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Eight-and-a-Half-Month-Old Infants' Reasoning about Containment Events

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The present research examined whether 8.5-month-old infants take into account the width and compressibility of an object when determining whether it can be inserted into a container. The infants in Experiment 1 saw 2 test events. At the start of each event, a tall container rested on the apparatus floor. Next, the container was hidden by a screen, and a large ball attached to the lower end of a rod was introduced into the apparatus and lowered behind the screen into the container. Finally, the screen was removed to reveal the ball's rod protruding above the container's rim. The only difference between the 2 test events had to do with the width of the containers: in 1 event (large-container event), the container was slightly wider than the ball; in the other event (small-container event), the container was only half as wide as the ball, so that it should have been impossible for the ball to be lowered into it. Infants in a control condition saw identical test events except that a small ball was used that could fit into either the large or the small container. The infants in the experimental condition looked reliably longer at the small- than at the large-container event, whereas those in the control condition tended to look equally at the 2 events. These results suggested that, although the infants never saw the ball and the container simultaneously, they realized that the large ball could fit into the large but not the small container, whereas the small ball could fit into both containers. In Experiment 2, the large ball used in Experiment 1 was replaced with an equally large but compressible ball. The results were negative, suggesting that the infants understood that the large compressible ball could be inserted into either the small or the large container. Finally, Experiment 3 confirmed the results of the experimental condition in Experiment 1, with a slightly different procedure. Together, the present results indicate that, by 8.5 months of age, infants are already capable of sophisticated reasoning about containment events.

INTRODUCTION

As they look about them, infants continually observe many different physical events: for example, they may see a parent pour juice into a cup, stack dishes on a table, or store groceries in a cupboard, or they may see a sibling drop a ball, hit a tower of blocks, or send a toy car crashing into a wall. How do infants make sense of the multitude of physical events that form an inextricable part of their daily lives?

Over the past few years, several accounts have been proposed that attempt to describe and explain important regularities in the development of infants' physical knowledge (e.g., Baillargeon, 1995; Leslie, 1995; Mandler, in press; Oakes & Cohen, 1995; Spelke, Breinlinger, Macomber, & Jacobson, 1992; Thelen & Smith, 1994). Our own account (e.g., Baillargeon, 1995, in press; Baillargeon, Kotovsky, & Needham, 1995) holds that at least two learning processes contribute to infants' acquisition of physical expectations. The first process is the formation of event categories that correspond to distinct ways in which objects behave and interact. The second process is the identification, for each event category, of an initial concept and variables. When learning about a new event category, infants first form an all-or-none concept that captures only the essence of the category. With further experience, infants slowly identify discrete and continuous variables that enable them to understand events from the category better and better over time.

Most of the evidence supporting this model has come from experiments on infants' knowledge about occlusion (e.g., Aguiar & Baillargeon, 1996; Baillargeon & DeVos, 1991), support (e.g., Baillargeon, Needham, & DeVos, 1992; Needham & Baillargeon, 1993), and collision (e.g., Kaufman & Kotovsky, 1997; Kotovsky & Baillargeon, 1994) events. To broaden the scope of our investigations, we have recently begun a series of experiments on infants' expectations about containment events. The present research was conducted as a part of this new effort and asked whether 8.5-month-old infants take into account the width and compressibility of an object when determining whether it can be inserted into a container. Before describing these experiments, however, we first review prior findings on infants' responses to containers.

Infants' Knowledge about Containment Events

During the 1980s, a large number of experiments were conducted to explore infants' knowledge about containment events. Infants aged 6–20 months were given tasks examining their manipulation of containers (e.g., Cornell, 1981; Freeman, Lloyd, & Sinha, 1980; MacLean & Schuler, 1989; Morss, 1983; Pieraut-Le Bonniec, 1985a, 1985b) or their visual attention to containment events (e.g., Caron, Caron, & Antell, 1988; Leslie, 1991; Stamback, Sinclair, Verba, Moreno, & Rayna, 1989). Two main questions were addressed. One was whether infants realize that an object can be inserted into a container with an open but not a closed top (e.g., MacLean & Schuler, 1989; Pieraut-Le Bonniec, 1985a, 1985b; Stamback et al., 1989). The other question was whether infants understand that an object placed in a container cannot move through the bottom or sides of the container and hence must remain in the container until removed through its opening (e.g., Caron et al., 1988; Cornell, 1981; Freeman et al., 1980; Leslie, 1991; Morss, 1983; Stamback et al., 1989).

A recent experiment by Sitskoorn and Smitsman (1995) extended these initial investigations by exploring a different facet of infants' knowledge about containment events. The experiment examined whether 4-, 6-, and 9-month-old infants appreciate that an object can be inserted into a container with an opening wider but not narrower than the object itself. The infants were habituated to two events presented on alternate trials. In both events, a block was repeatedly lowered into and lifted from a box with an opening at the top; one event involved a small block and a box with a small opening, and the other event involved a large block and a box with a large opening. Following habituation, the block and box pairs were rearranged, and the infants saw two test events. In one (large-opening event), the *small* block was lowered into the box with the *large* opening. In the other event (small-opening event), the *large* block was lowered into the box with the *small* opening (the box's side rims were partly collapsible). The 6- and 9-month-old infants looked reliably longer at the small- than at the large-opening event. These and control results suggested that the infants viewed the large- but not the small-opening event as consistent with their physical expectations.[1] In turn, this interpretation suggested that the infants (1) understood that the width of the block relative to that of the box opening determined whether the one could be lowered into the other and (2) recognized that the small block could be lowered into the box with the large opening but that the large block could not be lowered into the box with the small opening.

1. When shown two events, one that is consistent with their physical expectations and one that is not, infants typically look longer at the inconsistent than at the consistent event (see Bornstein, 1985; Spelke, 1985). Infants' greater interest in the inconsistent event is often taken to indicate that they (1) detect the violation of their physical knowledge and furthermore (2) are surprised or puzzled by this violation (e.g., Baillargeon, 1994; Spelke et al., 1992). Over the past few years, there has been a growing concern that references to surprise or puzzlement responses should be avoided until formal evidence is obtained involving facial, behavioral, or physiological correlates of surprise and puzzlement (e.g., Haith, 1997; Thelen & Smith, 1994). This more conservative stance is the one adopted here.

The Present Research

Experiment 1 was designed to replicate and extend the results obtained by Sitskoorn and Smitsman (1995). Participants in the present research were 8.5-month-olds and thus close in age to the oldest group tested by these authors. First, we sought to confirm that infants this age take into account the width of an object when determining whether it can be inserted into a container. Second, we wanted to explore what strategies 8.5-month-old infants are capable of using to reason about an object's width in a containment event.[2]

Computational models of everyday physical reasoning (e.g., Forbus, 1984) commonly distinguish between two types of reasoning strategy: quantitative and qualitative strategies. A strategy is said to be *quantitative* if it requires participants to encode and use information about absolute quantities (e.g., object A is "this" large, where "this" stands for some absolute measure of A's size). In contrast, a strategy is said to be *qualitative* if it requires participants to encode and use information about only relative quantities (e.g., object A is larger than object B). Experiments conducted with several different event categories have shown that infants can sometimes engage in quantitative as well as in qualitative reasoning about continuous variables (e.g., Baillargeon, 1987, 1991; see Baillargeon, 1995, for a review). In the experiment of Sitskoorn and Smitsman (1995), the infants could use a qualitative strategy to determine whether a block could be inserted into a box opening: they could visually compare the width of the block to that of the box opening as the one was lowered into or lifted from the other. There was thus no need for the infants to encode and use absolute information about the block's width. Experiment 1 attempted to extend these results and asked whether 8.5-month-

2. The term "reason" is used here very generally to refer to the mental processes involved in the representation and manipulation (e.g., selection, retrieval, comparison) of information (e.g., perceptual representations, images, concepts). One reason for preferring the term "reason" to other terms is that it conveys an element of directedness (Gleitman, 1991): it suggests that infants' mental activities are aimed at a particular goal (e.g., determining whether or not a specific object could fit into a specific container).

olds could reason quantitatively about an object's width in a containment event. Would infants be able to determine whether an object could be lowered into a container even if they were not allowed to visually compare the widths of the object and container?

To answer this question, we designed test events in which the object and container were presented sequentially, and the insertion of the object into the container took place out of view. These manipulations not only enabled us to investigate infants' ability to reason quantitatively about the object's width, but they also allowed us to avoid a possible confound in the procedure adopted by Sitskoorn and Smitsman (1995). Because in their experiment the insertion of the block into the box happened in full view, it left open the possibility that the infants preferred the small-opening event, not because they understood that the large block could not be lowered into the box with the small opening, but because they found unexpected the sight of one set of solid surfaces—the sides of the large block—moving through space occupied by another set of solid surfaces—the side rims of the box with the small opening. By showing infants test events in which the insertion of the object into the container occurred out of sight, we avoided this potential problem.

EXPERIMENT 1

Experiment 1 addressed two questions. First, did 8.5-month-old infants take into account the width of an object when determining whether it could be inserted into a container? Second, could infants reason quantitatively about the object's width?

The infants were assigned to an experimental or a control condition. The infants in the *experimental* condition saw two test events (see Figures 1 and 2). At the start of each event, a tall container rested on the apparatus floor. Next, the container was hidden by a screen, and a large ball attached to the lower end of a rod was introduced into the apparatus and lowered behind the screen into the container. The screen was then removed to reveal the ball's rod protruding above the container's rim. The only difference between the two test events had to do with the width of the containers: in one event (large-container event), the container was slightly wider than the ball; in the other event (small-container event), the container was only half as wide as the ball, so that it should have been impossible for the ball to be lowered into it. Prior to the test events, the infants saw familiarization events designed to acquaint them with the ball, the screen, and their motions.

The infants in the *control* condition saw the same familiarization and test events as the infants in the experimental condition, except that the large ball was replaced with a small ball that easily fit into either the large or the small container (see Figures 3 and 4).

We reasoned that if the infants in the experimental condition (1) understood that the width of the large ball relative to that of each container determined whether the ball could be lowered into the container, (2) remembered the width of the ball after it disappeared from view, and (3) realized that the ball could be inserted into the large but not the small container, then they should view the large- but not the small-container event as consistent with their physical expectations; the infants should therefore look reliably longer at the small- than at the large-container event. Furthermore, if the infants in the control condition realized that the small ball could be inserted into either the large or the small container, then they should view both the large- and the small-container events as consistent with their physical knowledge, and they should therefore look about equally at the two events.

Method

Participants

Participants were 38 healthy term infants, 21 male and 17 female, ranging in age from 7 months, 28 days to 9 months, 24 days (M = 8 months, 14 days). Eighteen infants, 10 male and 8 female (M = 8 months, 13 days), were randomly assigned to the experimental condition, and 20 infants, 11 male and 9 female (M = 8 months, 15 days), to the control condition. An additional six infants were tested but eliminated; they failed to complete at least three valid pairs of test trials, two because of fussiness, two because they looked for the maximum amount of time allowed (60 s) on most trials, one because of parental coaching, and one because the primary observer had difficulty following the direction of the infant's gaze.

The infants' names in this and in the subsequent experiments were obtained from birth announcements in the local newspaper. Parents were contacted by letters and follow-up phone calls. They were offered reimbursement for their travel expenses but were not compensated for their participation.

Apparatus

The apparatus consisted of a wooden display box 124 cm high, 102 cm wide, and 57 cm deep that was positioned 76 cm above the ground. The infant faced an opening 56 cm high and 95 cm wide in the front

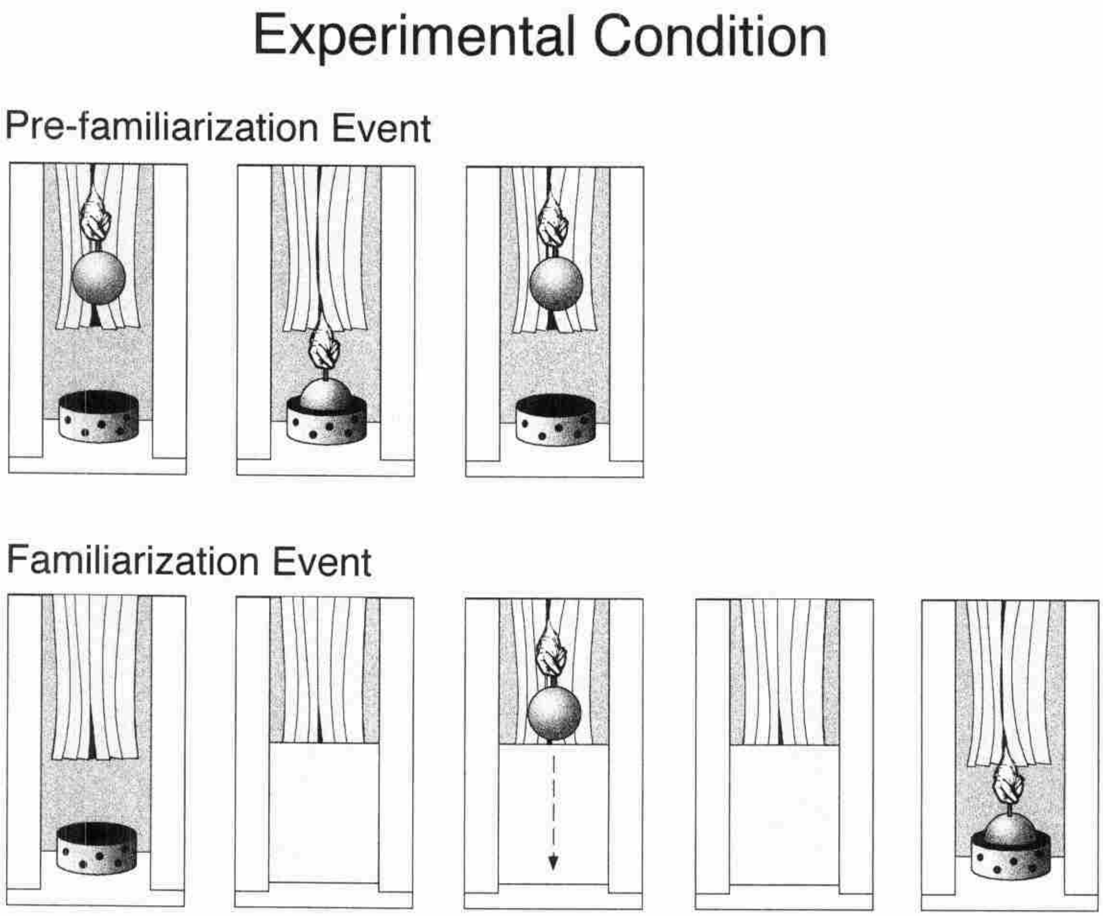

Figure 1 Schematic drawing of the prefamiliarization and familiarization events shown in the experimental condition in Experiment 1.

of the apparatus. The floor of the apparatus was covered with contact paper decorated with pastel flowers, and the side walls were painted white. Positioned against each side wall, 19 cm from and parallel to the front of the apparatus, was a large panel constructed of foam-core board and covered with the same contact paper as the floor. The two panels served to restrict the infants' view to the center portion of the apparatus; the right panel was 74 cm high and 41 cm wide, and the left panel was 74 cm high and 29 cm wide. The back wall of the apparatus was constructed of red foam-core board and had a T-shaped opening, filled with a red cloth fringe, centered between the two panels 10 cm above the floor; the top portion of the opening was 30 cm high and 30 cm wide, and the lower portion was 33 cm high and 13 cm wide.

A blue cardboard screen, 33 cm high and 41 cm wide, was used to occlude the area between the two panels. The screen stood in a wooden track at the back of the right panel; a wooden rod attached to the right edge of the screen allowed an experimenter to slide the screen along the track.

The large ball used in the experimental condition and the small ball used in the control condition were made of Styrofoam and had a wooden rod 1 cm in diameter glued to their tops; the balls and their rods were coated with white gesso and then painted green. The large ball was 15 cm in diameter and was attached to a 10 cm long rod; the small ball was 5 cm in diameter and was attached to a 20 cm long rod.

Five different containers were used in each condition: one container was short and wide (shallow container), two were tall and narrow (small containers), and two were tall and wide (large containers). All five containers were made of aluminum cans, and all had their top and bottom rims lined with black tape.

The shallow container was used in the familiarization events; it was 19 cm in diameter and 8 cm in height and was covered on the inside with white paper and on the outside with blue paper decorated with small red dots.

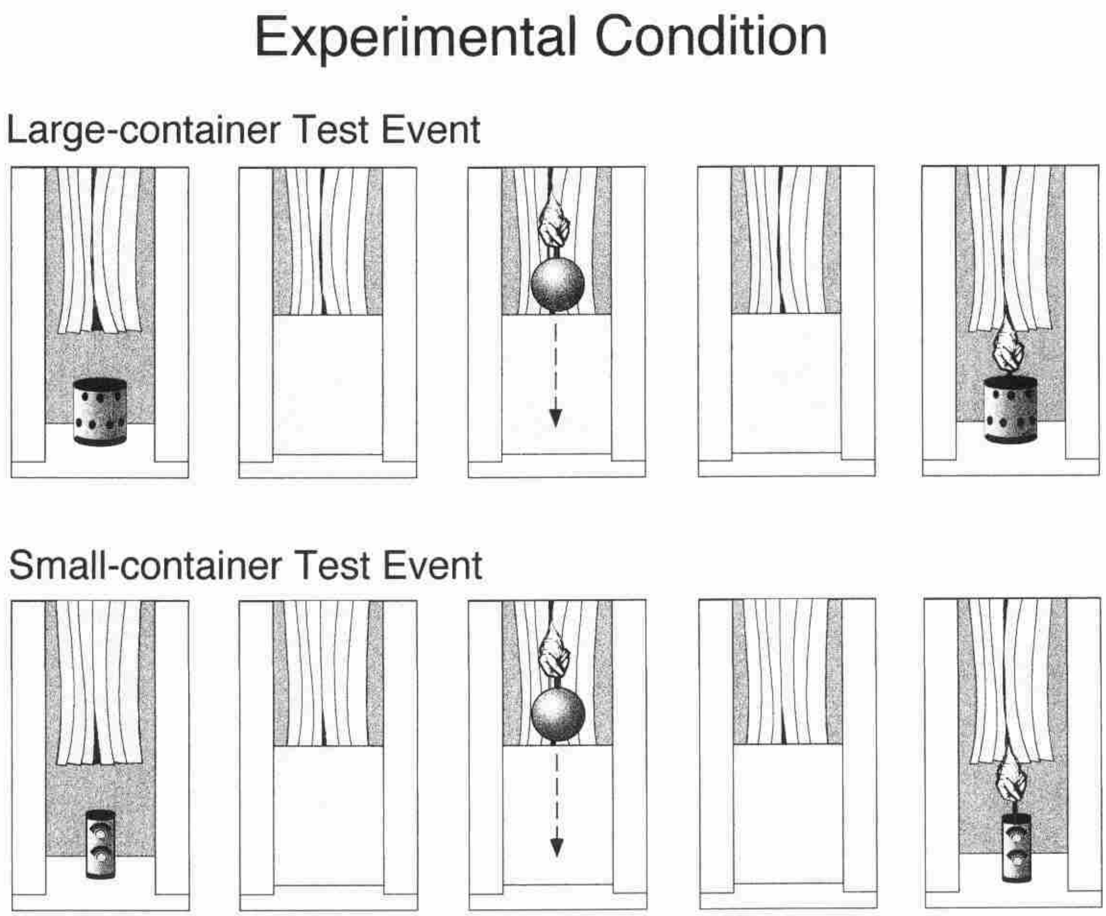

Figure 2 Schematic drawing of the test events shown in the experimental condition in Experiment 1

The small containers were used in the small-container test event. Both were 7.5 cm in diameter and 19 cm in height, and were covered on the inside with red paper and on the outside with yellow paper decorated with small rainbows. One of the containers was pre-filled with a small ball similar to the one described above. The container was sufficiently tall that the infants could not see the ball; only the top 6 cm of the ball's rod protruded above the container. During the small-container event, the pre-filled container was surreptitiously substituted for the empty container; this served to create the illusion in the experimental condition that the large ball had been inserted into the container.

The large containers were used in the large-container test event. Both were 15.5 cm in diameter and 19 cm in height, and were covered on the inside with red paper and on the outside with orange paper decorated with multi-colored balloons. As with the small containers, one of the large containers was pre-filled with a large ball identical to the one described above (this ball was again not visible to the infants; only the top 6 cm of the ball's rod protruded above the container). Although the large ball could simply have been lowered into the empty large container during the large-container event, the same substitution procedure used with the small containers was adopted with the large containers to keep the two test events as similar as possible.

During all of the events, an experimenter's left hand reached through the opening in the back wall of the apparatus to raise and lower the ball; the experimenter wore a long black Spandex glove. The experimenter also wore a long bib made of the same red cloth as the fringe that filled the opening in the back wall; the bib covered the experimenter's torso and made him or her less noticeable when standing behind the opening. To help the experimenter move the ball at a constant pace, a column of numbered marks was placed on the back wall of the apparatus, next to the opening.

The infants were tested in a brightly lit room.

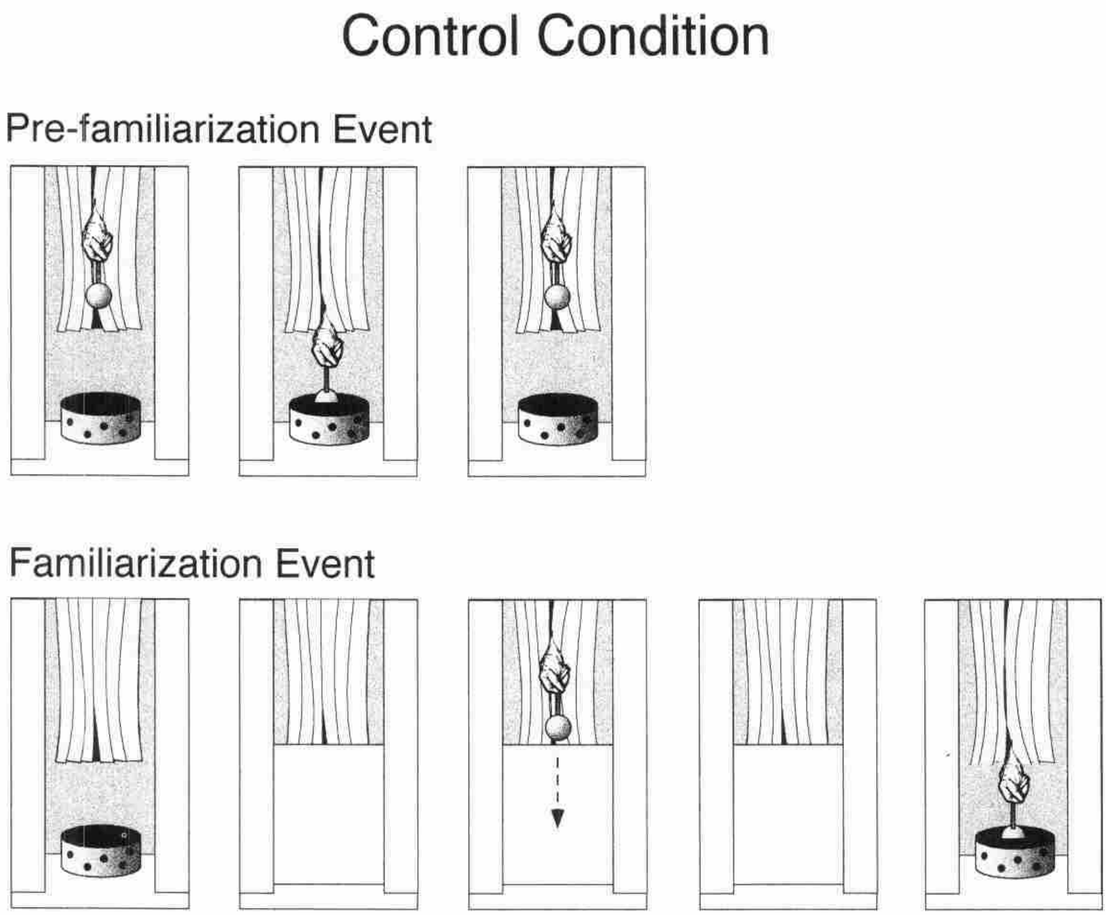

Figure 3 Schematic drawing of the prefamiliarization and familiarization events shown in the control condition in Experiment 1

Three 20 watt fluorescent light bulbs were attached to the front and back walls of the apparatus to provide additional light. Two frames, each 182.5 cm high and 71 cm wide and covered with blue cloth, stood at an angle on either side of the apparatus; these frames served to isolate the infants from the experimental room. At the end of each trial, a curtain consisting of a muslin-covered frame 60 cm high and 101 cm wide was lowered in front of the apparatus.

Events

Three experimenters worked in concert to produce the events: the first raised and lowered the ball, the second manipulated the screen and the pre-filled containers (from an opening in the right wall of the apparatus behind the right panel), and the third manipulated the empty containers and the ball (from an opening in the left wall of the apparatus behind the left panel). To help the experimenters adhere to the events' scripts, a metronome beat softly once per second. In the following text, the numbers in parentheses indicate the number of seconds taken to perform the actions described.

Experimental Condition

Prefamiliarization event. The prefamiliarization event served to acquaint the infants with the ball and its trajectory, and with the type of physical event—containment event—shown in the test events. At the start of the event, the shallow container rested on the apparatus floor, centered between and 4.5 cm behind the two panels. The first experimenter's hand held the large ball by the tip of its rod about 29 cm above the container. After a 1 s pause, the hand lowered the ball until it lay centered inside the container (2 s). In this position, about half of the ball was visible above the container's rim. After another 1 s pause, the hand raised the ball back to its starting position (2 s). Each event cycle thus lasted approximately 6 s. Cycles were repeated until the computer signaled that the

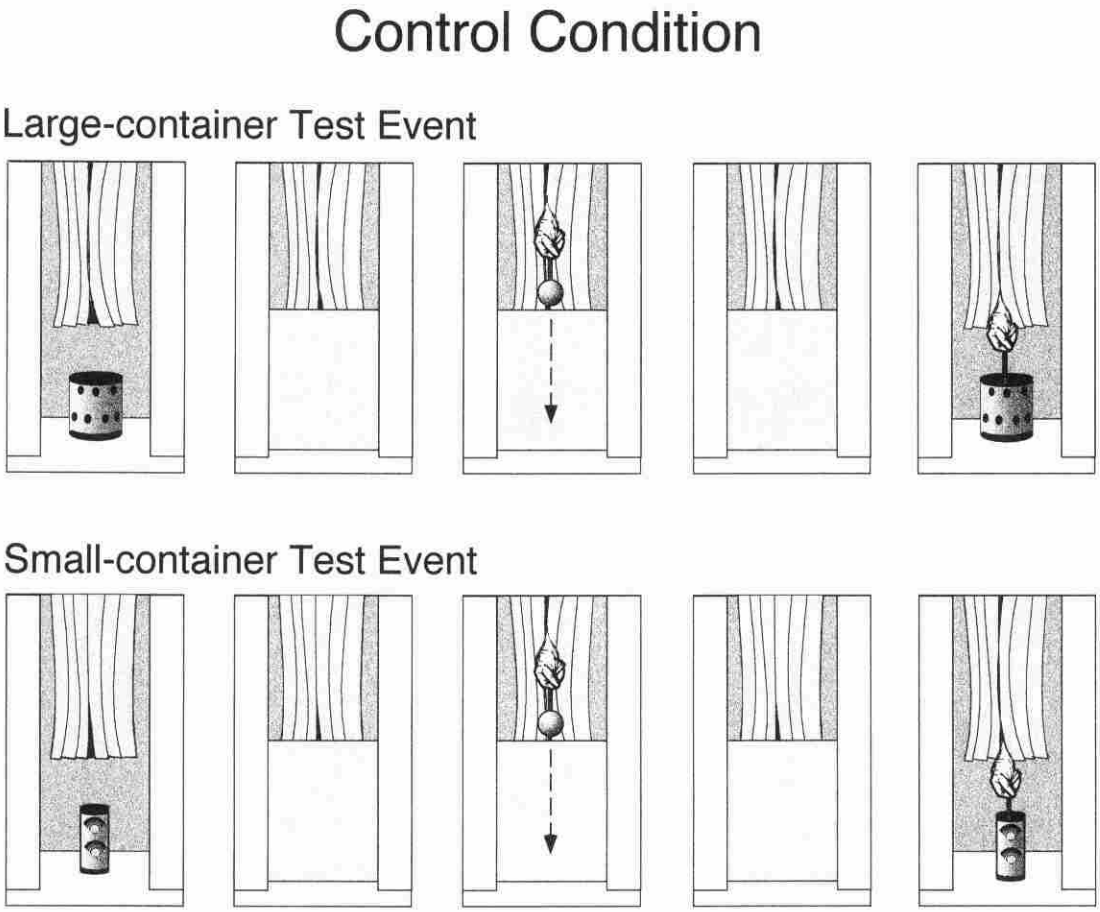

Figure 4 Schematic drawing of the test events shown in the control condition in Experiment 1

trial had ended (see below). When this occurred, the third experimenter lowered the curtain in front of the apparatus.

Familiarization event. The familiarization event served to acquaint the infants with the screen and its motion, and with the occlusion of the container and ball. At the start of the event, only the shallow container was present in the apparatus, in the same position as in the prefamiliarization event. After the computer signaled that the infant had accumulated 3 s of looking at the container, the first event cycle began. The second experimenter slid the screen to the left until it filled the area between the two panels and hid the container (1 s). After a 1 s pause, the first experimenter's hand introduced the large ball into the apparatus through the opening in the back wall; the hand held the ball by the tip of its rod and positioned it about 3 cm above the screen, centered above the hidden container (2 s). Next, the hand lowered the ball behind the screen until it rested inside the container (2 s). In this position, the ball, the ball's rod, and the first experimenter's hand and forearm were completely hidden from the infant's view. After a 1 s pause, the second experimenter slid the screen open (2 s) to reveal the hand holding the ball upright in the container (2 s). The first event cycle ended at this point and was followed immediately by the second event cycle. At the start of this cycle, the second experimenter slid the screen shut to hide the ball and the container (1 s). After a 1 s pause, the hand raised the ball to its starting position above the screen (2 s) and then lowered it again inside the container (2 s). After another 1 s pause, the second experimenter slid the screen open (2 s) once again to reveal the hand holding the ball upright in the container (2 s). The first and second event cycles thus each lasted approximately 11 s. The first cycle was shown only once (because it was necessary to introduce the ball into the apparatus only once); the second cycle was repeated until the end of the trial.

Small-container test event. At the start of the small-container test event, the empty small container stood on the apparatus floor centered between and 11.75 cm behind the two panels. After the computer signaled that the infant had accumulated 3 s of looking at the container, the first event cycle began. The second experimenter slid the screen shut, thus hiding the container (1 s); the third experimenter then removed the container from the apparatus (1 s). The first experimenter's hand introduced the large ball into the apparatus and positioned it above the screen, as in the familiarization event (2 s). Next, the hand lowered the ball behind the screen until it rested on the apparatus floor (2 s). The third experimenter swiftly removed the ball, and the second experimenter replaced it with the pre-filled small container (1 s). Next, the second experimenter slid the screen open (2 s) to reveal the first experimenter holding the tip of the rod protruding from the container's rim (2 s). The first event cycle ended at this point and was immediately followed by the second event cycle. At the start of this cycle, the second experimenter slid the screen shut to hide the pre-filled container (1 s). Next, the second experimenter removed the pre-filled container and the third experimenter replaced it with the ball (1 s). The first experimenter raised the ball to its starting position above the screen (2 s) and then lowered it again to the apparatus floor (2 s). The ball was exchanged with the pre-filled container (1 s), and the second experimenter opened the screen (2 s) to reveal the first experimenter holding the tip of the rod protruding from the container (2 s). As in the familiarization event, each event cycle lasted approximately 11 s. The first cycle was shown only once (because it was necessary to introduce the ball into the apparatus only once); the second cycle was repeated until the end of the trial.

Large-container test event. The large-container test event was identical to the small-container test event, except that the small containers were replaced by the large containers, which were positioned between and 8 cm behind the two panels.

Control Condition

The prefamiliarization, familiarization, and small- and large-container test events shown in the control condition were identical to those shown in the experimental condition, except that the large ball was replaced with the small ball.

Procedure

Prior to the experiment, each infant was allowed to manipulate, one at a time and for a few seconds, the large or small ball (according to their condition), the familiarization container, and the (empty) test containers. During the experiment, the infant sat on the parent's lap in front of the apparatus. The infant's head was approximately 60 cm from the panels and 97 cm from the back wall of the apparatus. The parents were asked to avoid interacting with their infant during the experiment, to keep the infant seated at all times, and to close their eyes during the test trials.

The infant's looking behavior was monitored by two observers who viewed the infant through peepholes in the cloth-covered frames on either side of the apparatus. The observers could not see the events from their viewpoints, and they did not know the order in which the events were presented. Each observer held a button box linked to a DELL microcomputer and depressed the button when the infant attended to the events. The looking times recorded by the primary observer were used to determine when a trial had ended. At the end of each trial, the observers rated on a coding sheet (1) the state of the infant (drowsy, quiet, active, fussy, or crying) during the trial and (2) their confidence (high, medium, or low) that they had accurately recorded the infant's looking behavior during the trial.

The infants in both conditions were tested using a three-phase procedure that consisted of a prefamiliarization, a familiarization, and a test phase. During the *prefamiliarization* phase, the infants saw the prefamiliarization event appropriate for their condition on one trial. The trial ended when the infant either (1) looked away for 2 consecutive seconds after having looked at the event for at least 6 cumulative seconds or (2) looked for 60 cumulative seconds without looking away for 2 consecutive seconds. Analysis of the prefamiliarization data revealed no difference between the looking times of the infants in the experimental (M = 47.0, SD = 18.3) and the control (M = 46.6, SD = 16.5) conditions, $F(1, 36) = 0.01$.

During the *familiarization* phase, the infants saw the familiarization event appropriate for their condition on three successive trials. Each trial ended when the infant (1) looked away for 2 consecutive seconds after having looked at the event for at least 11 cumulative seconds or (2) looked for 60 cumulative seconds without looking away for 2 consecutive seconds. As with the prefamiliarization data, analysis of the familiarization data revealed no difference between the looking times of the infants in the experimental (M = 52.0, SD = 9.6) and the control (M = 46.4, SD = 13.9) conditions, $F(1, 36) = 2.09$, $p > .05$.

During the *test* phase, the infants saw the small- and large-container test events appropriate for their condition on alternate trials until they completed four pairs of test trials. In each condition, half of the infants saw the small-container event first, and half saw the large-container event first. The criteria used to determine the end of each test trial were the same as for the familiarization trials. The 11 s minimum value was chosen because it corresponded to the length of a full event cycle.

Eight of the 38 infants in Experiment 1 failed to contribute a full set of four pairs of test trials to the analyses; these infants completed only three test pairs, four because the primary observer had difficulty following the direction of the infant's gaze, two because of fussiness, one because of a procedural problem, and one because of parental coaching. In this and in the subsequent experiments, infants were included in the data analyses whether they had completed three or four test pairs.

Interobserver agreement during the test trials was measured for 36 of the infants (only one observer was present for the other two infants). Each trial was divided into 100 ms intervals, and the computer determined in each interval whether the two observers agreed on the direction of the infant's gaze. At the end of each trial, percent agreement was calculated on the basis of the number of intervals in which the computer registered agreement out of the total number of intervals in the trial. Agreement averaged 93% per trial per infant. We also measured interobserver agreement on the ending of each test trial. In the experiment, data were obtained from 272 test trials (28 infants $\times$ 8 trials + 8 infants $\times$ 6 trials). Based on the primary observer's responses, 46 trials ended because the infant looked at the event for the maximum amount of time allowed, 60 s, and 226 trials ended because the infant looked away from the event for 2 consecutive seconds. For each of the 60 s trials, the computer calculated the looking time registered by the secondary observer; the average looking time obtained in these trials was 58.6 s. For each trial that ended with a 2 s look away, the computer inspected (1) whether the secondary observer agreed that the infant was looking away from the event in the final 100 ms interval and, if yes, (2) for how many consecutive intervals prior to and including the final interval the secondary observer registered that the infant was looking away. The secondary observer agreed that the infant was looking away during the final interval on 219 of the 226 trials; the average look away recorded by the secondary observer at the end of these trials was 2.1 s. The seven trials with a disagreement in the final interval were retained in the analyses because on each trial the primary observer (who was typically the more experienced observer) reported high confidence in his or her judgment of the infant's behavior. Pairs of test trials were eliminated if at least one of the trials in the pair had a final-interval disagreement and the primary observer reported only medium or low confidence on those trials. Comparable trial-ending agreement results were obtained in the other experiments included in this report.

Preliminary analyses revealed no significant effect of sex on the looking times of the infants in the experimental and control conditions at the test events, all $Fs < 1.33$, $p > .05$; the data were therefore collapsed across sex in subsequent analyses.

Results

Figure 5 presents the mean looking times at the test events of the infants in the experimental and control conditions. It can be seen that the infants in the experimental condition looked longer at the small- than at the large-container event, whereas the infants in the control condition tended to look equally at both events.

The infants' looking times at the test events were averaged and compared by means of a 2 $\times$ 2 $\times$ 2 mixed-model analysis of variance (ANOVA), with condition (experimental or control) and order (small- or large-container event first) as between-subjects factors and with event (small- or large-container) as a within-subject factor. The analysis yielded a significant condition $\times$ event interaction, $F(1, 34) = 6.90$, $p < .025$. Planned comparisons confirmed that the infants in the experimental condition looked reliably longer at the small- ($M = 34.6$, $SD = 10.3$) than at the large-container ($M = 27.3$, $SD = 5.0$) event, $F(1, 34) =$

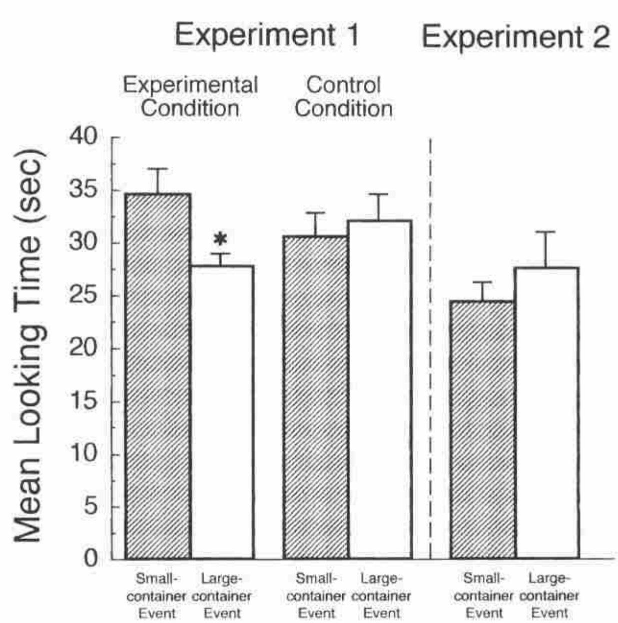

Figure 5 Mean looking times of the infants in Experiments 1 and 2 at the small- and large-container test events.

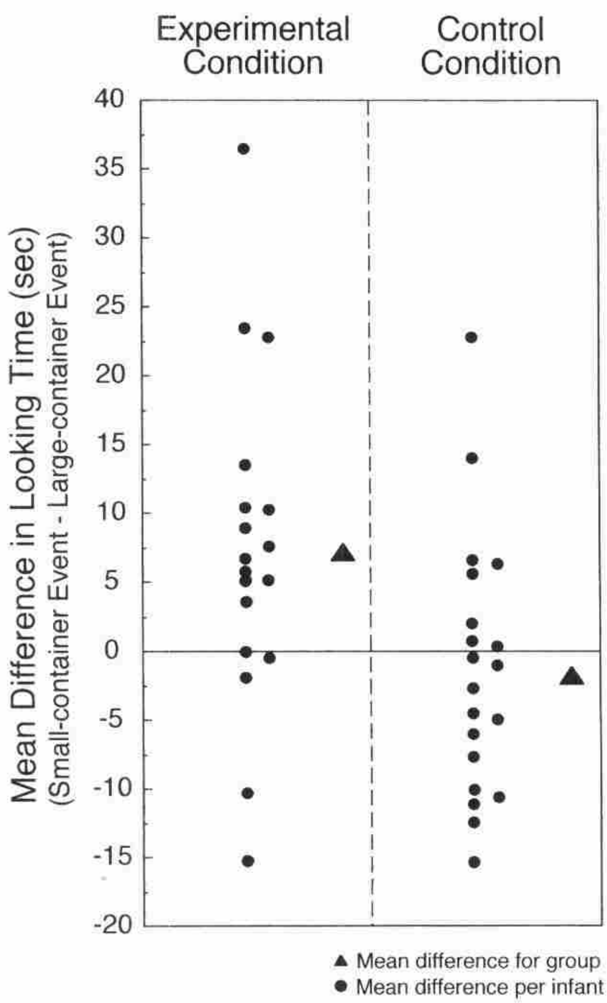

Figure 6 Difference in the mean looking times of the infants in Experiment 1 at the small- and large-container test events. Each triangle represents the entire group of infants in the experimental or the control condition; each dot represents an individual infant.

9.08, $p < .005$, whereas those in the control condition looked about equally at the small- (M = 30.7, SD = 10.0) and the large-container (M = 32.1, SD = 11.2) events, $F(1, 34) = 0.41$. Inspection of the individual infants' mean looking times yielded similar findings (see Figure 6): whereas 13 of the 18 experimental infants looked longer at the small- than at the large-container event (cumulative binomial probability, $p < .05$), only eight of the 20 control infants did so ($p > .05$).

The analysis also revealed a significant event × order interaction, $F(1, 34) = 4.43$, $p < .05$. Post hoc comparisons indicated that the infants who saw the small-container event first looked reliably longer at this event (M = 34.2, SD = 10.5) than at the large-container event (M = 28.1, SD = 9.9), $F(1, 34) = 6.72$, $p < .025$, whereas the infants who saw the large-container event first tended to look equally at the two events, $F(1, 34) = 0.10$ (small-container event: M = 30.8, SD = 9.9; large-container event: M = 31.6, SD = 7.9). Because this effect did not interact with condition, it does not bear on the present hypotheses and will not be discussed further.

Discussion

The infants in the experimental condition looked reliably longer at the small- than at the large-container event; in contrast, the infants in the control condition tended to look equally at the two events. These data suggest that the experimental infants saw the large- but not the small-container event as consistent with their physical expectations, whereas the control infants viewed both events as consistent with their expectations. This interpretation, in turn, suggests that the infants in Experiment 1 (1) understood, in each test event, that the width of the ball relative to that of the container determined whether the ball could be lowered into the container; (2) remembered the width of the ball after it disappeared from view; and (3) realized that the small ball could fit into the large or the small container, but that the large ball could fit into only the large container.

These results suggest two conclusions. The first is that, by 8.5 months of age, infants recognize that an object can be lowered into a container wider but not narrower than the object itself. This conclusion is consistent with the results of Sitskoorn and Smitsman (1995) and more generally with reports that infants aged 8.5 months and younger take into account the width or height of objects when reasoning about collision, occlusion, and arrested-motion events (e.g., Baillargeon, 1987, 1991; Baillargeon & DeVos, 1991; Baillargeon & Graber, 1987; Kotovsky & Baillargeon, in press; Spelke et al., 1992; Wilcox & Baillargeon, in press).

The second conclusion suggested by the present results is that 8.5-month-old infants can reason quantitatively about the width of an object in a containment event. The infants in Experiment 1 were never able during the test events to visually compare the width of the ball to that of the container; to perform this comparison, the infants had to rely on their representation of the ball's absolute width. These results are consistent with evidence that infants aged 8.5 months and younger are able to reason quantitatively about height or width variables in collision and arrested-motion events (e.g., Baillargeon, 1987, 1991; see Baillargeon, 1995, for a review). However, another explanation is possible for the present results and indeed for most results taken to reveal quantitative reasoning in infants. Instead of engaging in quantitative reasoning, the infants in Experiment 1 might have engaged in a form of transitive qualitative reasoning. When watching the experimental small-container event, for example, the infants might have noticed, at different points in the event, that the hand holding the rod was considerably narrower than the large ball, but about as wide as the small container. Putting these two observations together, the infants might have concluded that the large ball was too wide to fit into the small container. The same argument could be put forth using background elements of the test situation (e.g., the gap between the two side panels, the curtained opening in the back wall, and so on).

Although logically possible, this alternative interpretation is unlikely. Investigations of infants' qualitative reasoning have typically found that their ability to use extraneous objects in a test situation for comparison purposes is extremely limited (e.g., Baillargeon, 1991, 1993; see Baillargeon, 1995, for a review). For example, experiments conducted with unveiling events (Baillargeon, 1993) indicated that 12.5-month-olds could determine whether a small or a large toy dog had been hidden under a cloth cover only when the dog was held immediately next to a second, identical cover; when the distance between the dog and the second cover was increased, so that their sizes could no longer be visually compared, negative results were obtained. Similarly, experiments conducted with arrested-motion events (e.g., Baillargeon, 1991, 1993) revealed that 6.5-month-olds could determine at what point a rotating screen would reach a box in its path only when a second, identical box stood next to the hidden box; negative results were obtained when the second box (1) was moved forward so that its height could no longer be visually compared to that of the screen's stopping point or (2) differed in color and pattern from the box behind the screen. Such results cast serious doubt on the notion that the infants in Experiment 1 were able to successively compare the ball and container shown in each event to some third, arbitrary element of the test display.

EXPERIMENT 2

Experiment 2 sought to extend the results of Experiment 1 and asked whether 8.5-month-old infants take into account not only the width but also the compressibility of an object when determining whether it can be inserted into a container. The infants in Experiment 2 saw the same prefamiliarization, familiarization, and test events as the infants in the experimental condition in Experiment 1, except that the large ball was replaced with an equally large but compressible ball.

Our reasoning was as follows. If the infants (1) understood that a compressible object, unlike a rigid object, can be inserted into a container narrower than itself and thus (2) recognized that the compressible ball could be lowered into either the small or the large container, then they should look about equally at the small- and large-container events. On the other hand, if the infants (1) did not realize that the width rule in containment events applies to rigid but not to compressible objects and hence (2) took into account only the width of the compressible ball when determining whether it could be lowered into each test container, then they should look reliably longer at the small- than at the large-container event.

Method

Participants

Participants were 16 healthy term infants, eight male and eight female, ranging in age from 8 months, 1 day to 8 months, 29 days (M = 8 months, 18 days). An additional three infants were tested but eliminated; they failed to complete at least three valid test pairs, one because of fussiness, one because of parental coaching, and one because the primary observer had difficulty following the direction of the infant's gaze.

Apparatus, Events, and Procedure

The apparatus, events, and procedure in Experiment 2 were similar to those in the experimental condition in Experiment 1 with three exceptions. First, the large ball was made of highly compressible Super-soft foam material. Second, prior to the experiment, the infants watched the experimenter squeeze the ball three times in 15 s; they were then given the ball to manipulate for another 15 s. Third, during the prefamiliarization and familiarization trials, the first experimenter compressed the ball each time it was lowered into the shallow container by pressing the ball's rod against the bottom of the container; the flattened ball was clearly visible inside the container. It was hoped that the last two modifications would help make clear to the infants that the ball was compressible.

Five of the 16 infants in Experiment 2 completed only three test pairs, three because of fussiness and two because the primary observer had difficulty following the direction of the infant's gaze. Interobserver agreement during the test trials was calculated for 15 of the infants (only one observer was present for the other infant) and averaged 92% per trial per infant.

Preliminary analyses revealed no significant effect of sex on the infants' looking times at the small- and large container test events, all $Fs < 0.50$; the data were therefore collapsed across sex in subsequent analyses.

Results

The infants' looking times during the test trials were averaged and analyzed by means of a 2 × 2 mixed-model ANOVA, with order (small-container event first or large-container event first) as a between-subjects factor and with event (small or large container) as a within-subject factor. The main effect of event was not significant, $F(1, 14) = 0.01$, indicating that the infants tended to look equally at the small- ($M = 25.7$, $SD = 11.2$) and the large-container ($M = 26.6$ $SD = 10.3$) events. Examination of the individual infants' mean looking times yielded similar findings (see Figure 7): only nine out of 16 infants in Experiment 2 looked longer at the small- than at the large-container event (cumulative binomial probability, $p > .05$).

The analysis also revealed a significant order × event interaction, $F(1, 14) = 5.00$, $p < .05$. Examination of the data suggested that the infants in each order condition tended to look longer at the event they saw first, although neither tendency was statistically significant: small-container event first: small-container event, $M = 30.2$, $SD = 15.2$, large-container event: $M = 24.4$, $SD = 9.7$, $F(1, 14) = 2.06$, $p > .05$; large-container event first: small-container event: $M = 22.2$, $SD = 5.4$, large-container event: $M = 28.2$, $SD = 11.0$, $F(1, 14) = 3.06$, $p > .05$.

Two additional analyses were conducted to compare the responses of the infants in Experiments 1 and 2 (see Figure 5); the first analysis focused on the infants in Experiment 1 who were in the experimental condition, and the second on the infants who were in the control condition. Each analysis consisted of a 2 × 2 × 2 mixed-model ANOVA, with Experiment (1 or 2) and order (small-container event first or large-container event first) as between-subjects factors, and with event (small or large container) as a within-subject factor. As expected, the first analysis yielded a significant experiment × event interaction, $F(1, 30) = 4.09$, $p = .05$, but the second analysis did not, $F(1, 32) = 0.15$. Planned comparisons across the two analyses confirmed that the experimental infants in Experiment 1 looked reliably longer at the small- than at the large-container event, $F(1, 30) = 8.28$, $p < .01$, whereas the control infants in Experiment 1 and the infants in Experiment 2 tended to look equally at the events (all $Fs < 0.46$). Each analysis also yielded a significant order × event interaction: in the first analysis, $F(1, 30) = 8.56$, $p < .01$, in the second analysis, $F(1, 32) = 5.49$, $p < .05$. Because neither of these effects interacted with experiment, they do not bear on the present hypotheses and will not be discussed further.

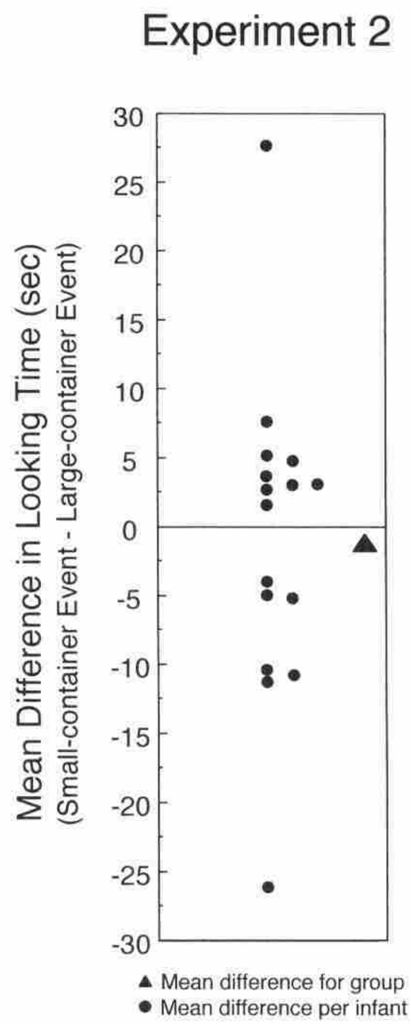

Figure 7 Difference in the mean looking times of the infants in Experiment 2 at the small- and large-container test events. The triangle represents the entire group of infants in Experiment 2; each dot represents an individual infant.

Discussion

Unlike the infants in the experimental condition in Experiment 1, the infants in Experiment 2 tended to look equally at the small- and the large-container events. These results suggest that the infants (1) realized that a compressible object can be inserted into a container wider or narrower than itself and (2) understood that the large compressible ball could be lowered into either the large or the small container. Such results suggest that, by 8.5 months of age, infants take into account not only the width but also the compressibility of an object when determining whether it can be inserted into a container. This conclusion is consistent with evidence that 7.5-month-old infants consider both the height and compressibility of objects in arrested-motion events (Baillargeon, 1987).

There is, however, another possible interpretation for the results of Experiment 2. It might be that the infants had not yet learned that the width of compressible objects is irrelevant to their insertion into containers. The infants' limited knowledge would normally have led them to compare the width of the compressible ball to that of the test containers. The infants did not attempt to do so, however, because they were confused by the repeated changes in the ball's width that occurred during the prefamiliarization and familiarization trials as the ball was pressed against and lifted from the bottom of the shallow container.

The present results are not sufficient to establish whether the infants in Experiment 2 tended to look equally at the small- and large-container events because (1) they realized that the width of the compressible ball was irrelevant to its insertion into the test containers or (2) they were led by the prefamiliarization and familiarization trials to pay little attention to the ball's width. Further research is necessary to provide a more definitive answer to this question.

EXPERIMENT 3

We have argued that the infants in the experimental condition in Experiment 1 looked reliably longer at the small- than at the large-container event because their knowledge of containment events led them to realize that the large ball could fit into the large but not the small container. However, the results are open to an alternative interpretation. During the prefamiliarization and familiarization trials, the infants watched the large ball being repeatedly lowered into the shallow, wide container. In the course of these trials, the infants could have formed a superficial expectation that the ball would always be lowered into a container wider than itself. Such an expectation would have led the infants to accept the pairing of the large ball and large container (large-container event), but not that of the large ball and small container (small-container event).

The same objection could be applied to the results of Sitskoorn and Smitsman (1995). As the habituation trials progressed, the infants could have formed an expectation that the block would always be lowered into a box with an opening wider than the block. Such an expectation would have led the infants to accept the block-box pair shown in the large- but not the small-opening test event. A similar objection could also be raised in the context of results obtained by Spelke et al. (1992) in an experiment examining 4-month-olds' expectations about arrested-motion events. The infants were habituated to the following event. First, a ball was held above a slightly wider gap in a horizontal surface positioned above an apparatus floor. Next, a screen was raised to hide the gap, and the ball was dropped behind the screen. Finally, the screen was removed to reveal the ball resting on the apparatus floor, below the gap. Following habituation, the infants saw two test events identical to the habituation event except that a smaller (small-ball event) or a larger (large-ball event) ball was used. The infants looked reliably longer at the large- than at the small-ball event. These and control results suggested that the infants realized that the small but not the large ball could pass through the gap. However, another interpretation for the results is that in the course of the habituation trials the infants came to expect that the ball would always pass through a gap wider than the ball. Such an expectation would have led the infants to prefer the large-ball test event, because it involved a ball wider rather than narrower than the gap.[3]

The results of Experiment 2 provided some evidence against the alternative interpretation of the re-

3. Sitskoorn and Smitsman (1995) and Spelke et al. (1992) reported additional data that partially address the alternative interpretation raised here. Sitskoorn and Smitsman habituated 6- and 9-month-olds to events in which a small or a large block was lowered onto a closed, slightly smaller box. During the test trials, the pairings of the blocks and boxes were rearranged. Spelke et al. (1992) showed 4-month-old control infants habituation and test trials identical to those in the experimental condition, except that the hand simply deposited the ball under the horizontal surface, beneath the gap. Both experiments yielded equal looking times at the test events. Had the infants in the experiments learned a specific pairing during habituation (e.g., the block and the smaller box, the ball and the wider gap), they should have preferred the test event displaying the novel pairing. Although these data provide some evidence against the alternative interpretation raised here, they do not entirely refute it. Because no insertion occurred during habituation in either experiment, the infants might have no reason to attend to and compare the relative dimensions of the objects, and thus no basis to detect the invariant association in their pairing.

sults of Experiment 1. The large compressible ball in Experiment 2 was consistently paired during the prefamiliarization and familiarization trials with the shallow, wide container; nevertheless, the infants showed no preference for the small- over the large-container test event. However, the results of Experiment 2 could be given another interpretation: perhaps the infants were too entranced by the transformation of the compressible ball, as it was pressed against the bottom of the shallow container, to pay much attention to the relation between the widths of the ball and shallow container during the prefamiliarization and familiarization trials. As a result, the infants failed to form an expectation about this relation and thus had no basis subsequently for distinguishing between the small- and large-container test events.

In light of these ambiguities, we decided to conduct an additional experiment to directly test the alternative interpretation of the results of Experiment 1. The infants in Experiment 3 were tested with a procedure similar to that of the experimental condition in Experiment 1, except that *no container* was present during the prefamiliarization and familiarization trials; the ball was simply lowered to the floor of the apparatus. With this modification, the infants could no longer acquire a superficial expectation that the large ball would always be paired with a wider container. We reasoned that positive results in this experiment would both confirm the results of Experiment 1 and make clear that they reflected infants' knowledge about containment events rather than limited expectations formed during the initial trials of the experiment.

Method

Participants

Participants were 18 healthy term infants, 10 male and eight female, ranging in age from 8 months, 6 days to 9 months and 12 days (M = 8 months, 26 days). An additional two infants were tested but eliminated; they failed to complete at least three valid test pairs, one because of fussiness and one because of experimenter error.

Apparatus, Events, and Procedure

The apparatus, events, and procedure in Experiment 3 were identical to those in the experimental condition in Experiment 1 except that the shallow container was not used in the prefamiliarization and familiarization trials; the ball was simply lowered to the apparatus floor. Four of the 18 infants in Experiment 3 completed only three test pairs, three because of fussiness and one because the primary observer had difficulty following the direction of the infant's gaze. Interobserver agreement during the test trials averaged 93% per trial per infant.

Preliminary analyses revealed no significant effect of sex on the infants' looking times at the small- and large-container test events, all $Fs < 1.09$, $p > .05$; the data were therefore collapsed across sex in subsequent analyses.

Results

The infants' looking times during the test trials were averaged and analyzed by means of a 2 × 2 mixed model ANOVA, with order (small-container event first or large-container event first) as a between-subjects factor and with event (small- or large-container) as a within-subject factor. The main effect of event was significant, $F(1, 16) = 8.69$, $p < .01$, confirming that the infants looked reliably longer at the small- ($M = 30.1$, $SD = 8.9$) than at the large-container ($M = 23.7$, $SD = 7.7$) event. Examination of the individual infants' mean looking times yielded similar findings (see Figure 8): 15 of the 18 infants in Experiment 3 looked longer at the small- than at the large-container event (cumulative binomial probability, $p < .01$).

The analysis also yielded a significant order × event interaction, $F(1, 16) = 4.68$, $p < .05$. Post hoc comparisons indicated that the infants who saw the small-container event first looked reliably longer at it ($M = 32.1$, $SD = 6.4$) than at the large-container event ($M = 20.9$, $SD = 5.0$), $F(1, 16) = 13.06$, $p < .01$, whereas the infants who saw the large-container event first tended to look equally at the small- ($M = 28.2$, $SD = 10.8$) and the large-container ($M = 26.5$, $SD = 9.2$) events, $F(1, 16) = 0.31$. This type of order effect is not uncommon in tasks in which infants are shown an event consistent and an event inconsistent with their physical knowledge (e.g., Baillargeon, 1986; Baillargeon, DeVos, & Graber, 1989). One explanation for the effect is that two separate tendencies contribute to infants' responses: a tendency to look longer at whichever event is shown first, and a tendency to look longer at the inconsistent event. For infants who see the inconsistent event first, the two tendencies combine to generate a marked preference for the inconsistent event; for infants who see the consistent event first, however, the two tendencies cancel each other, resulting in statistically equal looking times at the consistent and inconsistent events.

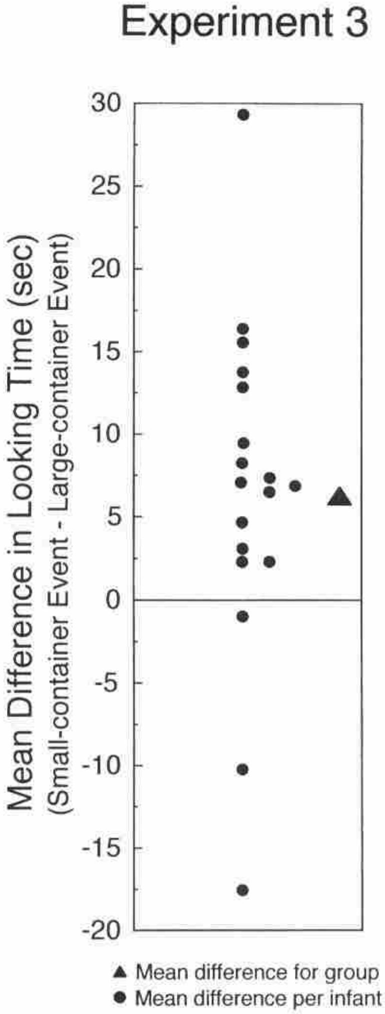

Figure 8 Difference in the mean looking times of the infants in Experiment 3 at the small- and large-container test events. The triangle represents the entire group of infants in Experiment 3; each dot represents an individual infant.

Discussion

The infants in Experiment 3 looked reliably longer at the small- than at the large-container event, suggesting that they (1) understood that the width of the ball relative to that of the containers determined whether it could be lowered into the containers, (2) remembered the width of the ball after it was hidden from view, and (3) realized that the ball could fit into the large but not the small container. The results of Experiment 3 thus provide evidence against the hypothesis that the responses of the experimental infants in Experiment 1 were simply based on an expectation—derived from the prefamiliarization and familiarization trials—that the large ball would always be paired with a wider container. The infants in Experiment 3 saw prefamiliarization and familiarization events that did not involve a container; nevertheless, they still showed a reliable preference for the small- over the large-container event.

The results of Experiment 3 thus confirm those of Experiment 1. In addition, the present results indicate that 8.5-month-old infants can determine quantitatively whether an object will fit into a container, even if they are not shown a containment event prior to the test trials.

CONCLUSION

The present research was designed to address three questions. First, do 8.5-month-old infants realize that the width of an object relative to that of a container determines whether the object can be inserted into the container? Second, can infants reason about this width variable quantitatively, by representing the absolute width of the object and comparing it to that of the container? Finally, do infants understand that the width variable does not apply equally to rigid and to compressible objects and that compressible objects, unlike rigid objects, can be lowered into containers wider or narrower than themselves? The results we have obtained suggest that the answer to all three of these questions is positive. The infants in Experiments 1 and 3 looked reliably longer at the small- than at the large-container test event, indicating that they recognized that the large ball could fit inside the large but not the small container. Furthermore, the infants were able to arrive at this conclusion even though they could not visually compare the width of the ball to that of the containers and hence needed to represent and remember the width of the ball after it was hidden from view. Finally, the infants in Experiment 2 tended to look equally at the small- and large-container test events, suggesting that they realized that the large compressible ball, unlike the large rigid ball used in Experiments 1 and 3, could be inserted into either the small or the large container.

The present results confirm and extend earlier results obtained with containment (e.g., Sitskoorn & Smitsman, 1995) and arrested motion (e.g., Baillargeon, 1987, 1991; Spelke et al., 1992) events and suggest several directions for future research. A first line of research would be to explore in greater detail the quantitative reasoning abilities that contributed to the infants' responses in the present tasks. Consider, in particular, the findings of Experiments 1 and 3. What kind of quantitative representation did the infants construct and use when reasoning about the large ball? Did they encode the dimensions of the entire ball or only of its top portion (which lay closest to the hand), middle portion (which happened to be the widest), or bottom portion (which stood closest to the top of the container)? Further research is needed to determine whether changes take place with experience in the quantitative information infants encode when faced with containment events. Do infants focus from the start on the widest portion of the object, wherever it happens to be, or do they begin by attending to the portion of the object closest to the container and only in time learn to take into account all portions of the object? Experiments with asymmetrical objects (e.g., a tall cylinder with a wider ring around its top, middle, or bottom portion) would help address these questions.

A second, closely related line of research would be to examine how precisely infants encode and reason about quantitative information. The infants in Experiments 1 and 3 were presented with a very large violation: a 15 cm wide ball was apparently lowered into a 7.5 cm wide container. Would infants have been able to detect a less salient violation (e.g., a 15 cm wide ball lowered into a 10 or 12 cm wide container)? Previous research suggests that infants detect finer and finer quantitative violations with age (e.g., Baillargeon, 1993, 1995): for example, 6.5-month-olds were found to detect a violation in which a screen rotated through the top 80%, but not the top 50%, of a hidden box; 8.5-month-olds, in contrast, readily detected the 50% violation. These developmental findings suggest that, when reasoning about containment events, infants may similarly detect smaller quantitative violations with age.

A third line of research suggested by the present findings again has to do with developmental predictions. Our model of the development of infants' physical reasoning (e.g., Baillargeon, 1995, in press; Baillargeon et al., 1995) makes two predictions concerning the development of infants' reasoning about containment events. The first prediction is based on the observation that, when infants identify a continuous variable as being relevant to an event category, they succeed in reasoning about the variable first qualitatively and only later quantitatively (e.g., Baillargeon, 1991, 1993, 1995). This developmental pattern suggests that, at some time prior to 8.5 months of age, infants go through a stage where they have identified width as an important containment variable but can reason about it only qualitatively: they can determine whether an object can be lowered into a container only when they are able to compare in a single glance the width of the object to that of the container.

The second developmental prediction suggested by our model is derived from the observation that infants' learning about an event category is characterized by the formation of an initial, preliminary concept (e.g., "an object can be inserted into a container with an open top"), followed by the identification of variables that enrich and refine the initial concept (e.g., "an object can be inserted into a container wider but not narrower than itself"). This developmental sequence suggests that prior to entering the qualitative stage described above, infants go through a more primitive stage in which they do not yet understand that the width of an object places restrictions on the containers it can enter. Infants in this stage would not be surprised to see a large ball being lowered into a very small container, even if they were given ample opportunity to visually compare the widths of the object and container. Because Sitskoorn and Smitsman (1995) obtained negative results with their 4-month-old participants, it may be that infants this age are still in the primitive stage described here; as with most negative results, however, other interpretations are possible.

A fourth line of research suggested by the present experiments, as well as by the above speculations, would be to compare the development of infants' reasoning about width variables in containment and other categories of physical events. One assumption of our developmental model is that infants identify, not general physical principles that apply broadly to multiple event categories, but limited variables that apply strictly to individual event categories. In this view, it would be quite possible for an infant to consider the width of an object when reasoning about an occlusion or an arrested-motion event but not a containment event. Additional research is required to test whether knowledge of a variable in one event category is tied to or independent from knowledge of analogous variables in other event categories.

A fifth line of research aimed at extending the present results would be to investigate what variables other than width infants know to be relevant to containment events. For example, one might ask at what age infants begin to appreciate that the height of an object relative to that of a container determines whether the object will be fully or only partially hidden when lowered into the container. Additional experiments could explore at what age infants begin to consider the combined volume of objects when judging how many identical objects can simultaneously be stored in a container. For example, would infants understand that a tall or a short container could both hold a single ball, but that the tall container could contain more balls than the short one?

A final line of research would be to compare the performance of the infants in Experiments 1 and 3 to that of infants tested with a containment task that used object manipulation, rather than visual attention, as its main measure. To illustrate, 8.5-month-old infants could be given a means-end task in which a ball is lowered behind a screen; next, the screen is removed to reveal two containers, one smaller and one larger than the ball. Would the infants use the same physical knowledge and quantitative reasoning ability as in the present experiments to guide the planning of their actions and search for the ball in the larger container? Our model of infants' acquisition of physical knowledge (e.g., Baillargeon, 1995, in press) suggests that it is primarily through their own actions on containers, and more particularly their attempts at inserting objects (e.g., fist, finger, tongue, nose, toy) of different widths into containers, that infants come to view width as an important containment variable. This is not because infants cannot learn from relevant observations: it is simply that, in their daily lives, infants must have few opportunities to observe their caregivers attempt to lower objects into too-narrow containers. As a result, the identification of width as a relevant variable typically awaits infants' own manipulations of containers (for a discussion of the importance of contrastive observations for infants' identification of variables, see Baillargeon, in press). Because infants learn about containers at least in part by acting on them, it follows that they should reveal whatever knowledge they have acquired in both visual-attention and object-manipulation tasks, as long as the two are of comparable difficulty (we would naturally expect complex object-manipulation tasks to introduce planning difficulties that interfere with infants' performance and thus tend to mask the richness of their physical knowledge; for similar arguments, see Lockman, 1994, and Willatts, 1990).

The findings of the present experiments indicate that, by 8.5 months of age, infants take into account the width and compressibility of an object when determining whether it can be inserted into a container. These results add to a growing body of experimental evidence that even young infants possess sophisticated expectations about various types of physical events. Additional research, along the lines proposed above, should extend the present results and shed light on the processes involved in infants' acquisition, representation, and use of the physical knowledge revealed here.

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