Manual rotation experience on mental rotation strategies

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Introduction

- **Children develop a preference for categorizing objects by shape around 2-to-3-years of age (Landau, Smith, & Jones, 1988), but shape recognition can be affected by the orientation of the object. Recognition of an object across changes in viewpoint involves forming a shape-constant representation.**
- **By viewing multiple perspectives of the same object, adults can form orientation-invariant object representations (Tarr & Pinker, 1989), and active manipulation of 3-D structures facilitates object recognition (James, Humphrey, & Goodale, 2001)**
- **How do children develop shape-constant representations, and how does active manipulation influence categorization across orientation transformations?**

Experiment 1

Participants:

- **Adults** (M_{age}= 22.7 yo)
- **6+ yo** (M_{age}= 8.0 yo)
- **5 yo** (M_{age}= 5.5 yo)
- **4 yo** (M_{age}= 4.3 yo)
- **24.0-42.0 mo** (M_{age}= 32.4 mo)

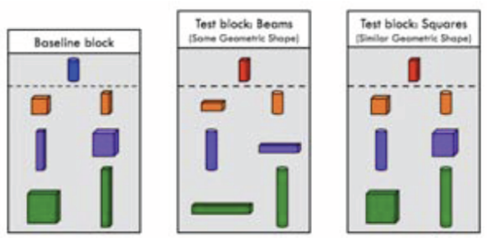


Figure 1. Examples of stimuli and trials used in Experiment 1.

Procedure:

All participants received 3 blocks of trials *(see Figure 1)*. In each block, participants were first familiarized with an exemplar object labeled with a novel name (e.g. *dax*). For the Test block trials, participants were presented with two object choices *(orientation-match & geometric shape-match)* and asked to select the one that was also labeled with the novel name. The Baseline block measured participant's ability to categorize objects based on *orientation* (defined by the object's axis of elongation). All participants successfully categorized by *orientation* when there wasn't a shape similarity choice. Block order, pair order, and exemplar orientation were counterbalanced.

Participants were separated into two conditions: *active* and *passive*. In the *active* condition, participants were given the exemplar objects to freely manipulate, whereas in the *passive* condition, participants only viewed the stationary exemplars from behind a Plexiglas screen.

Results:

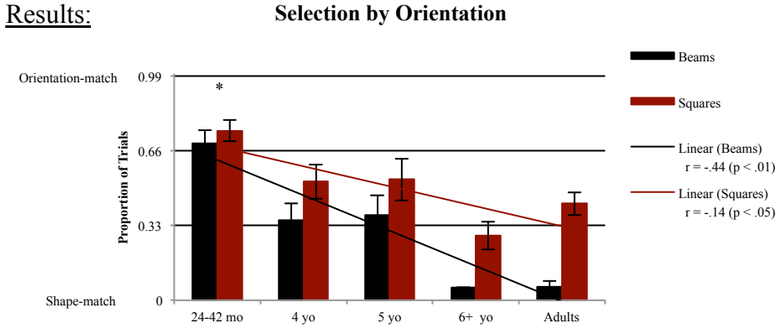
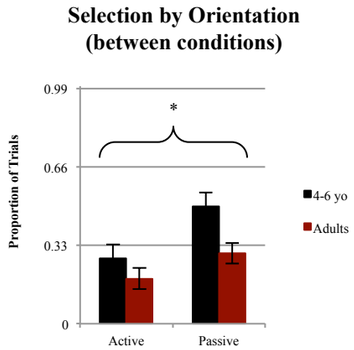


Figure 2. A 30-month-old child selecting the orientation-match choice



Experiment 1 Results *(continued)*

Exp. 1 demonstrates a significant linear correlation between age and orientation categorization. Young children (24-42 mo) categorize objects by orientation, and with increasing age, participants categorize objects more by shape.

Older children and adults also categorized objects more by shape after *actively exploring* the exemplars.

Experiment 2

Exp. 2 explored categorization when orientation was not manipulated to demonstrate that 24-42-month-old children *do* recognize changes in shape.

Participants:

- **24.0-42.0 mo** (M_{age}= 33.1 mo)

Procedure:

Exp. 2 presented the same Test blocks from Exp. 1, but used two new Baseline blocks that measured children's ability to categorize objects when only *shape* was varied. All participants were successful at categorizing by shape in the Baseline trials, but attended more to the *orientation-match* objects in the Test trials.

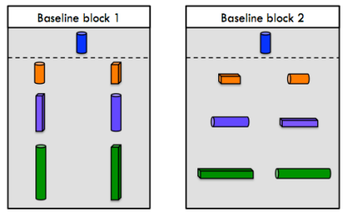
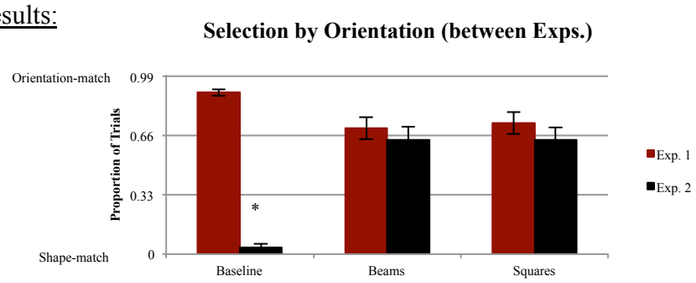


Figure 3. New Baseline blocks used in Exp. 2.

Results:



When orientation is a not factor, 24-42-month-olds categorize objects based on shape similarity. However, they still prefer to select the *orientation-match* in the Test blocks for both experiments.

Experiment 3

In Exp. 1, older children and adults categorized objects by *shape* more often in the *active* condition. For Exp. 3, we instructed 24-42 mo children to manipulate the exemplars in different orientations to observe how guided active experience affects object categorization.

Participants:

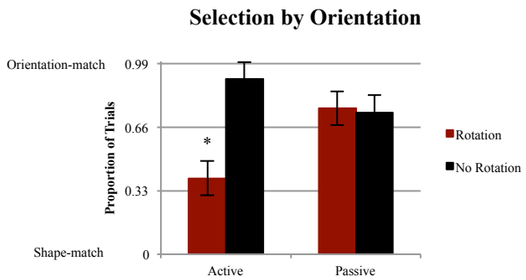
- **24.0-42.0 mo** (M_{age}= 33.9 mo)

Procedure:

Baseline and Test blocks from Exp. 1 were used in Exp. 3. Exp. 3 consisted of 4 conditions: *active* and *passive* (same as Exp. 1) & *active* and *passive rotation*. In the *active rotation* condition, children were shown how to rotate the exemplars and then asked to mimic the actions. In the *passive rotation* condition, children only watched the experimenter rotate the objects.

Results:

Children who *actively rotated* the exemplars selected the *shape-match* choice significantly more than children in the passive rotation and no rotation conditions.



SUMMARY

How do individuals categorize objects across changes in viewpoint?

- Exp. 1 illustrates a developmental change in how children and adults categorize objects, with adults and older children categorizing more by shape even when objects were presented in different orientations.
- Exp. 1 also shows that older children and adults categorized objects by shape more when allowed to actively explore the exemplar objects, suggesting that active experience contributes to shape-constant object representations.
- Exp. 2 confirms that when orientation was not manipulated, 24-42-month-olds categorized objects by shape.
- Exp. 3 demonstrates that when 24-42-month-olds were shown how to *actively* explore the objects so that they experienced variations in object orientations, they categorized objects more by shape.

Younger children categorize objects more based on orientation similarity than shape similarity, but after actively exploring objects across changes in orientation, children of all ages then categorize objects more based on shape similarity.

Thus, active interaction may contribute to shape constancy.

References:

James, K. H., Humphrey, G. K., & Goodale, M. A. (2001). Manipulating and recognizing virtual objects: Where the action is. *Canadian Journal of Experimental Psychology, 55*, 111-120.
Landau, B., Smith, L., & Jones, S. (1988). The importance of shape in early lexical learning. *Cognitive Development, 3*, 299-321.
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