



Discussion

Bringing theories of word learning in line with the evidence

Amy E. Booth*, Sandra R. Waxman

Department of Psychology, Northwestern University, 2029 Sheridan Road, Evanston, IL 60208-2710, USA

Received 11 December 2002; accepted 12 December 2002

Two issues are at stake in this interchange. One concerns the relation between perceptual, conceptual and linguistic knowledge in early word learning. The other concerns the judicious treatment of evidence.

Briefly stated, we designed our experiments (Booth & Waxman, 2002) with one clear goal: to document the pervasive role of conceptual information in naming. Three-year-old children in all conditions witnessed the same novel target objects, labeled with the same novel word (a count noun, e.g. *dax*). To vary the conceptual status of these named objects, we created brief vignettes that described them either as animate objects (e.g. "...has a mommy and daddy who love it very much") or as artifacts (e.g. "...was made by an astronaut to do a special job on her spaceship"). We examined children's extension of these newly learned words. When the objects were described as artifacts, children extended on the basis of shape alone. But when the *very same* objects were described as animate objects, children extended on the basis of both shape and texture. Moreover, when we placed eyes (a strong perceptual cue to animacy) on the objects, but described them with the artifact vignette, children's performance was consistent with the artifact, rather than the animate, pattern of word extension. This documents that the conceptual status of an individual permeates early word learning, and does so even in the face of conflicting perceptual cues.

It is not surprising that our paper sparked a response from Smith, Jones, Yoshida, and Colunga (2003). This work, like that of others (e.g. Bloom, 2000; Gelman & Markman, 1987; Gelman & Medin, 1993; Keil, 1994; Kemler Nelson, Russell, Duke, & Jones, 2000; Soja, Carey, & Spelke, 1991; Welder & Graham, 2001), challenges the contention that word learning can be accounted for by a "...dumb attentional mechanism" (Smith, Jones,

* Corresponding author. Fax: +1-847-491-7859.

E-mail address: a-booth@northwestern.edu (A.E. Booth).

& Landau, 1996) that "...primarily engages the perceptual systems and is immune to influences from general world knowledge" (Landau, Smith, & Jones, 1998, p. 20).¹ What is quite surprising, however, is the content of SJYC's response. They (a) disavow having claimed that word learning can be accounted for by an appeal to perceptual information alone, (b) protest that they themselves have shown precisely the same effects as those we reported, and (c) insist that our data shed no light on the mechanisms underlying early word learning. We take issue with each of these claims.

First, how are we to interpret SJYC's disavowal? Perhaps they have revised their theory, and now acknowledge the powerful role of conceptual information in early word learning. This is unlikely. Despite the fact that Smith and her colleagues have mentioned the possibility that conceptual information may contribute to early word learning, they have consistently concluded that it is in fact unnecessary (e.g. Jones & Smith, 1993, 2002; Jones, Smith, & Landau, 1991; Smith, 1995, 1999; Smith et al., 1996).² A more likely alternative is that SJYC seek to dismiss our contribution by engaging in what seems best described as terminological sleight of hand. They attempt to re-characterize our vignettes as linguistic (rather than conceptual) information, and then assert that linguistic information of this sort has long been included in their account of word learning. This is incorrect. The information conveyed in our vignettes is conceptual; it identifies the ontological status of the objects as animate kinds or artifacts. As is apparent in our original paper, this information cannot be reduced to simple linguistic or perceptual gist for an associative mill. Moreover, the linguistic cues that Smith and her colleagues have manipulated in their own work (e.g. Gasser & Smith, 1998; Samuelson & Smith, 1999; Smith, 1999; Yoshida & Smith, in press) are syntactic in nature and a far cry from the conceptual information we provided in our vignettes. Yoshida, Smith, Drake, Swanson, and Grudel (2001) do report one experiment (Experiment 2) that manipulated information roughly comparable to that conveyed in our vignettes.³ However, this manipulation yielded a null effect which the authors interpreted as evidence that children "...were unaffected by the linguistic cue" (p. 3). Therefore, contrary to SJYC's claim, their existing work neither makes the same predictions nor obtains the same results as our own.

Although we find SJYC's disavowal unconvincing, let us take them at their word. If they do now endorse a more inclusive view of early word learning, this will have serious consequences. First, it chips away significantly at the explanatory force of their account. Smith's group has long maintained that the speed and efficiency of early word learning derives from its encapsulation from deliberative thought and its immunity to certain types of information. But if perceptual, linguistic, and even conceptual information influence

¹ We assume that "knowledge about objects" includes their function, and other conceptually relevant information, like that conveyed in our vignettes.

² Note that Landau (1994) has endorsed a conclusion similar to our own regarding the role of conceptual information in early word learning. She suggests that conceptual knowledge regarding ontological kind (i.e. animate vs. artifact) likely determines the range of shape transformations a child will accept for a particular object, and thereby mediates the effects of perceptual information on word learning.

³ This paper, which figures prominently in SJYC's response, is part of conference proceedings and was published after our own paper had gone to press. We hope that interested readers will find it and determine for themselves its relation to our own work.

word learning, then in what sense is it encapsulated, and from what information is it immune?

Second, if they now admit the importance of conceptual information, then they must consider the ways in which it interacts with other sources of information in the process of word learning. Smith's group has insisted that perceptual information contributes to the process of word learning directly and obligatorily. They suggest that as development proceeds, "...more and more attentional biases should emerge, each fit to and cued by specific object properties", including one in which "...object rigidity in the context of a count noun frame [cues] attention to shape" (Jones & Smith, 1998, p. 332), another in which "children attend to texture as well as shape in classifying objects with eyes" (Jones et al., 1991, p. 499), and yet another in which "...shoes in the context of a noun frame [cue] attention to texture and shape" (Jones & Smith, 1998, p. 332). We have offered a different view in which perceptual cues (e.g. eyes) can operate indirectly, serving as a gateway to conceptual information regarding ontological status, which in turn directs children's attention to relevant object properties. We demonstrated that conceptual information guides children's word extension even in the presence of a conflicting perceptual cue. In light of this evidence, it is misleading to continue to claim that perceptual information contributes directly to early word learning, unmediated by conceptual information.

Importantly, SJYC appeal to neural network modeling as if it is a panacea of explanatory force in debates over mechanism. However, unless the resulting models are firmly grounded in behavioral evidence, their explanatory force as psychological theories is actually quite limited. The evidence that we (and many others) provide regarding the importance of conceptual knowledge in early word learning is centrally relevant to mechanism and will therefore have to be incorporated into any viable model. However, resolving the current debate over mechanism requires more than simply incorporating conceptual information into connectionist models. We must compare models in which perceptual and conceptual information *directly* and independently influence word learning to those in which perceptual information *indirectly* influences word learning by activating conceptual knowledge whenever it is available (Imai, Gentner, & Uchida, 1994).

It is difficult to read SJYC's commentary as anything but dismissive. It fails to engage the data presented and their implications. Although some may see adversarial science as the best road to progress, we have a different vision. In acquiring a lexicon, learners seamlessly integrate perceptual, linguistic and conceptual information. We should expect no less of our theories. It is time to treat judiciously the contributions of these various sources and the interactions among them. This inclusive approach will offer considerable explanatory force, across ontological kinds and across development.

Acknowledgements

This research was supported by NIH grant #HD-08595-02 to the first author and NIH grant #HD-28730 to the second author. We are grateful to our entire lab group for helpful discussion. We are especially indebted to Russ Burnett, Susan Gelman, Douglas Medin, and Peter Vishton for their encouragement and insights.

References

- Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.
- Booth, A.E., & Waxman, S. R. (2002). Word learning is 'smart': evidence that conceptual information affects preschoolers' extension of novel words. *Cognition*, 84, B11–B22.
- Gasser, M., & Smith, L. B. (1998). Learning nouns and adjectives: a connectionist account. *Language & Cognitive Processes*, 13, 269–306.
- Gelman, S. A., & Markman, E. M. (1987). Young children's inductions from natural kinds: the role of categories and appearances. *Child Development*, 58, 1532–1541.
- Gelman, S. A., & Medin, D. L. (1993). What's so essential about essentialism? A different perspective on the interaction of perception, language, and conceptual knowledge. *Cognitive Development*, 8, 157–167.
- Imai, M., Gentner, D., & Uchida, N. (1994). Children's theories of word meaning: the role of shape similarity in early acquisition. *Cognitive Development*, 9, 45–75.
- Jones, S. S., & Smith, L. B. (1993). The place of perception in children's concepts. *Cognitive Development*, 8, 113–139.
- Jones, S. S., & Smith, L. B. (1998). How children name objects with shoes. *Cognitive Development*, 13, 323–334.
- Jones, S. S., & Smith, L. B. (2002). How children know the relevant properties for generalizing object names. *Developmental Science*, 5, 219–232.
- Jones, S. S., Smith, L. B., & Landau, B. (1991). Object properties and knowledge in early lexical learning. *Child Development*, 62, 499–516.
- Keil, F. C. (1994). Explanation, association, and the acquisition of word meaning. *Lingua*, 92, 169–196.
- Kemler Nelson, D. G., Russell, R., Duke, N., & Jones, K. (2000). Two-year-olds will name artifacts by their functions. *Child Development*, 71, 1271–1288.
- Landau, B. (1994). Where's what and what's where: the language of objects in space. *Lingua*, 92, 259–296.
- Landau, B., Smith, L., & Jones, S. (1998). Object shape, object function, and object name. *Journal of Memory & Language*, 38, 1–27.
- Samuelson, L. K., & Smith, L. B. (1999). Early noun vocabularies: do ontology, category structure and syntax correspond? *Cognition*, 73, 1–33.
- Smith, L. B. (1995). Self-organizing processes in learning to learn words: development is not induction. In C. A. Nelson (Ed.), *Basic and applied perspectives on learning, cognition, and development. The Minnesota Symposia on Child Psychology* (pp. 1–32), Vol. 28. Mahwah, NJ: Lawrence Erlbaum Associates.
- Smith, L. B. (1999). Children's noun learning: how general learning processes make specialized learning mechanisms. In B. MacWhinney (Ed.), *The emergence of language* (pp. 277–303). Mahwah, NJ: Lawrence Erlbaum Associates.
- Smith, L. B., Jones, S. S., & Landau, B. (1996). Naming in young children: a dumb attentional mechanism? *Cognition*, 60, 143–171.
- Smith, L. B., Jones, S. S., Yoshida, H., & Colunga, E. (2003). Whose DAM account? Attentional learning explains Booth and Waxman *Cognition*, 87, 211–215.
- Soja, N. N., Carey, S., & Spelke, E. S. (1991). Ontological categories guide young children's inductions of word meaning: object terms and substance terms. *Cognition*, 38, 179–211.
- Welder, A. N., & Graham, S. A. (2001). The influence of shape similarity and shared labels on infants' inductive inferences about nonobvious object properties. *Child Development*, 72, 1653–1673.
- Yoshida, H., & Smith, L. B. (in press). Shifting ontological boundaries: how Japanese- and English-speaking children generalize names for animals and artifacts. *Developmental Science*.
- Yoshida, H., Smith, L. B., Drake, C., Swanson, J., & Grudel, L. (2001). Competition between linguistic cues and perceptual cues in children's categorization: English- and Japanese-speaking children. *Proceedings of the twenty-third annual conference of the Cognitive Science Society*. Mahwah, NJ: Erlbaum.