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Linguistic labels, dynamic visual features, and attention in infant category learning

Wei (Sophia) Deng, Vladimir M. Sloutsky *

Department of Psychology, The Ohio State University, Columbus, OH 43210, USA

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ABSTRACT

How do words affect categorization? According to some accounts, even early in development words are category markers and are different from other features. According to other accounts, early in development words are part of the input and are akin to other features. The current study addressed this issue by examining the role of words and dynamic visual features in category learning in 8- to 12-month-old infants. Infants were familiarized with exemplars from one category in a label-defined or motion-defined condition and then tested with prototypes from the studied category and from a novel contrast category. Eye-tracking results indicated that infants exhibited better category learning in the motion-defined condition than in the label-defined condition, and their attention was more distributed among different features when there was a dynamic visual feature compared with the label-defined condition. These results provide little evidence for the idea that linguistic labels are category markers that facilitate category learning.

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Introduction

The ability to form categories is an important component of human cognition that appears early in development: infants exhibit evidence of category learning during the first months of life (Quinn, Eimas, & Rosenkrantz, 1993; Younger & Cohen, 1985). There is also evidence suggesting that language may affect this process, although the mechanisms underlying the effects of language remain a matter of debate.

* Corresponding author.
E-mail address: sloutsky.1@osu.edu (V.M. Sloutsky).

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Some have suggested that words accompanying category members have the special status of category markers and, as such, guide or supervise category learning during infancy (Waxman & Markow, 1995; see also Westermann & Mareschal, 2014). At the same time, others have suggested that early in development words are akin to other features, but they may become category markers during the course of development (Gliozzi, Mayor, Hu, & Plunkett, 2009; Sloutsky, 2010; Sloutsky & Fisher, 2004; Sloutsky & Lo, 1999; Sloutsky, Lo, & Fisher, 2001). As we discuss below, distinguishing between these positions has profound consequences for our understanding of the relationships between language and cognition and the nature of learning early in development.

According to the former theory, "infants embark on the task of word learning equipped with a broad, universally shared expectation, linking words to commonalities among objects" (Waxman, 2003, p. 220). As a result, words, but not other kinds of auditory input, facilitate infants' category learning by attracting attention to within-category commonalities (Waxman & Booth, 2001; Waxman & Markow, 1995), thereby effectively supervising category learning. These effects are supervisory because labels guide learning by attracting attention to commonalities.

There is some evidence consistent with this view. First, words may facilitate infants' categorization above and beyond other kinds of auditory input (Balaban & Waxman, 1997; Ferry, Hespos, & Waxman, 2010; Fulkerson & Haaf, 2003). Second, facilitative effects of words were reported at the basic level as well as at the superordinate or global level (Balaban & Waxman, 1997; Waxman & Booth, 2003; Waxman & Markow, 1995). Third, there are reports that facilitative effects of labels are specific rather than general in nature: count nouns and adjectives initially have similar effects on category learning, whereas at around 14 months of age count nouns are more likely to facilitate category learning than adjectives (Waxman & Booth, 2001). This finding suggests that count nouns may play a special role in category learning. Finally, labels may facilitate property induction above other kinds of input (Keates & Graham, 2008).

There are challenges, however, to the idea that words are category markers during infancy. First, even if words affect category learning during infancy, they do not need to function as category markers supervising learning but can instead be part of the stimulus input and influence learning in a bottom-up fashion. For example, Plunkett, Hu, and Cohen (2008) presented 10-month-old infants with a category-learning task, such that the to-be-learned category consisted of two clusters of artificial creatures (i.e., a broad category somewhat analogous to a global category encompassing cats and horses). When the category was presented in silence, participants learned two narrow categories, whereas when one common label accompanied each item, participants learned the single broad category. Although it is tempting to conclude that these results indicate that labels supervised category learning, this conclusion is unwarranted. Specifically, when Gliozzi et al. (2009) modeled data reported by Plunkett et al. (2008) using self-organizing maps, a model that assumed that labels are features and function as input rather than top-down supervisory signals was able to account for the reported pattern.

Second, findings that labels facilitate infant category learning are tenuous at best – facilitation transpires in some studies but does not transpire in others. This is because many studies compared the effects of labels with those of unfamiliar sounds but not with a silent condition. When a silent baseline was introduced (e.g., Robinson & Sloutsky, 2007), labels were not found to facilitate infants' category learning above the silent baseline.

Finally, even studies demonstrating facilitative effects of labels have generated inconsistent findings regarding the age at which labels facilitate category learning. For example, Booth and Waxman (2002) demonstrated that for an artifact category, words alone facilitated category learning only at 18 months of age, whereas at around 14 months of age words needed to be paired with object function to facilitate learning above the baseline. It was argued that both words and functions (a) indicate human agency and (b) highlight commonalities among objects. Results of this study seem to be in sharp contrast to studies where words were claimed to facilitate category learning in very young infants. In particular, Ferry et al. (2010) found evidence that labels facilitate category learning in 3- and 4-month-olds. Why do labels facilitate category learning in 3- and 4-month-olds while failing to facilitate learning in much older infants (e.g., Booth & Waxman, 2002; Robinson & Sloutsky, 2007, 2008)?

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