OBJECT CATEGORY FORMATION IN 4.5 MONTH-OLD INFANTS

By

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Abstract

Previous studies suggest that 4.5 month old infants are capable of forming an object category of an elongated box if they are familiarized with at least three exemplars from the category before testing (Needham, Dueker, & Lockhead, 2005). Our experiment replicated Needham's design, using new stimuli in order to obtain additional control over variable such as the novelty of the object category and the cue of line continuation. Taking the previous literature into consideration, the category was designed to be genuinely novel to infants. Furthermore, the disruption of line continuation (a cue in previous studies) was removed. If the infants are able to form an object category of a truly novel object and if this ability is robust to competing cues such as line continuation, they will see a new exemplar of the novel object as a separate entity even when it is adjoined with its complement such that the two form a rectangular box. Preliminary results suggest this to be the case.
Introduction

Infant are immersed in stimulation constantly from their surroundings, and must try to make sense of it all. Forming categories from recognizable objects is helpful for both infants and adults in making sense of the intricate visual stimulation they encounter. Needham has conducted a number of studies investigating infants' capacity to form object categories and the age at which they begin to use this skill (Dueker & Needham, 2005; Needham, Dueker, Lockhead, 2005; Needham & Modi, 2000). Needham et al. (2005) found that infants must be presented with three exemplar boxes that are similar enough to a test box but maintain variability in order for the infant to form an object category of the box. In their study, three boxes were placed on a stage apparatus (the same apparatus that was used for testing) together. The boxes were identical in shape but differed in color and pattern. The infant was shown the three familiarization objects that remained stationary. The familiarization period ended when the infant looked at the three objects for an accumulation of 5 seconds. At test, the infant saw a box with a different pattern connected to a yellow coil situated on a stage. In one test condition, a purple-gloved hand pulled the yellow coil such that it separated from the box (move-apart event). In a second condition the coil and box moved together as one entity (move-together event). If infants formed an object category of box, their looking times should be longer in the move-together event because that should violate the infant's expectation that the box was a separate entity. This is what was Needham et al. found, demonstrating that 4.5- month-old infants were able to form an object category of a box.

In replicating one of the experiments from Dueker and Needham (2005), two potential confounds of this study arose: 1) does previous experience aid in object segregation and 2) do the
perceptual features of the test objects enhance the segregation. In addressing point one, do infants’ previous experiences help segregate the test box and coil? A box is a basic geometric shape found in daily encounters, so it is likely that infants have had prior experience of the category box. If infants have an existing knowledge of a box, does the presentation of the familiarization objects further broaden this grouping rather than create a novel object category? As per point two, are infants using the perceptual features during test to aid in segregation? As illustrated in Needham (1999), 4 month-old infants used shape dissimilarity in order to segregate two objects that were touching side-by-side. In subsequent Needham object categorization experiments, infants were tested on a tall box touching a short round cylinder (Dueker & Needham, 2005; Needham, Dueker, Lockhead, 2005; Needham & Modi, 2000). These two objects are different shapes, raising the possibility that infants are segregating the box from the coil at test due to the dissimilarity of the shapes.

With this in mind, my thesis advisors and I constructed new stimuli to ask whether infant learners could acquire a truly novel object category (based on an object shape they would not have encountered) without breaks in line continuation. Needham and Baillargeon (1995) found that if two objects that are touching side by side share line continuation, the 8-month-olds will interpret these objects as one entity. However, when an experimenter ran a blade between the two objects, the infants saw the two objects as separate (Needham & Baillargeon, 1995). For the present study, good line continuation will be shared between the novel object and an adjoining object to more stringently control the cues available to infants. If infants are able to form an object category of a truly novel object, as opposed to a fairly commonly shaped object during familiarization, they will ignore the cue of line continuation at test.
Methods

Participants

A total of four infants (two females, two males) participated in this study (\(M = 4\) months 8 days, range 4.03-4.49). One participant was discarded due to excessive crying during testing. Each infant was randomly assigned to the move-apart or move-together event. All experimental procedures were approved by the Internal Review Board of the University of Arizona.

Materials

Three novel familiarization objects were made of wood with dimensions 5 inches wide by 14 \(\frac{3}{8}\) inches tall by 3 inches deep (refer to Figure 1). One of the objects was painted purple with small white squares. A second novel object was painted green with small white triangles. The third object was painted blue with small red squares.

![Figure 1: Familiarization stimuli](image)

The experimenter wore a short black sleeve t-shirt and a black glove on the left hand. The experimenter also used a stop watch to make sure every infant had the same amount of exposure to the familiarization objects. During test, sunglasses that had duct tape on the lenses was worn by the infant’s parent.

The novel test object had the same dimensions as the familiarization objects but was painted blue with small white squares painted in a similar pattern to the
familiarization objects. The adjoining object was the complement such that shown the two pieces formed a large rectangular shape (see Figure 2), measuring 14½ in tall, 10 in wide, and 3 in deep. The counter-piece object was painted yellow. The black glove was also present. Videos were made of two types of test events (described in the procedure below). For the videos, the novel object and its counter-piece were filmed on a flat white surface against a green wall. We chose to test infants using video to more easily assess looking time with our lab setup but because we wanted in future studies to familiarize infants with novel objects in their homes before testing in the lab. We needed to pilot familiarization with real objects and test with video for this reason.

![Figure 2: Test stimuli](image)

**Procedure**

During familiarization, three novel objects were placed on the floor and were covered by a black cloth. The experimenter, wearing a short black sleeve t-shirt and a black glove on the left hand, sat approximately 45.7 in away from where the infant was seated in order to keep the visual angle (18 degrees) consistent throughout familiarization and testing. Once the infant was situated on their parents lap, the experimenter lifted the back cloth and began the familiarization period. The experimenter picked up the first object, which is purple with white squares, with her left black gloved hand and moved it back and forth slightly while the infant watched for a total looking time of 20 seconds.
(measured with a stopwatch), stopping the timer whenever the infant looked away to ensure the infant was exposed for a full 20 seconds. That object was placed back on the floor and the second object, which is green with white triangles, was picked up. The same procedure for the first object was repeated. After the infant looked at the second object for 20 seconds, the same procedure was performed for the final object painted blue with red squares. Then the experimenter repeated that entire sequence, giving the infant a total exposure time of two minutes to the objects. The experimenter placed the black cloth over the objects and removed her glove.

The experimenter next took the parent and infant into 91.5 by 71 in. test booth with a chair facing a wall with a 30 by 40 in. projection screen. The child was seated on the parent’s lap about 46 in away from the screen, in order for the visual angle to remain 18 degrees. The parent wore sunglasses that prevented her from seeing the test videos so as to ensure that parental reactions to the stimuli would not influence the infant’s behavior. Once the infant and parent were situated, testing began.

The infant first watched a test familiarization video projected from a ceiling mounted LCD projector showing the test novel object connected to its counter-piece (as shown in Figure 2). Infants saw a video of the stationary objects for 30 seconds. During this time, the infants’ looking times were recorded to see how long they watched the test familiarization.

Once the 30 seconds were over, testing began. Infants were randomly assigned to receive six trials of the move-together or move-apart event (see Figure 3). The move-together event began with a black gloved hand resting on the flat white surface halfway between the end of the frame and the yellow counter-piece. After waiting for one second,
the hand took a hold of the yellow counter-piece object for one second. Then the hand pulled the object towards itself for two seconds. The yellow and blue objects moved together as one entity. The hand then paused for one second. Next, the hand pushed the objects back to their original position in two seconds. Finally, the hand resumed its original placement on the white surface for one second. This entire process counted as one cycle which lasted approximately eight seconds. The move-apart event was identical to the move-together event except the yellow object separated from the blue test object.

The cycle continued to repeat without stopping until that test trial ended. A test trial ended when the infant looked away from the event for 2 consecutive seconds or after a cumulative time of 60 seconds if the infant did not look away for 2 seconds consecutively.

Testing finished after all six trial videos were shown to the infant. The parent and infant were then taken back into the waiting room where they were debriefed about the study.

Results
At the present time, this study only has data for three infants, which is not enough to conduct statistical tests. One infant, run in the move-together event showed a longer looking time (34.1s) than the two infants in the move-apart (M = 10.97s). Once enough data is collected for statistical power, an analysis will be run.

Discussion

The novel shape that the infants were shown beforehand, and at test, is an original shape that they are not likely to have encountered or experienced before coming into the lab. Furthermore, at test the novel object and its counter piece object formed a larger rectangular shape, removing the shape cue to object segregation that was present in Needham’s earlier studies. Given Needham & Baillargeon (1997) where the use of a blade is needed to help infants this age see objects with line continuation as separate, if infants do not form a robust object category they may see the test stimulus as a rectangle rather as two separate objects. If so, they would look longer to the move-apart event than to the move-together event (or they might look equally long at both event types).

However, if infants are able to form a novel object category and if they can use this information to segment a new exemplar of the category at test, they will look longer at the move-together event than to the move-apart event as the former will violate their expectation that the stimulus consists of two objects. In order to draw conclusions about this study, more participants will need to be tested.

If the infant look significantly longer at the move-together event than at the move-apart, then this is excellent evidence that they are indeed able to form a category of the novel object because they are able to disregard the cue of line continuation. It can then be said more conclusively that infants formed an object category of the novel object.
This would imply that at 4.5 months of age, an infant is using past experiences to segregate objects into different categories to aid in breaking down the visual stimuli they are constantly seeing. This emphasizes the important role object categorization can have in aiding an infant’s learning processes. However it will be important to run control groups also, where infants are tested without familiarization. With no previous exposure to the novel objects, the infants should depend upon the good line continuation the test stimuli share and determine that these two objects are one entity. This control group should look longer at the move-apart condition if it violates their expectation that the rectangle forms one object.

If infants’ in the primary experiment look longer to the move-apart than to the move-together condition, then it may be that they are not capable of forming a category of a truly novel object at 4.5 months of age. However, it might be the media forms in which the infants were shown the stimuli that might obscure their learning. In this study, infants were familiarized with objects that were presented in 3D. Yet during testing, they see a 2D image of the 3D test stimuli. It could be that infants are capable of learning a novel object category but seeing the objects in different mediums might cause a transfer problem where they are unable to make a connection between the 3D objects and their pictorial representation in 2D displays. This explanation could be explored by ensuring that both the familiarization and testing period introduce the objects in the same dimension (whether both in 2D or 3D).
References


