6 The mechanism of lexical development: implications from Japanese children's word learning

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Background

Young children face a serious problem of induction in word learning, as there are virtually an unlimited number of candidates for the meaning of a word that can be induced from a single referent (Quine, 1960). However, researchers have converged on the view that young children do not go astray in the labyrinth of the induction problem. Children possess a certain set of principles or biases about how words are mapped onto their meanings, and these principles/biases enable them to map a word to its meaning even at the first exposure to the word (e.g. Gleitman, 1990; Markman & Hutchinson, 1984). For example, young children assume that a new word (noun) refers to the entirety of the referred entity rather than its part, color, texture, or material (Markman, 1989; Landau, Smith & Jones, 1988). They also assume that the word denotes a category, and hence that it should be generalized to other objects of like kind (Hall, 1991; Markman & Hutchinson, 1984). It has been also shown that children use shape similarity as a basis for determining what objects are of "like kind" and what are not (e.g. Golinkoff et al., 1995; Imai, Gentner & Uchida, 1994).

At the same time, these so-called constraint theories are not sufficient to fully explain young children's lexical development, because while word learning constraints/biases help learning of basic-level object category names, they do not help learning of other types of nouns such as substance names, proper names, subordinate and superordinate category names. In other words, the word-learning constraint theories say very little about how children infer meanings of words that are not basic-level object category names.

In this chapter, I discuss how Japanese children learn various types of nouns. In each section, I specify how data from Japanese children can advance our understanding of issues that have been much debated in the literature. I then discuss the implications and insights drawn from the Japanese data for our understanding of the general mechanism of lexical development.

How do children learn nouns other than non-basic-level object category terms?

As stated earlier, the grammatical category "noun" is divided into subclasses that are governed by different extension principles. Well-known word-learning biases such as the whole-object bias, the shape bias/noun-category bias, and the mutual exclusivity bias can constrain the inference of a particular type of noun, i.e. basic-level object names, fairly well. However, obviously, a theory of lexical acquisition must explain how children learn words other than basic-level object category names, including substance names, proper names, and non-basic-level object category names (e.g. subordinate and superordinate category names).

In order for children to learn the meanings of a full range of nouns, it is crucial that they be able to identify a novel word's syntactic class and have knowledge of how each syntactic form class maps onto the corresponding conceptual class. In fact, some researchers have gone so far to argue that with this knowledge, together with other abilities children can recruit (e.g. ability to infer the speaker's intention), word-learning biases are not needed to explain the mechanism of early word learning (e.g. P. Bloom, 1994).

However, not all languages in the world syntactically distinguish the different types of noun that English does. In English, it so happens that there is a high correlation between semantic (ontological) classes and grammatical form classes. That is, individuated entities, typically solid objects, are mapped onto count nouns, while nonindividuated entities, typically substances, are mapped onto mass nouns. Furthermore, among names for individuated entities, names for particular individuals (i.e. proper nouns) are syntactically distinguished from names for object kinds, in that count nouns, but not proper nouns, occur with determiners (e.g. P. Bloom, 1994).

By contrast, different semantic classes of nouns are not syntactically distinguished in Japanese: there is no grammatical apparatus which distinguishes between proper nouns and common nouns, nor is there any grammatical distinction between names for individuals (coded as count nouns in English) and names for nonindividuals (coded as mass nouns in English). Moreover, there is no syntactic device marking the singular/plural distinction. Thus, the following five English expressions, "This is *a dax* (single instance of an object category)," "Those are *daxes* (multiple instances of an object category)", "This is *some dax* (material name)," "This is *dax* (property)," "This is *Dax (proper name)*" are all translated into a single expression, "Kore (This) wa (Topic/Subject marker) *dax* desu (IS)." In other words, when someone hears "Kore wa *dax* desu" without seeing the named entity, there is no way of inferring whether *dax* refers to a single object, multiple objects, a substance, a property (such as color), or a particular individual.[1]

[1] See Imai and Mazuka (2003) and Imai and Haryu (2004) for more detailed description of linguistic properties of Japanese.

For this reason, how Japanese children learn different classes of nouns is of great interest for theories of lexical development. Can Japanese children learn substance names as well as object names, applying different extension principles for object names and substance names? How do Japanese children determine whether a noun given to an object is a common name or a proper name for the object? How do they learn non-basic-level object category names? We will deal with these questions in turn.

Can Japanese children learn substance names as well as object names?

In order for children to learn names for substances, the whole object bias and the shape bias must be relaxed. Previous studies have demonstrated that English-speaking children do attend to cues from syntax for learning object names and substance names from very early stages of word learning (Soja, 1992; Subramanyam, Gelman & Landau, 1999). An extremely interesting and important question is whether Japanese children learn substance names in the absence of direct syntactic cues. Philosopher Quine argued that children come to learn the ontological distinction between objects and substances only through the observation that the two types of the concepts are distinguished by syntax (Quine, 1969). If Quine is correct, then Japanese children would not understand the ontological distinction, and hence would project word meanings randomly onto any salient perceptual property, be it color, shape, material, texture, and so forth, when a word is given either to an object or to a substance.

Imai and Gentner (1997) compared Japanese children and English-speaking children in a novel noun generalization task in which a novel noun was given to an object or a substance, and asked whether Japanese children would be able to project word meanings ontologically correctly (i.e. to project the meaning onto shape when a word was associated with an object, and project the meaning onto material when a word was associated with a substance), just as English-speaking children do (Soja, Carey & Spelke, 1991). Imai and Gentner found that both Japanese speakers and English speakers from 2 years of age through adulthood were able to project word meanings differently for objects and substances, and, by and large, to do so ontologically correctly. When a novel noun was given to a complex-shaped object, they projected the meaning based on shape; when it was given to a nonsolid substance, they projected the meaning based on material.

However, the crosslinguistic data also suggest that the linguistic structure of the speaker's native language influences his or her construal of individuation for a particular type of entity, that is, entities whose perceptual saliency is weak and ambiguous with respect to the status of individuation. English speakers, both children and adults, uniformly construed simple-shape solid entities

(e.g. a kidney-shaped lump of wax) as individuated objects, and projected the meaning of a novel word onto shape. In contrast, Japanese children did not show unambiguous construal for these entities, and in fact Japanese adults showed a preference for construing them as nonindividuated chunks of substances.

Imai and Gentner's (1997) results thus suggest that children can learn object names and substance names even when object names and substance names are not syntactically distinguished;[2] yet there is also influence from the structure of the speaker's native language when the referred entity's perceptual saliency is low. In short, their results showed that children can constrain the application of the whole object bias and the shape bias using ontological knowledge, whether or not their native language grammatically marks the ontological distinction (see also Soja, Carey & Spelke, 1991); at the same time, however, the range of application of these biases may be influenced by the structure of speakers' native language (see Imai & Mazuka, 2003, for more detailed discussion of this issue).

Learning common names and proper names

Many studies have shown that children assume that a label associated with an object refers to a object category (e.g. Golinkoff et al., 1992; Hall, 1991; Haryu & Imai, 2002; Imai, Gentner & Uchida, 1994; Landau, Smith & Jones, 1988; Markman & Hutchinson, 1984; Waxman & Markow, 1998). However, this assumption could block learning of proper names. In the case of English, again, syntax provides useful information for children to circumvent this problem (e.g. Katz, Baker & Macnamara, 1974; Gelman & Taylor, 1984; Hall, Lee & Belanger, 2001). However, for Japanese children, this clue is not available. Can Japanese young children learn proper names at all?

To examine this question, Haryu and I studied how Japanese 2-year-olds and 4-year-olds interpret novel labels given to animals and artifacts that are either familiar or unfamiliar (Imai & Haryu, 2001). Children heard a novel noun in association with an object. Depending on the condition they were assigned to, the named object was an unfamiliar animal, an unfamiliar artifact,

[2] Interestingly, Japanese children are not likely to interpret a novel noun associated with a familiar object as a material name. Markman and Wachtel (1988) argue that children assume that a novel word given to a familiar, already labeled object is a material name because of the mutual exclusivity bias. To test this hypothesis, Haryu and Imai (2002) gave a novel label to an object children know well (e.g. a plate). They then asked the children to select another referent of the word among choice items. Of interest was whether the children would select a material item (chunks of the material the originally named object was made of) or a subordinate item (an object that was identical to the original object except for the color). Different from Markman and Watchel's prediction, the Japanese children did not interpret the novel word to be a material name; they assumed the word to be another label for the familiar object, mapping it to a category subordinate to the old, familiar category.

a familiar animal, or a familiar artifact. However, the structure of the stimuli and the procedure were identical across these four cases. The standard object was named in a sentence frame something like "Kore wa *neke* desu," where *neke* is a nonsense noun. As mentioned above, it is simply impossible to infer whether the noun is a proper noun or a common noun from the structure of the sentence.

The named object was taken out of the child's view after the naming session, and then it was presented again with four test objects. The four objects included a subordinate-level item, a basic-level item, a superordinate-level item, and a distractor. The subordinate item was identical to the original in shape, size, and material. When the original was a toy animal, the subordinate item was distinguishable from the original object by clothes and/or accessories (e.g. a hat, a ribbon, or hair-band). For the inanimate object sets, the original and the subordinate item differed only in color. The basic-level item was very similar (but not identical) to the original in shape, but was different from it in material, color, and/or size. The superordinate item had a very different appearance (both in shape and color) from the original but it came from the same superordinate category. The distractor item was drawn from a different ontological category (i.e. when the named object was a toy animal, then the distractor object was an inanimate object, and vice versa).

The five objects (the original and the four variations) were all presented in front of the child. The experimenter said to the child, "*neke* o sagashite," which could mean "find *a neke/nekes/Neke/some neke*." The child could select either a single object or multiple objects at one time. Since Japanese does not mark the singular/plural distinction, the instruction could not have biased the child toward selecting only one or selecting more than one object. The selected object(s) were put into a box, leaving the nonselected objects in front of the child. The experimenter then asked the child whether there was any more *neke* there. This procedure was repeated until she said "No" to the prompt.

Both 2-year-old and 4-year-old Japanese children interpreted the noun as a common name, whether it was given to a toy animal or an inanimate object, more than 85 percent of the time for both conditions. Among the possible common noun interpretations (i.e. subordinate, basic-level, superordinate responses), the basic-level interpretation was made most frequently. This suggests that, when Japanese children hear a novel noun associated with an unfamiliar object, either animate or inanimate, they assume the noun to refer to a category, and generalize it to other shape-similar objects.

When a novel name was given to a familiar object, the Japanese children's response pattern was very different, however. Interestingly, they did not show much difficulty in accepting novel labels given to the familiar objects, which contradicted the mutual exclusivity bias (Markman & Wachtel, 1988), but was consistent with the principle of contrast (Clark, 1987). Even more interesting

was that the children interpreted a novel noun differently across the cases when the named object was an animal and when it was an artifact. The children who heard a label in association with a familiar animal interpreted the noun as a proper name, whereas those who heard it in association with a familiar artifact interpreted the new noun as a subordinate category name.[3]

Role of word-learning biases in lexical development

The results of studies reviewed above show that, by 2 years of age, Japanese children know different subclasses of nouns, even though their syntax does not indicate what subclass of the noun category a given noun belongs, together with extension principles that govern each subclass of nouns. This suggests that children possess much richer knowledge about the noun lexicon than just the so called "word-learning biases" from very early stages of word learning (see also L. Bloom, 1993; Haryu & Imai, 2002; Hollich, Hirsh-Pasek & Golinkoff, 2000; Imai & Haryu, 2004 for similar views). Coordinating the knowledge they have about the lexicon and cues that are available in a given situation (e.g. the denoted entity's perceptual properties, the speaker's eye-gaze and facial expression, and so on), they are able to control word-learning biases to learn non-basic-level object names as well as basic-level object names.

On the other hand, the way Japanese children learn different types of nouns suggests that word-learning biases are indeed necessary, contrary to some researchers who are dubious about the necessity of the word-learning biases for early word learning (P. Bloom, 1994; L. Bloom, 1993; Nelson, 1988; Tomasello, 1997). Because a noun's subclass is not syntactically marked, without any assumptions about what a noun typically refers to and how it is generalized, it would be very difficult for Japanese children to get started in the endeavor of word learning. For efficient word learning, it is important that children have a system that allows them to make a reasonable and plausible inference about the meaning of a newly introduced word even when there is little prior knowledge about the named object or few external resources to rely on for the inference. Word-learning biases serve this purpose, providing children with a default solution when other constraints are not immediately available in a given situation or when children do not have sufficient knowledge about the domain of the concept the new word refers to.

[3] However, when a named artifact had an shape atypical of the familiar category, children mapped the novel label to a category mutually exclusive to the familiar category, excluding the newly named object from the old category. Thus, children do not have a fixed assumption that a new word should be mapped onto to a subordinate category. Rather, they flexibly shift their interpretation to satisfy both the principle of contrast and the shape bias (see Haryu & Imai, 2002, for detailed discussion).

The contribution of Japanese data to the noun–verb debate

I have so far reviewed how Japanese children infer the meanings of novel nouns and discussed the implications of the Japanese data for theories of noun learning. Moreover, Japanese data can make important contributions with regard to many other issues and debates in the literature of lexical acquisition. For example, researchers have noted that Japanese is a very important language for the debate over the question of whether noun learning universally takes place in advance of verb learning (e.g. see Murase & Ogura, this volume, chapter 2; Oshima-Takane, this volume, chapter 7; see also Gentner, 1982; Tardif, 1996). Results from my laboratory suggest that this is in fact the case. Unlike most other studies addressing this question, which use the checklist or corpus data as an index of relative ease of noun/verb learning, we examined how children generalize a novel noun and a novel verb presented during an ongoing action event (Imai, Haryu & Okada, under review; see also Imai & Haryu, in press). While 3-year-old Japanese children had no problem generalizing a novel noun to a new instance, they could not generalize a novel verb to the same action when the object used in the action was replaced with a different one. A parallel study with English-speaking children showed a markedly similar pattern (Meyer et al., 2003). Together, these results support the view that verb learning is more difficult than noun learning independently of the distributional properties of the language children learn, and that the relative ease is determined by the conceptual complexity and abstractness of the word class. When a domain of concepts is simple and well organized, children can readily extract rules (principles) and learn words in the domain rapidly by applying the rules. In contrast, when a domain is abstract and complexly structured, children may experience difficulty in learning a word in that domain no matter what linguistic cues they receive, or how often they hear the word.[4]

Concluding remarks

Researchers have come to agree that, to draw a full picture of early lexical development, it is crucial to investigate how children learn words across wide range of word classes in a wide range of languages (e.g. Hollich et al., 2000; Imai, 1999; Woodward & Markman, 1998). Children are very flexible and adaptive in learning words in the sense that they take different routes in learning words to

[4] Classifier acquisition is another good example. Children hear common animal classifiers and shape classifiers (e.g. *hiki*, *tou*, *ko*, *mai*, *hon*) very frequently, especially since mothers use only limited types of classifiers when talking to young children (Naka, 1999). Despite this, young children have extreme difficulty in sorting out the semantics of these most frequent classifiers (Uchida & Imai, 1999). This is presumably because the meanings of these frequent classifier classes are extremely complex and ill-structured, with many exceptions.

accommodate the structure of the target domain of words in the language they are learning. At the same time, there seem to be universal patterns that emerge independent of the structure or the input properties of the language children are learning, which in turn suggests that language-universal constraints are at work in early word learning.

Future research must specify exactly how children utilize and coordinate different cognitive resources, including nonlinguistic cognitive and/or perceptual biases, word-learning biases, knowledge about the syntax–semantics interface and the ability to recruit social-pragmatic cues, and how these cognitive resources interact with the structure of the language children are learning and the perceptual/conceptual properties of the concepts words refer to (see also Haryu & Imai, 1999; Imai, 1999; Imai & Haryu, 2004; Uchida & Imai, 1999). For this goal, we cannot put too much emphasis on the importance of crosslinguistic comparison of how children learn words in different lexical domains. Given the linguistic properties of the Japanese language, I end this chapter noting that Japanese data can make an invaluable contribution to our understanding of the nature and mechanism of early word learning.