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How we categorize objects is related to how we remember them: The shape bias as a memory bias

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ABSTRACT

The "shape bias" describes the phenomenon that, after a certain point in development, children and adults generalize object categories based on shape to a greater degree than other perceptual features. The focus of research on the shape bias has been to examine the types of information that learners attend to in one moment in time. The current work takes a different approach by examining whether learners' categorical biases are related to their retention of information across time. In three experiments, children's ($N = 72$) and adults' ($N = 240$) memory performance for features of objects was examined in relation to their categorical biases. The results of these experiments demonstrated that the number of shape matches chosen during the shape bias task significantly predicted shape memory. Moreover, children and adults with a shape bias were more likely to remember the shape of objects than the color and size of objects. Taken together, this work suggests that the development of a shape bias may engender better memory for shape information.

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Introduction

Categorization and generalization are fundamental processes in human cognition. As a result, much research has examined the developing ability to categorize objects and generalize this information to novel objects. Children's ability to categorize objects has been described as particularly impressive

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because there are a seemingly infinite number of ways in which objects in the world can be partitioned. How do children acquire and generalize object categories?

One proposal has been that children develop categorical biases, which are used to narrow the possible ways in which objects can be categorized. An example of one of these biases is the "shape bias," which describes the finding that, after a certain point in development, learners generalize named object categories based on shape to a greater degree than on other perceptual features (Baldwin, 1992; Colunga & Smith, 2008; Diesendruck & Bloom, 2003; Gershkoff-Stowe & Smith, 2004; Hupp, 2008; Imai, Gentner, & Uchida, 1994; Landau, Smith, & Jones, 1988; Perry & Samuelson, 2011; Samuelson, 2002; Smith, Jones, Gershkoff-Stowe, & Samuelson, 2002; Yee, Jones, & Smith, 2012; Yoshida & Smith, 2003). In a typical paradigm (e.g., Landau, Smith, & Jones, 1988), participants are presented with a novel object and a novel linguistic label (e.g., "toma"). Participants are simultaneously presented with three additional objects, one that matches the target object's shape and two additional objects that match one of the target object's other dimensions such as color, size, or texture. While all four objects are in learners' view, the experimenter prompts participants to pick which one of the three unnamed objects is also a "toma". Many children over 2 years of age and most adults will pick the shape match over the color, size, or texture match, suggesting that learners assume that shape is a more defining feature of object categories than of other perceptual features.

The shape bias literature largely consists of arguments regarding the types of information children attend to during categorization and generalization such as perceptual, linguistic, and conceptual information (for an overview of theories, see Samuelson & Bloom, 2008). As an example, according to the attentional learning account (ALA) of the shape bias (e.g., Colunga & Smith, 2008; Samuelson & Horst, 2008), attention is shifted to properties of objects that have historically been relevant for the task context. The relevant properties of objects are likely to be determined by statistical regularities among perceptual features of objects, language (e.g., linguistic labels), and categorical organization (e.g., relations between categories). That is, children's early experiences in learning words and categories leads them to notice statistical regularities among objects (e.g., shape), enabling children to shift attention to these regularities when comparing multiple novel objects. In brief, the ALA account proposes that learners with a shape bias have learned to allocate more attention to shape than to other perceptual features of objects.

The shape bias has been linked to several long-term outcomes in language development and categorization (Gershkoff-Stowe & Smith, 2004; Jones, 2003; Perry & Samuelson, 2011; Perry, Samuelson, Malloy, & Schiffer, 2010; Samuelson, 2002; Smith, Jones, Gershkoff-Stowe, & Samuelson, 2002). For example, individual differences in children's early productive vocabulary predict the type of categorical bias that children acquire and performance on a novel noun generalization task (Perry & Samuelson, 2011). Moreover, providing children with shape category training can engender an early shape bias, resulting in marked increases in vocabulary growth (Samuelson, 2002; Smith et al., 2002). Given that the shape bias has been linked to several long-term outcomes, it is important to outline the mechanisms that give rise to the relation between the shape bias and cognitive development (for a discussion, see Perry & Samuelson, 2011). That is, how does the shape bias promote word learning and categorization across time?

To date, the shape bias literature has a striking limitation in that this work has focused on the information that children attend to when comparing multiple objects in one moment in time. In real-world learning situations, there are likely to be frequent temporal gaps between encountering a new object and subsequently generalizing to a second object of the same category (Horst & Samuelson, 2008; McMurray, Horst, & Samuelson, 2012; Vlach, Sandhofer, & Kornell, 2008). However, little research has examined how learners access their learning history (i.e., when the first object is no longer in learners' view) and how this ability relates to categorization and generalization (for recent exceptions, see Perry, Axelsson, & Horst, 2015; Perry & Saffran, 2016). Indeed, a central tenet of all theoretical accounts of the shape bias is that learners access and use their learning history to guide generalization across time (Keil, 2008). Consequently, it is essential to understand how learners remember and retrieve information about objects across time. Rather than argue for one theory over the other, this work moves beyond arguments of what is attended to in the moment (i.e., perceptual vs. conceptual/linguistic information) to what is retained across time.

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