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Fast Mapping and Slow Mapping in Children's Word Learning

Daniel Swingley
University of Pennsylvania, Department of Psychology

When young children encounter a word they do not know, their guesses about what the word might mean are often surprisingly accurate. This is true not only with respect to the particular instance that the speaker refers to at that moment but also with respect to the entire category of things, states, situations, or events to which the word may refer in the language. For more than 30 years, understanding how this is possible has been the central empirical and theoretical concern of most of the developmental psychologists and linguists who study the process of word learning experimentally. This attention has not been misplaced. The domain of word learning has provided a fertile ground for testing competing accounts of children's understanding of reference in language, their use of ontological divisions and other world knowledge in categorization, and their grasp of syntactic regularities. On the whole, children have performed surprisingly well in these experiments—by the age of two or three, they make efficient and appropriate use of a wide range of sources of information in determining what speakers are referring to in the moment, and in evaluating how novel words may be used in future situations.

Most such tests have taken place in contrived but well-controlled experimental situations in which a brief exposure to a novel word, in a particular social or linguistic context, is revealed to lead children to choose one object or scene rather than another as a referent of the word. What gives such studies their force is the careful manipulation of the precise content of the introducing event, and the selection of the alternatives offered to the child, which pit one possibly tempting interpretation against another. The point is not that the experimental situation closely mimics children's daily lives but rather that children's interpretations reveal antecedent knowledge either innately specified or gained in development.

The experiments acknowledged as the primary intellectual ancestors to this research tradition are those reported in Carey and Bartlett (1978; see also Brown, 1957; Katz, Baker, & MacNamara, 1974). Carey and Bartlett (1978) introduced the term "fast mapping," which has become central to developmental psychology's narrative about how words are learned. In this narrative, it is children's accuracy in fast mapping that cries out for explanation. How can children arrive at the correct meaning of a word given only indirect and incomplete evidence? Yet in Carey and Bartlett's famous "chromium" study, fast mapping was not so successful. Fewer than one in ten of the 3-year-olds appeared to have linked the word to its intended meaning (olive green). The children who had been exposed to the word in the study's naturalistic teaching context ("bring

Correspondence should be addressed to Daniel Swingley, Department of Psychology, University of Pennsylvania, 3401 Walnut Street, Room 411, Philadelphia, PA 19104. E-mail: swingley@psych.upenn.edu

me the chromium one; not the red one, the chromium one") were scarcely more likely than controls to pick out the correct referent from an array of color patches upon hearing the word.

For Carey and Bartlett, the demonstration of fast mapping was noteworthy not because children appropriately determined that "chromium" was a color word (the sort of pragmatic inference that was dissected in dozens of follow-up studies). Rather, it was noteworthy because after very few exposures children were able to create a new lexical entry and maintain it in memory for several days, and because children's exposure to the word often changed their interpretation of how the color space is lexicalized. Much of the paper focused not on the fast mapping that made the paper so well-known but on what the authors called "extended mapping," the process by which children gradually brought into alignment the lexical entry "chromium" and its position in a color space that had not contained that region as a separate category.

Carey and Bartlett's decisions to explore a quite indirect teaching procedure, to place relatively long delays between teaching and testing, and to examine a semantic domain admitting many possible categorical divisions was deliberate: they wanted to test "the *outer* limits of the child's word learning skills" (1978, p. 17). All of these decisions probably contributed to the skeletal, placeholding nature of the children's fast-mapped lexical entries. Over the years, as work on word learning proceeded, the "outer limits" character of the 1978 study was abandoned. Teaching procedures became more explicit; delays from teaching to test were reduced or eliminated; the number of options given the child was reduced to two; and for the most part, the words tested were confined to objects or verbs denoting simple actions. These methodological maneuvers made sense for researchers whose goal was to establish the basis for children's extensions in fast mapping, preferably at the earliest age possible.

The focus on fast mapping had a range of motivations, some having to do with another trend toward the use of object labels as the usual referents of experimentally taught words (Merriman & Tomasello, 1995). Taking seriously Quine's (1960) arguments about the indeterminacy of reference made the learning of object labels just as pressing a scientific problem as the learning of more abstract words where fast mapping is less likely to be on target. Further, the interest in showing that children's categorization is informed by more than "mere" perception tended to take inquiry to the cases where perceptual-level association seemed most promising, yet failed nevertheless—if a perceptual-association account is insufficient for learning *bear* or *noodle*, it would probably fail on *clean* and *wonder* as well.

As described above, the study of how children fast-map words has been extremely fruitful. However, in taking these steps and focusing on the set of problems raised by fast mapping, psychological studies excluded other problems in word learning that are just as much a part of the "natural history" of words in children's vocabularies. For example, it is now widely accepted that children less than 9 months old readily learn the phonological forms of many of the words that they hear frequently (e.g., Jusczyk & Hohne, 1997); by this age, the average infant probably knows several dozen such forms, at least, and uses this knowledge to determine aspects of the phonology of his or her language (e.g., Swingley, 2005). These word-forms are generally believed to be free of semantic content, though this assumption probably underestimates infants' lexical knowledge (Bergelson & Swingley, 2010; Tincoff & Jusczyk, 1999). Given that infants 6–9 months old are not credited with the social-pragmatic capacities that are needed for efficient reference resolution in word learning (Bloom, 2000; Carpenter, Nagell, & Tomasello, 1989), word learning at more advanced ages cannot be limited to the mechanisms that yield word knowledge in early infancy. Whether we call such infantile

word-forms "words" or not, infants' knowledge of their language underlies, and is continuous with, toddlers' knowledge.

Additional studies with older children have begun to show how word knowledge can be built up from fast mapping experiences that leave behind only fragmentary semantic, syntactic, or phonological residues. For 1 and 1/2 year olds, hearing a word used in a semantically neutral context facilitates later learning of that word, probably by promoting construction of an accurate phonological representation (Graf Estes, Evans, Alibali, & Saffran, 2007; Swingley, 2007).

By the age of 2, children reveal long-term storage of syntactic information about a word, even when the initial presentation event provides essentially no additional semantic content (Yuan & Fisher, 2009). In that study, 28 month olds watched a film of two women talking about unpictured events ("Hey . . . Jim is gonna blick the cat!" . . . "Really?". . .) consistently using transitive sentences (e.g., "blick the cat") or intransitive sentences ("she was blicking"). One or two days later, children were told to "find blicking" while viewing pairs of scenes. One scene involved a novel activity appropriate for a transitive verb (two participants), and one scene was appropriate for an intransitive verb (one participant). Children's looking patterns depended upon their prior exposure to the word. If they had heard about something getting blicked, they appropriately fixated the transitive event more; if they had heard about someone blicking, they fixated the intransitive event more.

These studies show that very young children can construct and maintain extremely incomplete lexical representations that may then be "filled in" with more specific knowledge. Why does this matter outside the laboratory? Don't parents signal their referential intentions and provide children with clear examples while they talk (where "clear" must be taken with the customary Quinean grain of salt)? Sometimes parents do, and this helps; often, however, they do not, as when the semantics of the word prevent it. As Gleitman and her colleagues have pointed out, children learn a large number of words for which the set of appropriate usages (i.e., the word's meaning) cannot be determined by inspection of one, two, or even many of the situations in which the word is used (even if adults are doing the inspecting; Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005). Some of these words can be learned to a good first approximation if their linguistic contexts are understood, but this understanding requires prior learning of other words and acquisition of aspects of language-specific syntax. Since children do not hold off on learning these "hard" words until the conditions for complete determination of meaning are met, many words will require "extended mapping" rather than fast mapping alone.

Many of these observations are not new; similar comments about gradual learning were made by Carey (1978), among others (see, e.g., Clark, 2003, chapter 6, for a review). But these notions are not central to most discussions of word learning in the literature. Expanding outward from the prevailing focus on fast mapping to a more organic conception of word learning, as a process rather than an event, might bring with it several advantages. First, it would help integrate research on preschoolers and research on infants, who certainly learn about words but are often described as "preverbal" (e.g., because they are said not to understand reference; Bloom, 2001). Second, it might encourage attempts to characterize partial knowledge. This must be done if we are to understand extended mapping, but it is difficult and not frequently attempted, possibly out of a healthy respect for the problems that sank the semantic features hypothesis (Carey, 1982). Third, the considerable methodological and theoretical advances that have resulted from the intensive study of the fast mapping of linguistically relatively simple cases might be profitably applied to words whose meaning is less amenable to analysis from single instances, as well as to

phrases, morphology, and other linguistic structures. For example, studies that carefully control children's exposure to a given novel structure permit assessment of quantitative features like frequency (e.g., Casenhiser & Goldberg, 2005).

In the first months of 2008, as the thirtieth anniversary of the publication of Carey and Bartlett's "chromium" study approached, reflection on these considerations led the present author and the leadership of the Society for Language Development to assemble a symposium on the topic of fast mapping. We hoped to start an open conversation about the position of fast mapping and extended mapping in psycholinguistic theories of word learning, and by doing so to engage in a broad discussion of mechanisms of developmental change in fast mapping, the course of word learning from infancy through childhood, and interactions between words and concepts. We invited Susan Carey, Linda Smith, and Susan Gelman to speak, and they all accepted. The current issue of *Language Learning and Development* is devoted to the articles that these scholars and their collaborators wrote on this same theme.

In her article, Susan Carey provides a brief history of the study of fast mapping in word learning and argues that extended mapping of word meaning requires not only hypothesis testing but also the creation of new semantic primitives with which words may be defined in the child's mind. This argument is illustrated using the case of the words for integers. Shohei Hidaka and Linda Smith discuss learning that supports fast mapping. They outline a mathematical account of conceptual spaces, arguing that the geometry of semantic categories in conceptual space supports inference making by permitting implicit assumptions about category boundaries. Susan Gelman and Amanda Brandone make the case that *kind* concepts are central to fast-mapped, placeholder lexical entries. If one assumes that object labels refer to kinds, several types of inference follow; for example, kinds do not simply boil down to the set of individuals in the category. These ideas are explored by examining children's acquisition of *generics* such as "birds" in "birds lay eggs."

In different ways, all three papers exemplify a return to viewing "slow" or extended mapping as a crucial part of word learning. In addition, the collection of papers seems to suggest that understanding children's word learning will also require a better grasp on conceptual structure in development, just as Carey and Bartlett showed us more than 30 years ago.

REFERENCES

Bergelson, E., & Swingley, D. (2010, March). *6–9-month-olds match spoken words to visual referents*. Poster presented at the International Conference on Infant Studies, Baltimore, MD.

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Bloom, P. (2001). Précis of how children learn the meanings of words. *Behavioral and Brain Sciences*, *24*, 1095–1134.

Brown, R. (1957). Linguistic determinism and the part of speech. *Journal of Abnormal and Social Psychology*, *55*, 1–5.

Carey, S. (1978). The child as word learner. In M. Halle, J. Bresnan, & G. A. Miller (Eds.), *Linguistic theory and psychological reality* (pp. 264–293). Cambridge, MA: MIT Press.

Carey, S. (1982). Semantic development: The state of the art. In E. Wanner & L. R. Gleitman (Eds.), *Language acquisition: The state of the art* (pp. 347–389). Cambridge, UK: Cambridge University Press.

Carey, S., & Bartlett, E. (1978). Acquiring a single new word. *Proceedings of the Stanford Child Language Conference*, *15*, 17–29.

Carpenter, M., Nagell, K., & Tomasello, M. (1989). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, *63* (Serial No.255).

Casenhiser, D., & Goldberg, A. (2005). Fast mapping between a phrasal form and meaning. *Developmental Science*, *8*, 500–508.

Clark, E. V. (2003). *First language acquisition*. Cambridge, UK: Cambridge University Press.

Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A., & Trueswell, J. C. (2005). Hard words. *Language Learning and Development*,*1*, 23–64.

Graf Estes, K., Evans, J. L., Alibali, M. W., & Saffran, J. R. (2007). Can infants map meaning to newly segmented words?: Statistical segmentation and word learning. *Psychological Science*, *18*, 254–260.

Jusczyk, P. W., & Hohne, E. A. (1997). Infants' memory for spoken words. *Science*, *277*, 1984–1986.

Katz, N., Baker, E., & Macnamara, J. (1974). What's in a name? A study of how children learn common and proper names. *Child Development*, *45*, 469–473.

Merriman, W. E., & Tomasello, M. (1995). Introduction: Verbs are words too. In M. Tomasello & W. E. Merriman (Eds.), *Beyond names for things* (pp. 1–18). Hillsdale, NJ: Erlbaum.

Quine, W. V. O. (1960). *Word and object*. Cambridge, MA: MIT Press.

Swingley, D. (2005). Statistical clustering and the contents of the infant vocabulary. *Cognitive Psychology*, *50*, 86–132.

Swingley, D. (2007). Lexical exposure and word-form encoding in 1.5-year-olds. *Developmental Psychology*, *43*, 454–464.

Tincoff, R., & Jusczyk, P. W. (1999). Some beginnings of word comprehension in 6-month-olds. *Psychological Science*, *10*, 172–175.

Yuan, S., & Fisher, C. (2009). Really? She blicked the baby?: Two-year-olds learn combinatorial facts about verbs by listening. *Psychological Science*, *20*, 619–626.