Infants' Expectations about the Motion of Animate versus Inanimate Objects*

Amanda L. Woodward, Ann T. Phillips & Elizabeth S. Spelke
Department of Psychology
Cornell University
Ithaca, NY 14853-7601
amax@crux1.cit. cornell.edu

Abstract

This study explores the ways in which infants reason about human action. Although recent research supports the view that young infants' reasoning about object physics is guided by a set of core principles, there is little evidence for early principles of this sort in infants' reasoning about human action. To explore this issue, a habituation study was done comparing 7-month-olds' reasoning about simple causal sequences involving people to their reasoning about those involving inanimate objects. Our findings suggest that although 7-month-olds expect that the motion of inanimate objects will be constrained by the *principle of contact* (an object affects the motion of another object if and only if the two objects come into contact), they do not expect human motion to be constrained in this way. These findings provide preliminary evidence that infants have principled expectations to guide their reasoning and learning about human action.

Introduction

What do babies know about people? It has been suggested that infants are equipped with a naive psychology (Carey, 1985) or theory of mind (Fodor, 1992; Leslie, 1993; Premack, 1990), which operates from early in life and enables the development of mature conceptions of people as animate and sentient beings. This proposal is part of a general trend away from assuming all development is the result of domain general learning, and toward a view of development as the result of enrichment of domain specific core concepts or skeletal theories (Gelman, 1990). A prime example of this is the recent work on the development of physical knowledge (e.g., Baillargeon, in press; Spelke, 1991). This research shows that very young infants have principled expectations about how objects will move and change. For example, 4-month-old infants expect that objects will move on connected paths through time and space, and that objects will not pass through the space occupied by other objects (Spelke, 1991). Although it has been proposed that knowledge of people develops in the same way as knowledge of physical constraints on objects (i.e., as elaboration of a core "theory of mind") there is little empirical work which suggests that young infants have principled expectations about human action. The current study provides an initial look at this question by comparing young infants' expectations about human behavior to their expectations about inanimate objects in a simple causal sequence--a situation for which (1) young infants have expectations about the constraints on motion of inanimate objects; and (2) people can behave differently than inanimate objects. If young infants have a core theory of human action, then they may reason differently about people and objects in this context.

Studies of infants' knowledge about human action have largely focused on older infants, from about 12 months onward. Even very young infants react to people differently than to inanimate objects, but it is not until later in infancy that studies find infants acting as though they have specific notions of how humans should behave. For example, it is not until about 12 months that there is evidence that children use gaze direction to predict behavior--12-month-olds will use gaze direction to predict which of two objects a person will pick up, but 8 month-olds seem not to (Phillips & Spelke, in preparation), and by 15 months children use gaze direction as a cue to which object a speaker is labeling (Baldwin, 1991). Several studies which compare infants' expectations about the behavior of inanimate objects to their expectations about the behavior of people find similar patterns. Golinkoff and Harding (see Golinkoff, Harding, Carlson, & Sexton, 1984) found that 24-month-olds, but not 16-month-olds, reacted with surprise at seeing a chair apparently move itself across the floor. Poulin-DuBois and Schulz (1988) found that 13-month-olds, but not 8-month-olds showed heightened attention to an event in which an inanimate object acted as an agent. Carlson (see Golinkoff et al., 1984) provides some evidence that somewhat younger children, 10-month-olds,

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differentiate between the likely causes of human action as opposed to inanimate object motion. These infants were more likely to learn to use a physical mechanism (pushing or pulling a handle) to cause a picture to appear in a window than to cause a person to smile and wave. Thus, the evidence for core principles of human behavior in young infants is surprisingly scarce.

In contrast to the work on infants' understanding of human behavior, studies of infants' knowledge about inanimate objects has shown that infants as young as 4 months are guided in their reasoning by a core object concept, (e.g, Baillargeon, in press; Spelke, 1991). Spelke (Spelke, 1991; Spelke & Van de Walle, in press) has described this early knowledge in terms of two principles: the continuity and contact principles. These principles reflect the findings that infants expect that objects (1) will follow continuous paths through time and space, and not occupy the same space as another object (the continuity principle); and (2) will act upon each other if and only if they come into contact (the contact principle).

The contact principle provides infants not only with a method for determining which elements of a scene are connected (e.g., Kellman & Spelke, 1983), but also with a basis for understanding simple causal sequences. Infants as young as 2.5 months have shown an awareness of the role of contact in causal sequences. In a recent study, Baillargeon (1993) found that 2.5-month-old infants looked longer at an event in which a cylinder rolled down an incline and collided with a small toy and the toy remained stationary than at a similar event in which the cylinder did not make contact with the toy. Subsequent studies showed that 6.5-month-olds seemed to predict how far the toy would move after collision based on the size of the cylinder.

Other studies have shown that by 6 months, infants see some kinds of sequences involving collision as causal (Leslie, 1982; Leslie & Keeble, 1987), and infer that inanimate objects which seem to affect one another must have come into contact (Ball, 1973) In one study, Ball (1973) habituated infants to a scene in which two boxes moved behind an occluder. Since the occluder blocked the center of the display from view, infants could not see whether the objects were colliding, but the paths of motion were such that adults would assume that the boxes did collide. After habituation, infants were shown two test events, both of which were the same as the habituation event except that the occluder was removed and, thus, the activity in the center of the display was visible. In one event, the boxes collided, and in the other, they stopped short of each other. The infants, who ranged in age from 9 weeks to 24 months, looked longer at the test event in which the boxes stopped short, suggesting that they found this event more surprising. In a reanalysis of Ball's data, Spelke and Van de Walle (in press) determined that this finding held up when only those subjects 7 months and younger were included in the analyses.

Given this early understanding of contact in simple causal sequences involving inanimate objects, we thought that this might be a fruitful area to look for early understanding of human behavior. Infants know that objects must make contact to affect one another. Yet, people are not constrained in this way. Adults and older children know that people can react to stimuli at a distance, and act on other people by calling to them, frightening them, etc. If young infants have an understanding of mechanical causality, but lack an understanding of "intentional" causality, they may overextend this notion to people. That is, they may expect that people must come into contact in order to affect one another. However, if infants have a nascent understanding of human action, they may have a different set of expectations for how people will act in causal sequences. That is, they may suspend the contact principle for people, or apply an entirely different set of principles to human behavior.

We addressed this question using a habituation procedure similar to the one designed by Ball (1973). Infants were habituated to an event which was screened from view in the middle. They saw two objects move back and forth behind the screen. The display was ambiguous as to whether or not the objects were making contact behind the screen. Half of the babies saw this event with people as the objects which moved back and forth. The other half of the babies saw boxes moving back and forth. In the box condition, given Ball's findings, infants should look longer at test displays in which the objects do not make contact. The critical question is what infants do in the person condition. Do they extend the contact principle to people, or do they have a different set of expectations about human action?

Subjects

Thirty-two infants, 17 boys and 15 girls, with a mean age of 6 months 27 days (range = 6;6 to 7;17) participated in the study. There were 16 infants in each of two conditions--the *inanimate object* condition and the *person* condition. There were approximately equal numbers of girls and boys in each condition. Fourteen infants were run in the procedure but not included in the study. Of these, 8 failed to complete the procedure due to excessive fussiness and 6 were eliminated because of errors in the procedure.

Stimuli

There were two sets of videotaped events: one set involved large inanimate objects (a 5-1/2 foot tall red box and a 6-1/2 foot tall blue cylinder) mounted on small wheels, the other involved two people (a woman in a blue dress and a man in red pants and a red shirt). Except for the difference in protagonists, the sets of films were identical.. All films were made in an outdoor location with a light brick wall in the background and a cement floor. In the habituation film the center of the scene was occluded by a large gray screen. The film began with one object standing still, half hidden behind the right side of the screen. The second object entered the scene from the left and disappeared behind the screen. The first object then moved off from behind the screen and exited stage right. Then the first object re-entered from the right, moved behind the screen, stopping at its original place, and the second object moved out from the left side of the screen and went off stage. The loop then began again. In the films involving people, the actors walked normally, facing the direction they were headed, and turned to face front when they stopped moving. While approaching one another, the actors held their arms up close to their bodies, with palms facing forward. When they stopped and turned to the front, they dropped their arms to their sides. The boxes were pushed from behind by people who were not visible from the front.

There were two test films for each condition, each of which matched the habituation film's unscreened portions but were not screened in the middle. In one test film, the objects collided when they met in the middle of the set. In the other, the objects stopped short of each other, leaving 1 foot between the two objects. In the films with people, the collision was a full body slam with contact along as much of the two bodies as possible. In the non-collision film the actors held the same postures as in the collision film, but stopped 1 foot away from each other. In both test films, the actor who was standing still looked toward the approaching actor, turning away only when he or she turned to walk off screen.

Infants also saw two familiarization films, designed to acquaint them with the set and the items in the films. In one, an actor (not one of the people used in habituation and test films) pushed the screen on-stage, walked around it, and then pushed it off stage. In the other, either the two boxes or the two people were shown standing on either side of the screen. In the person film, the actors danced slightly from side to side. In the object film, the boxes stood still.

Procedure

Infants sat in an infant seat on a table top, two feet away from a 21-inch television screen. To minimize distractions, they were surrounded by curtains on three sides. Parents stood behind the infant so that they could see the displays, but infants could not see the parents. Some infants were run sitting on the parent's lap, with the parent sitting cross legged on the table. For these infants, parents were asked to close their eyes or look down at the baby during test trials. Two observers, who were behind the curtain above the television, monitored looking times. Looking times were recorded and habituation calculated by computer.

Infants were assigned to one of two conditions -- the *person* condition or the *inanimate object* condition. First, babies saw the two familiarization films. Then, habituation began. For each habituation trial, a screen in front of the television was raised and the habituation film was started at the beginning of the loop. Looking times were counted starting after the infant had seen one full pass of the event (movement from one side of the screen to the other). If the infant failed to attend to the first full pass, the observers attracted the infants' attention to the screen by making nonverbal noises (clicks, clucks, snaps, etc.) until the baby had seen one full pass. Once the baby had reached habituation criterion--defined as a 50% decrease in looking over three trials relative to the preceeding three trials--the test trials began.

Each infant had six test trials, three with collision and three without. The two trial types were alternated, yielding three pairs of collision/no-collision trials. Which test trial was given first was counterbalanced for each condition. As for the habituation trials, looking times on test trials were counted beginning after the infant had seen one full pass of the test event (one collision or non-collision).

Results

Total looking times to the collision and no-collision test films in for both groups are given in table 1. In the inanimate object condition, babies looked longer at the test films with no collision. Twelve out of sixteen babies in this condition looked longer at the no collision films. This difference is significant by sign test, $p<.05$ (one-tailed). Thus, the current findings replicate Ball's (1973) results. Babies seem to find the no-collision film more new, suggesting that during habituation they assumed the boxes were colliding behind the screen. In contrast, in the person condition, babies did not show this preference. In this condition, 10 of 16 babies looked

longer at the collision test film. A Mann Whitney test was performed on difference scores for each child, obtained by subtracting total looking time to the collision films from total looking time to the no-collision films. This test revealed that performance in the person condition differed reliably from performance in the inanimate object condition, $U = 83, p < 05$ (one-tailed).

Table 1. Average total looking time (in seconds) for inanimate object and person groups on collision and no-collision test trials.

Condition	Collision	No Collision
Obje ct	48.2	57.7
Person	49.1	40.3

Discussion

The current findings support the conclusion that by 7 months, infants differentiate between people and objects in their reasoning about simple causal sequences. Although they assume that inanimate objects which appear to affect each other must make contact, they do not make this assumption for people. In fact, in the person condition, there was a slight tendency for infants to look longer at the contact film than at the no contact film, suggesting that infants may expect people to avoid collisions. Thus, these findings provide a preliminary answer to the question posed above: 7-month-old infants do not extend the principle of contact to events involving human action. This suggests that by this age, infants may have a separate set of principles to guide their reasoning about human action, and with more empirical work, we may be able to determine what these principles are.

This study points out a plethora of new questions to be explored. What principles guide infants' reasoing about human action? How do the principles employed in understanding human behavior relate to the principles used in physical reasoning? It might be that initially the two classes are kept separate--humans are described by principles of human behavior, inanimate objects by the core object principles. In this case, then infants might fail to understand that humans are constrained by many of the principles which govern object motion--continuity, solidity, etc. Alternatively, perhaps humans are correctly understood as both animate and physical entities from the beginning. Another set of questions concerns the features infants use to distinguish between animate and inanimate objects. At first, maybe infants single out people as a class to be reasoned about differently, only later extending the core "animate principles" to other animate objects. Alternatively, maybe the "animate principles" are triggered by a single feature or small set of features, for example, things which move themselves, things which act contingently, or things which have eyes or faces.

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