Using Perceptually Rich Objects to Help Children Represent Number: Established Knowledge Counts

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Abstract

Concrete objects are used to help children understand math concepts. Research suggests that perceptually rich objects may hinder children's performance on math tasks relative to bland objects. However, previous studies have confounded the perceptual richness of objects with children's established knowledge of the objects. The present study examined how these two factors influence children's developing counting skill. Children (*M* age = 4 yrs, 1 mo) were randomly assigned to counting tasks that used one of four types of objects in a 2 (perceptually rich or not) x 2 (established knowledge or not) factorial design. Results revealed an interaction between the two factors. When children already had knowledge of the objects, perceptual richness hindered performance on the counting tasks. However, when children did not have established knowledge of the objects, perceptual richness facilitated performance. These findings suggest that the use of perceptually rich objects can convey both advantages and disadvantages for children's performance on math tasks, depending on how the objects interface with children's established knowledge.

Background

Many theories assume that children need experience with concrete objects to develop an understanding of abstract concepts (e.g., Piaget, 1953; Bruner, 1964).

However, recent work suggests that it is difficult for children to use concrete objects to represent abstract concepts because concrete objects require *dual representation*-- they must be represented both as objects themselves, and as the abstract concept they are intended to represent (DeLoache, 2000; Uttal et al., 2002).

The dual representation account suggests that the more salient an object is in its own right, the less likely a child will be able to use it symbolically.

In support of this view, recent research suggests that concrete objects may hinder learning and performance, particularly when objects are brightly colored and rich in perceptual detail (Amaya et al., 2007; McNeil et al., in press, Sloutsky et al., 2005).

Background (cont.)

However, poor performance in previous studies cannot be attributed to perceptual richness *per se*. This is because the perceptually rich objects were not only more perceptually rich than "control" objects, but also more similar to objects the children already had knowledge of outside of school.

Children's established knowledge of the objects in a non-school setting may have made it difficult to use the objects in a school math task. Several studies have shown that children and adults often resist changing their well-established knowledge of objects, concepts, and procedures (Duncker, 1945; Mack, 1995; McNeil & Alibali, 2005; Son & Goldstone, 2007).

Current experiment – We tested children's ability to count concrete objects (a.k.a., counters). We predicted that children's established knowledge of the objects would moderate the effect of perceptual richness.

Method

Participants – 54 three & four yr olds (*M* age = 4;1)

Tasks – Two tasks that have been used widely to assess children's understanding of counting:

Puppet counting task – (adapted from Briars & Siegler [1984] and Gelman & Meck [1983]): Puppet counts arrays of 5, 7, or 9 objects (random) in one of three ways: correct (5 trials), incorrect (5 trials), and unusual but correct (5 trials).

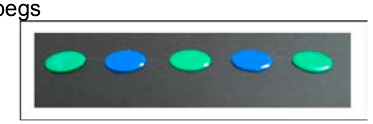
Give-a-number task – (adapted from Wynn [1990]): Child is asked to give a number of items (1-6) to a puppet. Child is credited as being a "knower" of the highest numerosity he or she can give correctly twice.

Method (cont.)

Design – Children were randomly assigned to counter conditions in a 2 (perceptually rich or not) x 2 (established knowledge or not) factorial design. Children used one set of objects for both counting tasks. We used two different sets of objects within each condition. To maximize external validity, we only used objects that could be purchased from teaching supply stores.

Conditions

Control – Solid-colored plastic disks (pictured) or solid-colored pegs



Perceptually rich – Sparkly pom poms (pictured) or neon and metallic pinwheels

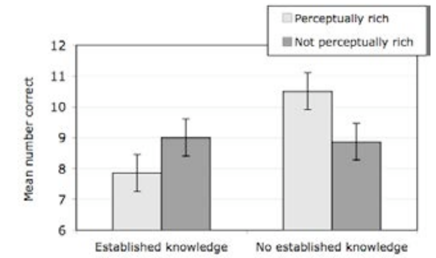
Established knowledge – Popsicle sticks (pictured) or solid-colored pencils

Perceptually rich + Established knowledge – Detailed, realistic-looking plastic animals (pictured) or miniature fruit

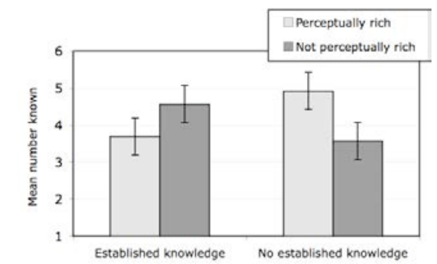
To confirm that we made a valid distinction between perceptually rich and bland objects, we asked a group of naïve undergraduates (N = 39) to rate all of the objects in terms of their perceptual richness using a 1-7 Likert scale. Participants rated the objects in the "perceptually rich" condition as significantly more perceptually rich (M = 5.46, SD = 0.72) than the objects that were in the "not perceptually rich" condition (M = 2.61, SD = 0.67), $F(1,38)$ = 416.45, $p < .001$.

Results

Performance on the Puppet Counting Task as a Function of Condition



Performance on the Give-a-number Task as a Function of Condition



- As predicted, we found a significant interaction between perceptual richness and established knowledge both on the puppet counting task, $F(1,50)$ = 6.25, p = .02, and on the give-a-number task, $F(1,50)$ = 5.43, p = .02.
- When children had established knowledge of the objects, perceptual richness hindered performance. However, when children did not have established knowledge of the objects, perceptual richness helped performance.

Summary and Next Steps

We found that perceptual richness could be positive or negative, depending on whether or not children already had established knowledge of the objects.

Ultimately, we hope results will inform theories of children's symbolic understanding, as well as help preschool teachers choose counters for their classrooms.