2 revealed that 19-, but not 13-month-olds, were able to develop an expectation that the role of agent should be played by animals in a causal event and treated an event as anomalous when this association was violated. These results suggest that infants' abilities to associate the role of an agent with animals develops somewhere between 13 and 19 months of age. Therefore, the results of the present study represent the first indication that infants by their second year of life are able to assign different roles to animates and inanimates in causal events. However, the fact that the two studies differ from each other in a number of important ways may have contributed to the discrepancy in findings. For example, events used in Golinkoff and Kerr's study lacked an auditory cue to highlight the causal interaction between the agent and recipient. Some studies have indicated that infants tend to downplay dynamic information (e.g., movement) when it competes with perceptual information about an object (Bullock, 1985; Massey & Gelman, 1988; Richards & Seigler, 1984). Thus, the addition of a sound cue in the present experiment may have helped infants to focus on the causal interaction between the object kinds. In addition, differences in findings may be accounted for by the different designs used in the two studies, that is, a within-subjects design vs. a between-subjects design. The between-subjects design of Golinkoff and

Kerr's study (1978) involved presenting only one of two plausible causal events (man pushing man or man pushing chair). Thus, it is possible that infants in both groups responded similarly to the test events as a result of detecting a role-reversal as opposed to understanding the causal roles played by animates and inanimates. To understand whether infants responded on the basis of a role-reversal or on the basis of a plausible agent role in a causal event, a between-subjects design with a role-reversal control during the test phase will be more suitable to address the question. Furthermore, the two studies differed with respect to the dependent variable that was used. In Golinkoff and Kerr's experiment, infants' ability to detect the anomalous test event was assessed using a heart rate measure, whereas visual fixation time was used to assess causal knowledge in the present study. Taken together, these different factors could potentially contribute to differences in findings between the present study and past research on infants' understanding of the causal role played by animate beings and inanimate objects. Finally the sample size in Golinkoff and Kerr's study limited the conclusiveness of their findings.

Previous studies investigating infants' association of animate and inanimate motion cues with object kinds has found that by 9 months of age, infants consider a novel inanimate object (e.g., robot) capable of self-initiated motion to be anomalous, but not a person capable of self-initiated motion (Poulin-Dubois, Lepage, & Ferland, 1996). Also, by 12 months of age, infants can associate a non-linear motion trajectory with animals and a linear motion trajectory with vehicles (Baker, Demke, & Poulin-Dubois, in preparation). Furthermore, infants by the age of 8 months expect physical contact to be necessary for an interaction to occur between a person and an object and between two people who are not facing each other (Kosugi & Fujita, 2001). Finally, by 6 months of age, infants develop the expectation that people communicate with persons but act on objects (Legerstee, Barna, & DiAdamo, 2000). Taken together, these findings indicate that infants associate the motion cue of trajectory with human agents and the motion cues of onset, contingency, and form of causal action (action at a distance vs. action from contact) with animal agents in a causal event. Thus, it appears that infants become sensitive to the motion trajectory of animate beings and inanimate objects in causal events before they become sensitive to the agent-recipient roles played by animates and inanimates.

The later emergence of infants' sensitivity to the roles played by animate and inanimate entities may be attributed to the rich information available within the causal event. Specifically, in order to link agent-recipient roles to category kind in the present experiments, infants had to attend to multiple aspects of the causal event. In particular, they had to attend to the perceptual information pertaining to the agent and recipient (e.g., visual characteristics of object, biochemical motion), the relationship between the two entities in the causal interaction, and be able to retrieve and compare this information with that provided in the test phase. As a result, infants in the younger age group may have found the task of attending to all this information to be challenging. The inability of 13-month-olds to associate the role of an agent with animals and the role of the recipient with furniture is consistent with the finding by Cohen and his colleagues (1998), which indicates that infants before the age of 14 months have difficulties detecting agent-recipient role-reversals in complex causal events. It is reasoned that the developmental progression of infants' causal perception evolves from perceiving the independent features of events (e.g., object features, contingency of motion) to distinguishing causal events from noncausal ones. Furthermore, the distinction between these causal and noncausal events first involves simple objects before more complex objects (Oakes, 2003).

It is worthwhile to note that the results of Experiment 2 do not answer the question of whether infants' abilities to associate agent-recipient roles to animates and inanimates represents a true conceptual understanding of these two categories or whether the association is a result of learning an on-line arbitrary co-variation between causal roles and object kind. For example, infants may have simply associated the moving legs of the animal with the agent role. To answer this question, the procedure of the present study would need to be modified such that half the infants would be presented with a plausible causal event during the habituation phase, and the other half with an implausible event. If infants merely learned an arbitrary association between the agent's causal role and object kind, then infants who were habituated to the incongruent causal event (e.g., table agent, horse recipient) during the habituation phase should look longer at the congruent test event (horse agent, table recipient), than at the incongruent test event (e.g., chair pushing horse). Likewise, infants who where habituated to the congruent causal event during the habituation phase should dishabituate when they see an incongruent test event. On the other hand, if the two groups of infants show similar pattern of looking time at the test events, then infants must be applying pre-existing knowledge of the motion abilities of animals and furniture to abstract its role in a causal event (Kannass, Oakes, & Wiese, 1999).

No doubt, the conclusion that infants are able to associate agent-recipient roles with broad categories of animates and inanimates will require, in future studies, the use of the same procedure and design to test whether the same association still holds when people represent animates. Specifically, if infants are able to associate differential roles to people and furniture items in causal events, then they will look longer at the test event featuring the incongruent role-reversal between a person and furniture item (e.g., table pushing man) than at the test event featuring a congruent role-reversal between an animal and human (e.g., man pushing animal). It would also be of empirical interest to discover whether the same developmental progression applies when associating the role of an agent with people as it does when associating the role of an agent with animals. Alternatively, infants may be better able to associate agent-recipient roles to the appropriate object kind in causal events if the animate exemplars consisted of people as opposed to animals. Given that infants are more likely to be exposed to humans in a variety of contexts than with animals, infants may associate the role of agent with people at a younger age than with animals. This view is supported by evidence that suggests that infants' knowledge of humans develops earlier than their knowledge of animals (Bonatti, Frot, Zangl, & Mehler, 2002; Pauen, 2000; Xu & Carey, 1996). Therefore, it is possible that infants' abilities to associate the causal role of an agent with an animate being emerges gradually, with infants being able to associate the causal role of an agent with a person first before other animate exemplars.

In addition, future studies are warranted to clarify to what extent infants use dynamic information, such as self-initiated and causal action, and featural cues to help them make the association between agent-recipient roles and object kind. As mentioned earlier, stimuli within events inherently contain a combination of featural and dynamic information that could influence infants' abilities to associate the appropriate causal role with each type of objects. Therefore, future research might explore ways of isolating motion information from other object features to determine the contribution of the various components to the A/I distinction. One possibility is to use point-light displays to uniquely convey the motion patterns of the causal event. An advantage to using point-light displays is that infants have been shown to be sensitive to the information contained in dynamic point-light displays. Specifically, infants have been shown to be sensitive to biomechanical motion in displays depicting humans. For example, 4-, 5-, and 6-month-olds can differentiate upright from inverted dynamic point-light displays of a walking human (Bertenthal, Profitt, & Kramer, 1987). Also, infants, as young as 3 months of age, can discriminate random from coherent point-light displays of motion (Bertenthal, Profitt, Spencer, & Thomas, 1985). Moreover, infants as young as 3-month-olds are able to categorize objects, such as animals and vehicles, on the basis of static color images and dynamic point-light displays (Arterberry & Bornstein, 2001). However, whether infants are able to discriminate animate beings from inanimate objects on the basis of the causal role of the agent using point-light displays is a matter of empirical investigation.

Additionally, future studies might address the importance of experience with real-world animate and inanimate objects on infants' abilities to attribute agent-recipient roles with object kind in a causal event. For example, it is possible that infants retrieve information of real-world horses and chairs to help them link agent-recipient roles to the appropriate category member. Using an object examination task, a study by Pauen and Traeuble (2004) revealed that experience with real-world animals, such as dogs and cats, influenced performance of older but not of younger infants in a basic-level categorization task. Therefore, it would be of empirical interest to examine whether infants who have regular contact with domestic animals in their environments would be better able to associate agent-recipient roles with the appropriate category member using a different categorization paradigm.

The findings from the present study are the first to show a link between agent and recipient roles with animate and inanimate categories during the second year of life. In addition, this research extends previous literature by demonstrating a link between motion cues and animals, whereas previous research has focused primarily on people. Considered together, these findings extend previous research investigating the link between object kinds and motion cues (Mandler, 1992; Rakison & Poulin-Dubois, 2001), validating the contribution of motion cues in the distinction of animate and inanimate entities.

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Appendix A

Parental Consent Form

In this study, we are examining how infants distinguish between living beings and non-living objects. More specifically, we are testing their understanding of the motion of members of these two categories. For example, how and at what age do children know that people move differently from chairs? Your child will be presented with animated films on a computer screen and the amount of time your child looks at each film will be measured. Your child will be shown two films repeatedly in which something moves across the screen until they begin to lose interest in the films. At that time several different films will be shown. You will be asked to remain silent and neutral during the session. The entire session is expected to last approximately 30 minutes. The videotapes and all the data obtained from them will be kept confidential.

_____________________ _____________________

Diane Poulin-Dubois, Ph.D.
Professor

Virginia Chow, B.A.
M.A. Candidate

The nature and purpose of this experiment has been satisfactorily explained to me and I agree to allow my child to participate. I understand that we are free to discontinue participation at any time and that the experimenter will gladly answer any questions that might arise during the course of the research.

_____________________ _______________

Parent's signature

Date

I would be interested in participating in future studies with my child (yes/ no): ____ ______

Subject #: __________ Researcher: ____________ ______

Appendix B

Participant Information

Infant's name:______________________ Date of Birth: ______________________

Gender:__________ Language(s) spoken at home:______________________

Mother's name: ____________________ Father's name: ____________________

Address: __________________________ Telephone #: ________________home

__________________________ ________________work

Postal Code:______________________ ________________work

Mother's occupation:______________ Father's occupation:______________

Mother's education (highest level attained):______________________________________

Father's education (highest level attained):______________________________________

Mother's marital status:____________ Father's marital status:____________

Please answer the following general information questions about your child:

Birth weight:____________ Length of pregnancy:__________weeks

Birth order:_____________(e.g., 1 = 1st child)

Number of siblings:__________

Were there any complications during the pregnancy?____________________________

Has your child had any major medical problems?_______________________________

Does your child have any hearing or vision problems? ___________________________

Please answer the following general information questions about your family:

Does your family have a pet (or pets)? (yes/no) _______ If you answered yes, please list your pet(s) indicating the kind of pet(s) (e.g., dog, cat, fish) and the number of pets:

____

Participant#:______ Researcher:________________

Table 1

Experiment 1: Experimental Design.

Group	Habituation events	Test Events
A1	Horse agent / Chair recipient Sheep agent / Table recipient	Table agent / Horse recipient Sheep agent / Chair recipient
A2	Horse agent / Chair recipient Sheep agent / Table recipient	Chair agent / Sheep recipient Horse agent / Table recipient
B1	Horse agent / Table recipient Sheep agent / Chair recipient	Table agent / Sheep recipient Horse agent / Chair recipient
B1	Horse agent / Table recipient Sheep agent / Chair recipient	Chair agent / Horse recipient Sheep agent / Table recipient

Note. Direction of causal interaction in Habituation and Test events were counterbalanced.

Table 2

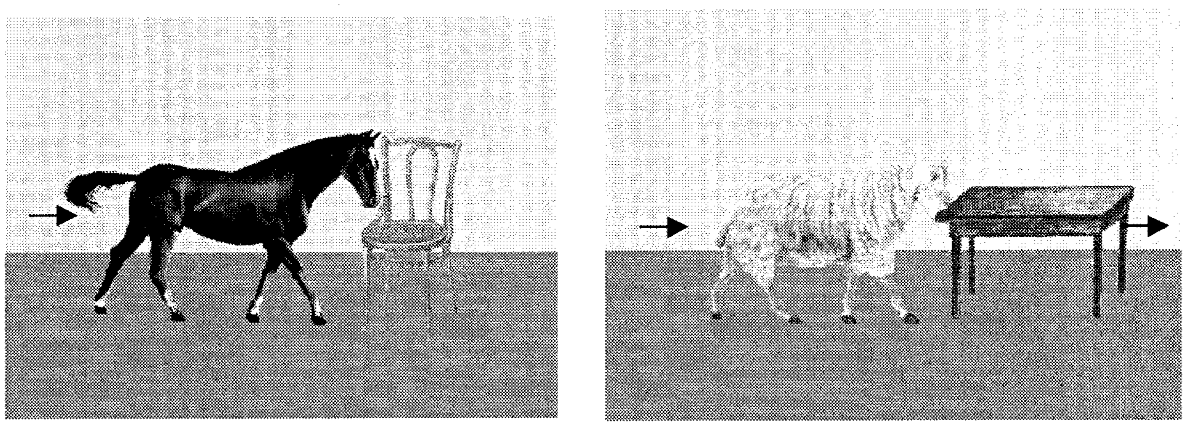
Experiment 2: Experimental Design.

Group	Habituation events	Test Events
A	Horse agent / Sheep recipient Horse agent / Table recipient	Sheep agent / Horse recipient Table agent / Horse recipient
B	Sheep agent / Pig recipient Sheep agent / Chair recipient	Pig agent / Sheep recipient Chair agent / Sheep recipient

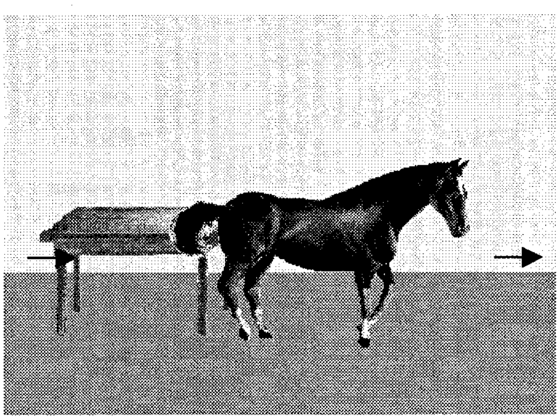
Note. Direction of causal interaction in Habituation and Test events were counterbalanced.

Figure 1: Selected frames from habituation and test events in Experiment 1.

Habituation Events



Role-reversal Test Event



Same-role test event

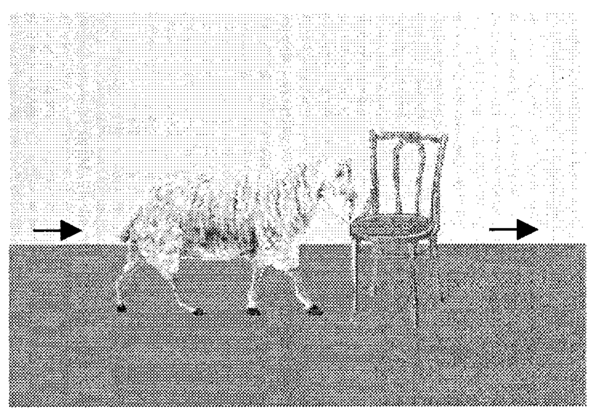
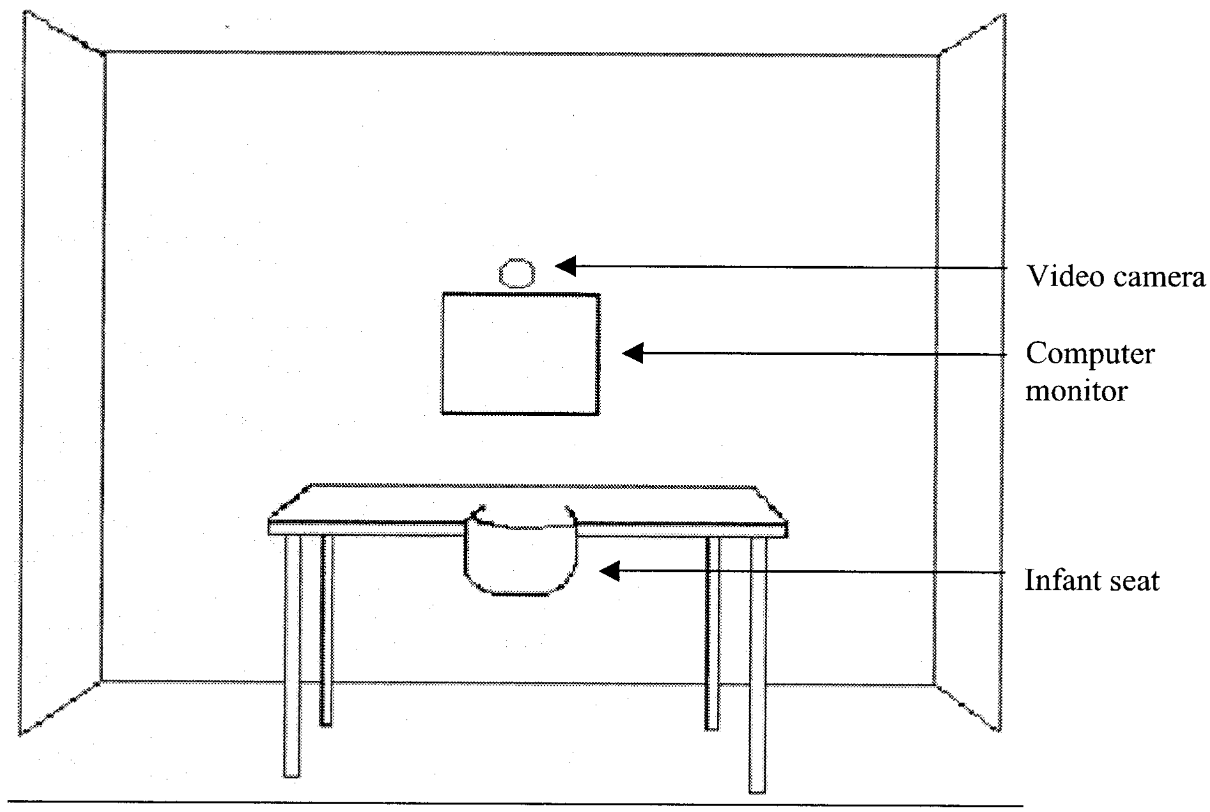


Figure 2: Diagram of testing apparatus



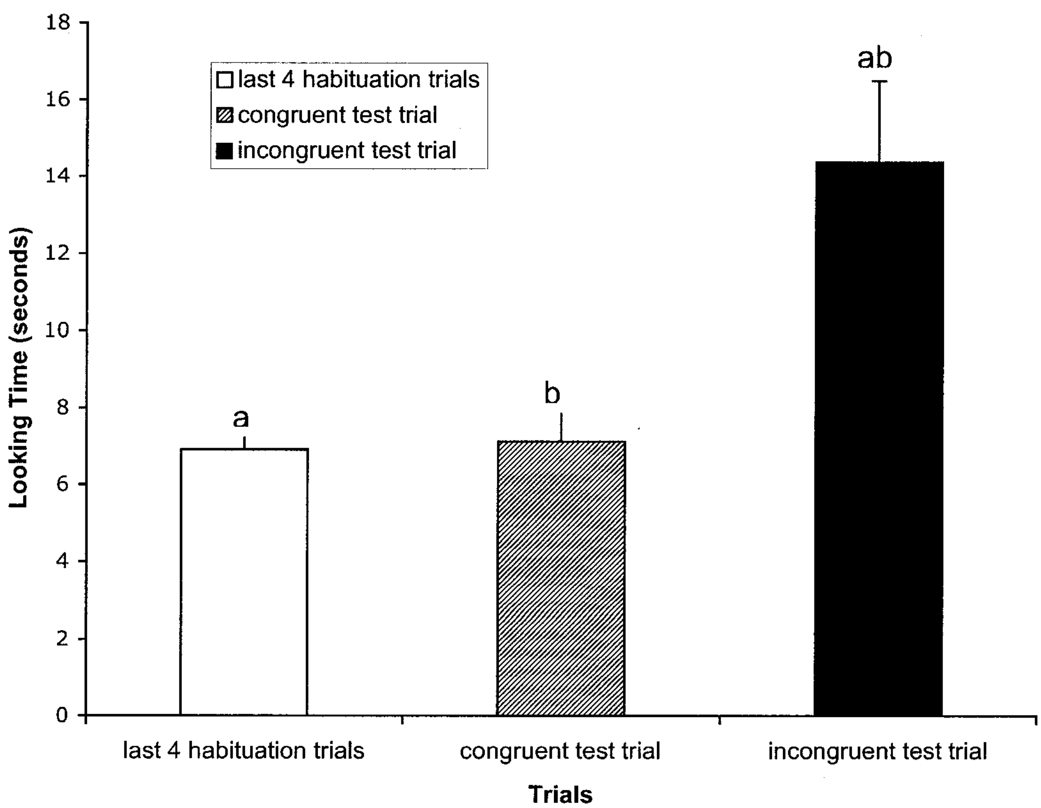
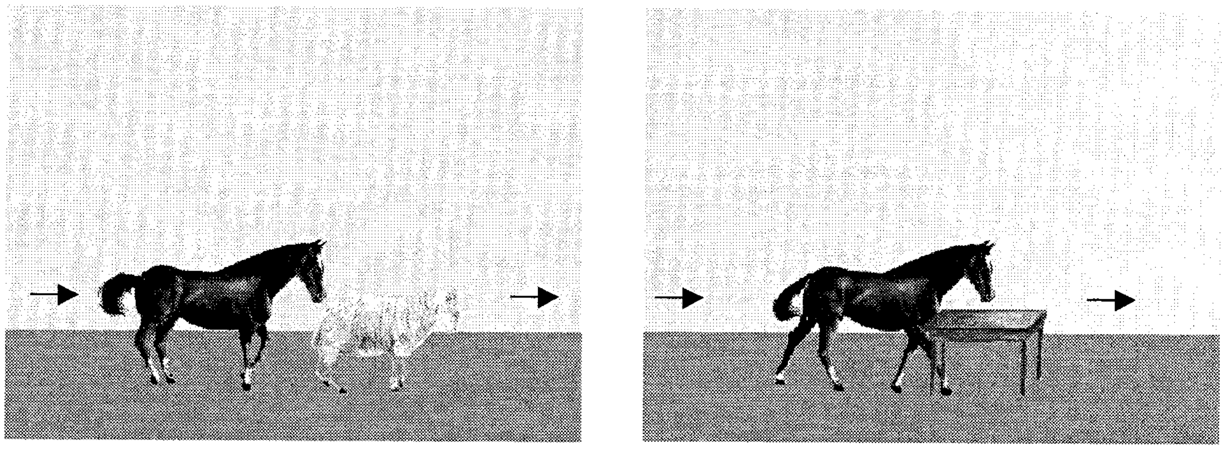


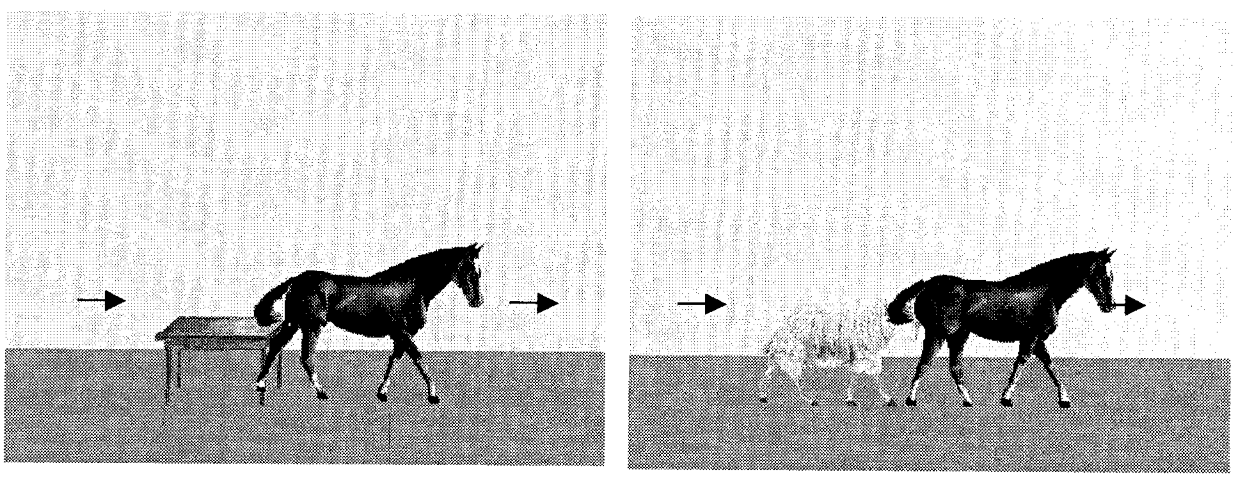
Figure 3: Mean looking times at the last 4 habituation trials, congruent, and incongruent test events for infants in Experiment 1. Bars labelled with the same letter differ significantly, a: $p < .001$, b: $p < .003$.

Figure 4: Sample frames from habituation and test events in Experiment 2.

Habituation Events



Incongruent Test Event *Congruent Test Event*



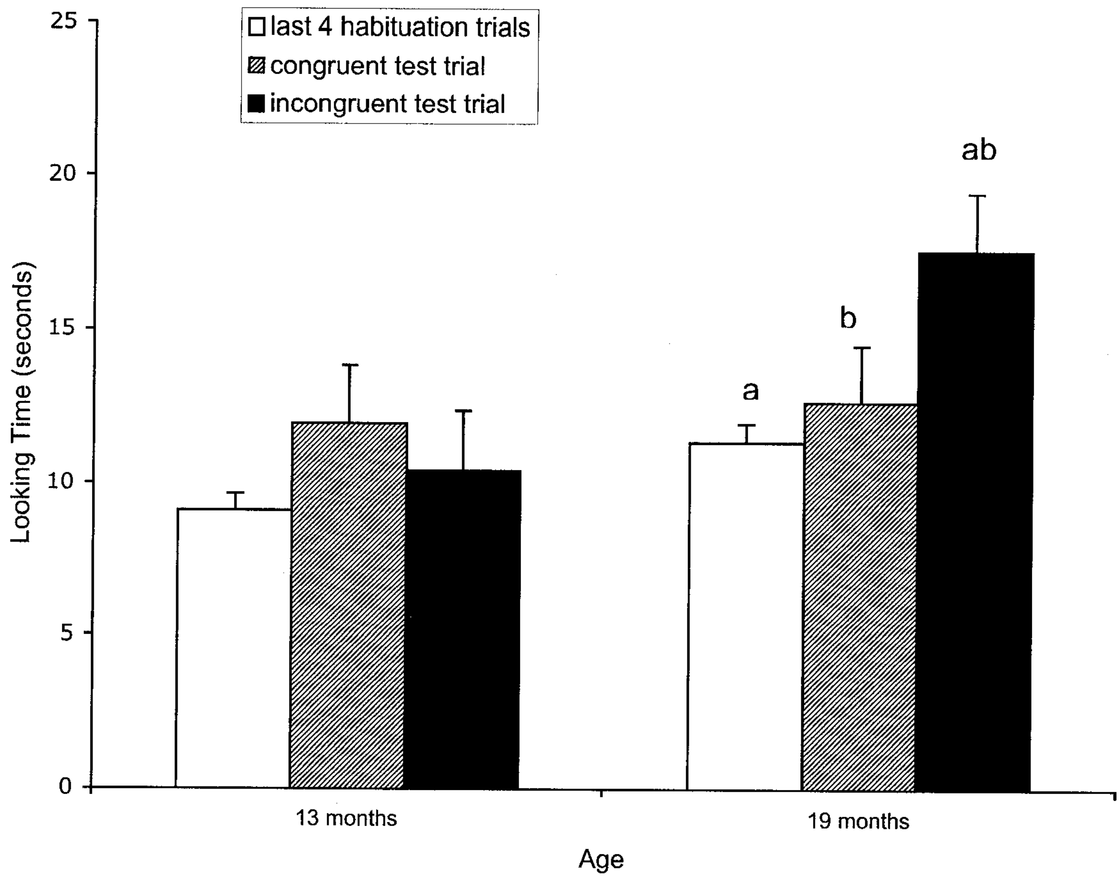


Figure 5: Mean looking times at the last 4 habituation trials, congruent, and incongruent test events for 13- and 19-month-olds in Experiment 2. Bars labelled with the same letter differ significantly, a: $p < .005$, b: $p < .038$.