The Role of Comparison in Infant Problem Solving When Using a Spoon

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KEYWORDS: infants, comparison, lightbox, tool use, spoons

BRIEF: These studies examine whether infants are able to utilize comparison to better solve a task.

ABSTRACT. In developmental psychology, infants' abilities to solve problems using tools have been a topic of recent research. Past research of this topic shows that 15-month-old infants have difficulty using a familiar tool in a novel way. The current study investigates different methods of encouraging infants to complete a task successfully. The experimental task required infants to activate lights inside a transparent box by inserting the handle of the spoon into the box's hole. Some infants saw only correct while others saw correct and incorrect demonstrations (holding the handle of the spoon and attempting to insert the too-large bowl into the box's hole). Infants who saw both correct and incorrect demonstrations either saw them sequentially or simultaneously. We hypothesized that simultaneous viewing allowed for comparison between actions and consequences, resulting in more sophisticated problem solving. However, our results showed instead demonstrated that the infants experienced more success viewing correct only demonstrations.

INTRODUCTION.

Research performed on infant tool use provides insight into how infants learn new skills Previous research has shown that 15-month-old infants have difficulty using a familiar tool in a novel way (1).A study by Barrett, Davis, & Needham (2007) found that infants had difficulty grasping the bowl end of a spoon in order to insert the straight end of the spoon into a hole in the side of a box, which activated LED lights (2).The results of this study suggested that infants store information from prior experiences with tools (i.e. grasping the straight end of a spoon to insert the bowl of the spoon into their mouth while eating), and this past experience influences infants' future actions with the tool. The current study investigates whether comparison can be used to encourage 15-month-old infants to successfully solve this same task. We hypothesized that infants would perform best when they could compare correct (successfully activating the light box) and incorrect (pressing the bowl of the spoon against the lightbox, which failed to activate the lights) demonstrations. A previous study showed that infants had better, more enhanced memory when they were exposed to contrasting stimuli (3). When only one item was presented to the infants, they failed to show evidence of memory for the item, but infants showed a strong memory for an item if there were two items presented when the infant was being familiarized with the items. This study concluded that infants' memory is enhanced through the use of comparison. Previous research on learning through comparison showed that older children who were able to contrast incorrect examples with correct examples better grasped the knowledge of the correct concepts and procedures (4, 5). These findings led us to believe that comparison of correct and incorrect attempts to solve the lightbox task would help infants to display more sophisticated problem solving techniques.

METHODS.

Experiment One.

Participants. Thirty-two full-term infants (females=16) between 13 and 18 months of age (*M*=15.47 months, *SD*=1.37 months) participated in the first experiment. Infants were randomly assigned to either the Sequential condition (n=16, females=8) or the Correct-only condition (n=16, females=8).

Materials. Experiment one utilized a lightbox and a spoon. The lightbox contained LED lights that were visible through a plexiglass window in the side of the box. Inserting the straight handle of the spoon into a hole in the side of the box activated the LED lights inside.

Measures. Video recordings of the study sessions were reviewed by a research assistant who was trained to code infants' behaviors. The coder marked each infant's hand preference (which hand the child used to grasp a small toy presented at midline). The coder also marked where the infant grasped the spoon (which part of the spoon the infant initially grasped: the handle, bowl, or the middle of the spoon). The coder noted whether the infant made correct and/or incorrect attempts to solve the task. Correct attempts were operationalized as when the infant held the bowl of the spoon and attempted to insert the straight end into the hole. Incorrect attempts were operationalized as when the infant held the straight end of the spoon and attempted to insert the bowl of the spoon into the hole. Lastly, the coder recorded whether the infant solved the task by successfully inserting the straight end of the spoon into the hole to activate the LED lights.

Procedure. To begin the procedure, infants were given a short assessment of hand preference. This test consisted of three trials in which participants were presented with a small toy (a penguin, monkey, and pig) at their midline. The experimenter held each toy with both hands when presenting it to the infant. After these three trials, infants completed a 30-second baseline assessment to see whether they were able to solve the lightbox task on their own before receiving any sort of instruction. During the baseline assessment, infants were presented with the lightbox and spoon and were given the opportunity to explore them. The experimenter placed the spoon in front of the lightbox with the bowl facing the infant. This baseline task allowed the infant to freely manipulate the spoon and the lightbox for the allotted time. After the baseline test was completed, the experimenter performed a series of demonstrations. Infants who solved the task during this baseline assessment were permitted to complete the remainder of the study session, but their data were not used.

Infants who were assigned to the Sequential condition viewed the experimenter perform two correct and two incorrect demonstrations. It was counterbalanced within this condition whether infants viewed the correct or incorrect demonstration first. When the experimenter presented a correct demonstration, the handle of the spoon entered the hole in the side of the lightbox and the LED lights were activated. When the experimenter presented an incorrect demonstration, she unsuccessfully attempted to push the bowl of the spoon into the hole on the side of the lightbox. The experimenter alternated between correct and incorrect demonstrations when performing the four demonstrations for infants in the Sequential condition. Infants who were assigned to the Correct-only condition viewed the experimenter perform four correct demonstrations. Across both conditions, each attempt (correct or incorrect) that the experimenter performed was five seconds in duration. After each demonstration, the experimenter placed the spoon on the platform of the lightbox and waited five seconds before performing subsequent demonstrations.

After the experimenter performed the four demonstrations, infants were given two opportunities to solve the lightbox task. The experimenter said "Now it's your turn," placed the spoon on the platform, and pushed the lightbox toward the infant. The infant was allowed 30 seconds to attempt to solve the task. Infants completed one easy test trial and one hard test trial. During easy test trials, the spoon was placed on the platform with the handle facing the hole. On the other hand, during hard test trial, the spoon was placed on the platform with the bowl facing the hole. Between the two test trials, the experimenter re-

trieved the spoon from the infant and pulled the lightbox across the table so that it was out of the infant's reach. The experimenter reversed the orientation of the spoon and then slid the lightbox toward the infant to begin the second 30 second test trial.

Experiment Two.

Participants. Forty-eight full-term infants (female=24) between the ages of 13 and 18 months (M=15.43 months, SD=.83 months) participated in Experiment 2. Infants were randomly assigned to one of three conditions: Simultaneous (n=16), Sequential (n=16), or Correct-only (n=16).

Materials. Experiment 2 utilized two lightboxes and two spoons during the experimenter demonstrations, whereas Experiment 1 only utilized one of each.

Measures. A trained research assistant coded the same behaviors as in Experiment 1. Additionally, a custom software system, Joycode, was used to code infants' looking behaviors during the demonstrations. Two buttons allowed research assistants to indicate whether an infant was looking toward the left lightbox or the right lightbox during the demonstrations. The button is pressed when the infant is looking at a lightbox and only for the duration that the infant is looking at the lightbox. When infants were not looking at either of the lightboxes, neither of the buttons was pushed.

Procedure. The procedures in Experiment 2 were similar to those in Experiment 1. Infants first completed 3 hand preference trials followed by a 30 second baseline introduction to the stimuli. In Experiment 2, after the baseline was completed, a second box was added to the table in front of the infant. The boxes were positioned so that the experimenter could see both holes. The windows of the lightboxes were facing toward the infant. In the Simultaneous condition, the experimenter performed a correct demonstration on one of the lightboxes while performing an incorrect demonstration on the second lightbox. The position of the correct and incorrect demonstrations (left or right lightbox) alternated across the four trials. In the Sequential condition, the experimenter performed correct demonstrations on both lightboxes during one trial, and performed two incorrect demonstrations on the subsequent trial. Correct and incorrect demonstrations alternated across the four trials. In the Correct-only condition, the experimenter used two lightboxes, but she only demonstrated how to correctly solve the task. In all cases, the experimenter held the spoons in place for about 5 seconds, then removed the spoons, set the spoons down, waited a couple seconds, flipped the spoons, and repeated the first two steps. The same procedure was performed four times so that each infant saw four demonstrations. After removing the spoons from the boxes after the fourth demonstration, spoons were left in place on the platforms. One of the boxes was removed from the table and placed on the floor, and then infants completed two test trials identical to the test trials in Experiment 1.

RESULTS.

Experiment One.

In the Sequential condition, five infants activated the lightbox, while eleven did not. In the Correct-only condition, seven infants activated the lightbox, while nine did not.

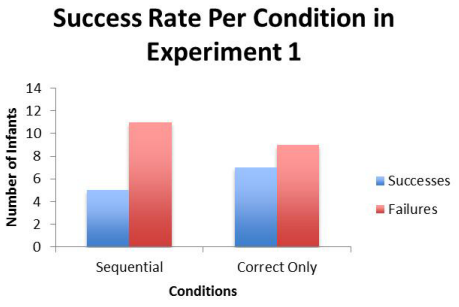

Figure 1: This graph displays how many infants succeeded in activating the lightbox (Successes) compared to how many infants did not succeed (Failures) in each condition.

Experiment Two.

In the Simultaneous condition, three infants solved the lightbox task while 13 did not. In the Sequential condition four infants solved the lightbox task while 12 did not, and in the Correct-only condition five infants succeeded in activating the lightbox while 11 did not (see Figure 2).

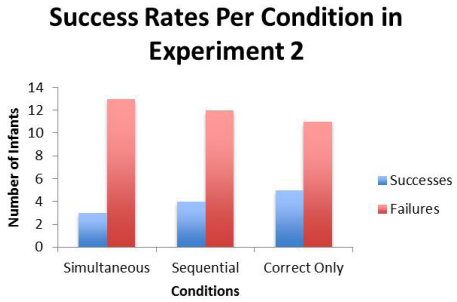

Figure 2. This graph shows the number of participants who did or did not activate the light box in each condition.

There was a significant difference between the number of gaze shifts between the two lightboxes made by participants in the Simultaneous condition (M= 9.81, SD=4.68) and the Sequential condition (M= 5.63, SD= 2.92),$t(30)$=3.04, p=.005, 95% CI [1.37, 7.00]. There was also a significant difference between the gaze shifts in the Simultaneous condition (M= 9.81, SD= 4.68) and the Correct Only condition (M=5.94,SD=3.30),$t(30)$=2.71, p=.01, 95% CI [.95,6.79]. In the Simultaneous condition, the infants looked significantly more towards the correct demonstration (M=3.82, SD=2.13) than towards the incorrect demonstration (M=2.03, SD=1.87),$t(15)$=5.01, p<.001, 95% CI [–1.07, 1.07] (see Figure 3).

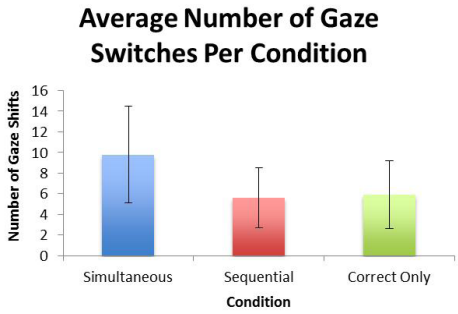

Figure 3. This graph displays the average number of gaze shifts per condition.

DISCUSSION.

Experiment One.

Due to the relatively low rates of success in Experiment 1, we decided to give infants an opportunity to use comparison between two lightboxes to better understand how to solve the lightbox task. In Experiment 2, we added a third condition in which the experimenter demonstrated a correct demonstration on one lightbox at the same time as an incorrect demonstration on the other lightbox. We thought that seeing both the correct and incorrect example at the same time would allow infants to actively compare the two problem solving techniques.

Experiment Two.

Our results from this study did not support our initial hypothesis. Infants subject to the Correct-only condition performed best in both experiments. In our studies, infants were given the opportunity to collect evidence to learn from correct and incorrect demonstrations. Infants looked back and forth between the demonstrations significantly more often when correct and incorrect demonstrations were shown at the same time in the Simultaneous condition (Figure 3), but this comparison opportunity led to less success, not more.

CONCLUSIONS.

One explanation for the higher success rates in the Correct-only conditions of Experiment 1 and Experiment 2 could be that the infants imitated the actions

that the experimenter showed them, instead of comparing the correct and incorrect actions. A previous study found that two-year-olds were unable to benefit from observing both correct and incorrect demonstrations, but 3-year-old children did benefit from the use of comparison (5). Adults tend to focus on demonstrating the correct procedure for a task to infants. Young infants may only be exposed to incorrect attempts when they are experimenting on their own. Thus, when teaching infants around the age of 15 months, we suggest showing only correct demonstrations because infants may become confused about what the teacher is trying to accomplish with incorrect demonstrations.

In continuing this research, we plan to investigate whether infants are able to benefit from the experience of solving the lightbox task using an unfamiliar tool (a spoon-like tool with a hole where the bowl would be) prior to the opportunity to solve the task using a spoon. The experimenter will perform side-by-side demonstrations of correctly solving the task with the spoon and the unfamiliar tool, in a fashion similar to the Simultaneous condition described in experiment 2. We hope to find out whether infants are able to make connections between how to solve the task using the unfamiliar tool and how to solve the task using the spoon. We hypothesize that infants may benefit from comparing different tools used to solve the same task, and that this may help them overcome the difficulty of grasping the bowl of the spoon in order to insert the straight end into the lightbox.

ACKNOWLEDGMENTS. This research was supported by grant #R01-HD057120 from the NICHD to AN.

SUPPORTING INFORMATION.

Supplemental Methods.

Figure S1. Success Rate Per Condition For Experiment 1

Figure S2. Success Rate Per Condition For Experiment 2

Figure S3. Average Number of Gaze Shifts Per Condition

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