The nature of word learning biases and their roles for lexical development: From a cross-linguistic perspective.

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INTRODUCTION

Many researchers have argued that children have a certain set of principles or biases about how words are mapped onto their meanings, and that these principles/biases enable them to map a word to its meaning even at the first exposure to the word (e.g., Markman & Hutchinson, 1984, Markman, 1990). Among the proposed principles or biases, the whole object bias, the taxonomic bias/the noun category bias, the shape bias, the mutual exclusivity bias, and the principle of contrast have attracted much attention and generated a massive body of research (e.g., Clark, 1987; Hall, 1991, 1994; Imai, Gentner & Uchida, 1994; Golinkoff, Mervis, & Hirsh-Pasek, 1994; Landau, Smith & Jones, 1988; Markman & Hutchinson, 1984; Markman & Wachtel, 1988; Waxman & Markow, 1995). Although most of the existing literature has converged into a view that these biases/principles are used by children from a very early age, there has been much debate with respect to the specific nature of each of these biases/principles. For example, are they available prior to the onset of word learning and applied from the first word (e.g., Hollich et al., 2000; Waxman & Markow, 1995)? Are they universally applied irrespective of any specific linguistic properties of the input language (e.g., Imai & Gentner, 1997; Waxman, Senghas, & Benveniste, 1997)?

A more serious problem that has remained unanswered, however, arises from the fact that all of these biases must be suspended or relaxed in some circumstances (Imai, 1999). That is, although these word-learning biases can constrain the possible search space in mapping words onto concepts if applied in appropriate situations, they could also block the learning of a substantial portion of vocabulary if applied in

inappropriate situations. For example, the whole object bias should not be applied when a child learns a name for a substance, such as *water*, *sand*, and *sugar* (Soja, Carey, & Spelke, 1991; Imai & Gentner, 1997; Imai & Mazuka, in press). Learning names for specific individuals, i.e., proper nouns, requires suspension of the taxonomic bias/ the noun category bias (Hall, 1991; Imai & Haryu, 2001; see also Woodward & Markman, 1998). The mutual exclusivity bias must be relaxed in order for a child to learn category names at different levels of the taxonomic hierarchy as well as names for particular individuals (Gelman & Taylor, 1984; Hall, 1991; Imai & Haryu, 2001; Taylor & Gelman, 1989; Waxman & Senghas, 1992). In sum, word learning biases alone would not function properly unless their applications were appropriately controlled.

Are young children able to control word learning biases in such a way that they would be used only in appropriate situations? The literature suggests that 2-year-olds' vocabulary includes non-object words such as names for substances and events as well as proper names (e.g., Bloom, Tinker & Margulis, 1993; Nelson, Hampson, & Shaw, 1993). This suggests that young children's word learning is not restricted to basic-level object category terms, and in turn means that the word learning biases are somehow suspended for the learning of those words. How, then, do children control and constrain the application of the biases? Furthermore, are the word learning biases necessary for word learning at all on top of other types of resources that can constrain word meanings such as semantic/ontological knowledge, social-pragmatic knowledge and clues provided from syntax? Are the biases universally available independent of the native language or influenced by the structure of a specific language?

In this paper, we will discuss these issues from a crosslinguistic perspective, mainly comparing word learning in English-speaking and Japanese-speaking children. Japanese has linguistic properties that provide interesting contrasts to English. In English, it so happens that there is a high correlation between semantic (ontological) classes and syntactic classes. That is, individuated entities, typically solid objects, are mapped onto count nouns, while non-individuated 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). Many studies have reported that English-speaking children utilize this information from syntax in inferring word meanings (e.g., P. Bloom & Keleman, 1995; Gelman & Taylor, 1984; Soja, 1992; Subrahmanyam, Landau, & Gelman, 1999). In fact, some researchers 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 necessary to explain the mechanism of early word learning (e.g., P. Bloom, 1994; see also L. Bloom, 1993; Nelson, 1988; Tomasello, 1997).

In contrast to English, different classes of nouns are not grammatically distinguished in Japanese. Thus, data from Japanese children give us a way of assessing the role of the word learning biases more directly than when studying English-speaking children. Furthermore, the comparison of how Japanese- and English- speaking children assign meanings for a novel noun in various situations should give us important insights into the issue of universality in early lexical development. In the next section, we provide a somewhat detailed description of the

properties of Japanese, highlighting differences from English. We then discuss how Japanese children apply or suspend the whole object bias, the shape bias, the noun category bias (the taxonomic bias) and the mutual exclusivity bias.

Linguistic properties of Japanese

As mentioned earlier, in Japanese, there is no grammatical apparatus distinguishing 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 one 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.

One may wonder if there is absolutely no syntactic device in Japanese that flags the distinction among proper names, object category names or substance names. Especially those who know that Japanese is a numeral classifier language may think that the noun's form class can be revealed or at least suggested by classifier use. However, a classifier is not obligatory at all, only appearing with a numeral. A new word is typically introduced in the sentence frame "Kore wa X desu." Note that in this sentence, no classifier appears. In fact, unless mention of number is contextually

required, the numeral + classifier construction is not usually used. Furthermore, even when a noun appears with a classifier, many classifiers, including the ones most frequently used such as *hon*, *ko*, and *hai*, are not very strong identifiers of the noun's form class. For example, although *hon* is usually characterized as a classifier for long, thin *object*, what is crucial to the meaning of *hon* is the long and thin shape; class members do not need to be objects at all. For example, a typical substance such as butter can appear with *hon*. The sentence "butaa (butter) o (Acc) ni (2) *hon* totte" (Please get me two *long-thin shaped* butter) is acceptable, and on hearing the sentence, the hearer usually interprets it as meaning that the speaker wants two *sticks* of butter based on contextual/pragmatic knowledge. Likewise, *hai*, a measuring classifier that is roughly translated as "*a container full of* "can appear both with nouns referring to substances (e.g., water, rice, etc) and objects (e.g., olives, beans, and any other relatively small objects).

As for distinguishing proper nouns from common nouns, one may think that honorific titles such as *san* (for general courtesy) and *chan* (usually for children and people who are very close to the speaker) signal that a noun is a proper noun. However, again, many proper nouns do appear without an honorific title. Proper names for animals and places do not usually appear with such a title, and even names for people frequently appear without it. Furthermore, in child-directed speech, adults sometimes add -*san* or -*chan* to common nouns, often for animals but sometimes even for non-animals (e.g., neko (cat)-chan, ninjin (carrot)-san) to express intimacy or affection. Thus, the use of honorific titles is not a very reliable cue for determining whether the given noun is a proper noun.

CONTROLLING THE WHOLE OBJECT BIAS AND THE SHAPE BIAS

In order for children to learn names for substances, the whole object bias and the shape bias must be suspended. In the absence of direct social-pragmatic cues and syntactic cues, can Japanese children learn substance names, correctly suspending these biases in learning names of substances? Imai and Gentner (1997) asked whether Japanese children are able to generalize novel nouns in an ontologically correct fashion, extending a noun associated with an object on the basis of shape but extending a noun associated with a substance on the basis of material identity, just as English-speaking children whose language does mark the ontological distinction between object kinds and substance kinds (Soja, Carey, & Spelke, 1992). They found that both Japanese speakers and English speakers from 2-years of age through adulthood are able to project word meanings differently (and ontologically correctly) depending on whether a novel label referred to a complex-shaped object or a non-solid substance. However, the crosslinguistic data also suggest that the linguistic structure of the speaker's native language influences people's construal of individuation for particular type of entities, that is, entities whose perceptual saliency is weak and ambiguous. English speakers uniformly construed such simple-shape solid entities (e.g., a kidney-shaped lump of wax) as individuated objects. In contrast, Japanese children's construal for these entities split between individuated and non-individuated; Japanese adults in fact showed preference for construing them as non-individuated chunks of substances.

Imai and Gentner's (1997) results thus suggest that word learning is constrained by ontological knowledge even without explicit syntactic markers; 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 application of the whole object bias and the shape bias are constrained by this early and universally present ontological knowledge (see also Hall, 1996; Soja et al., 1991); but at the same time, they showed that the range of application of these biases may be influenced by the structure of speakers' native language (see Imai & Mazuka, in press, for more detailed discussion of this issue).

CONTROLLING THE TAXONOMIC/NOUN CATEGORY BIAS

It has been reported that children have a disposition to extend labels to other objects of like things, and this disposition has been characterized as the taxonomic bias, the noun category bias, the principle of category scope, or the shape bias (e.g., Golinkoff et al., 1992; Hall, 1991; Imai, Gentner & Uchida, 1994; Landau et al., 1988; Markman & Hutchinson, 1984; Waxman & Markow, 1998). However, this disposition could block learning of proper names unless appropriately controlled. In the case of English, syntax provides useful information for this problem, since proper nouns and common nouns are syntactically distinguished. However, for Japanese children, this source of information is not available. We now discuss how Japanese children deal with this problem.

Earlier studies have demonstrated that English-speaking children do utilize information provided from syntax in inferring the meaning of a new word from a very early age (Katz, Baker & Macnamara, 1974; Gelman & Taylor, 1984; Soja, 1992; Hall, Lee, & Belanger, 2001; Waxman, 1999; Waxman & Markow, 1998 see also Imai, 2000). Then, can Japanese children select the single most appropriate interpretation out of several competing alternatives without this useful clue from

syntax? To examine this question, we studied how Japanese 2-year-olds and 4-year-olds interpret novel labels associated with animals and artifacts that are either familiar or unfamiliar (Imai & Haryu, 2001).

Naming unfamiliar objects

We first report how Japanese children interpreted novel nouns associated with unfamiliar objects in our study (Imai & Haryu, 2001). The children were randomly assigned to the *animal* condition or to the *inanimate* condition. The structure of the stimuli and the procedure were identical across the two conditions, the only difference being that the unfamiliar objects for the one group consisted of toy animals and of inanimate objects for the other (see Figures 1ab). An unfamiliar object was named in a sentence frame something like "Kore wa *neke* desu," where *neke* is the target 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, although we know that, based on the results of Imai and Gentner (1997), the child would be unlikely to interpret the noun as referring to a portion of the named object or to the material of it, since the labeled objects in this study were all objects with a complex structure.

The named object was taken out of the child's view after the naming session, and then it was presented again with four other objects. The four objects included a subordinate-level item, a basic-level item, a superordinate-level item, and a distractor (see Figures 1ab for a sample set). 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. A 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 would not bias the child toward selecting only one or more than one object. The selected object(s) were put into a box, leaving the non-selected objects in front of the child. The experimenter then asked her whether there was any more *neke* there. This procedure was repeated until she said "No," to the prompt.

The following patterns were predicted: (1) if the child interpreted the noun as a proper name, she would be expected to select only the named object; (2) if she interpreted the noun as a common noun, she should select multiple objects; (3) if the child observed the shape bias and the noun category bias, she should extend the label up to the basic-level item (i.e., selecting the original, the subordinate item and the basic-level item) but not to the superordinate item.

The child's response in each trial was classified into one of five mutually exclusive response categories: *Proper-noun* response, *Subordinate* response, *Basic-level* response, *Superordinate* response and *Unclassifiable* response. Note that, selecting a particular item (for example, a basic-level item) by itself did not lead to a

credit for the particular response. Instead, to be credited as the subordinate, the basic-level, or the superordinate response, *a single particular combination* of the items was required out of 32 (2^5) possible response patterns. For example, the child received a point for the Subordinate response *only when* she selected both the standard and the subordinate item, and rejected the three remaining objects as referents. To receive a point for the Basic-level response, *all and only* the standard, the subordinate item, and the basic level items must be selected. To be counted as the Superordinate response, all of the standard, subordinate, basic-level, superordinate items but not the distractor must be selected. Likewise, in order for a response to be coded as a Proper noun response, the child must select the standard object alone and must say "no" to the question of if there is any more "X." All other 28 combinations of item selections were put into the Unclassifiable response category.

Both 2-year-old and 4-year-old Japanese children showed very clear, consistent response behavior. Furthermore, the results from the Japanese children were similar to previous results from English-speaking children (Hall, 1991). The Japanese children interpreted the noun as a common name, whether it was given to a toy animal or an inanimate object. The children made common noun interpretations (either at the subordinate, basic, or superordinate level) more than 85 % of the time for both conditions (animal: 86.4%; inanimate: 94.3%). Among the possible common noun interpretations (i.e., Subordinate, Basic-level, Superordinate responses), the Basic-level interpretation was made most frequently (47.2%). This suggests that when Japanese children hear a novel noun associated with an unfamiliar object, either animate or inanimate, they assume by default that the noun refers to a kind of object

rather than to a particular instance of the object, using shape similarity for determining the extension of the category.

Naming familiar objects

We then examined how Japanese children interpret a novel noun associated with a familiar object, whose name they already know. The structure of each stimulus set was identical to that used in the above study except that the named object was familiar to the children. Novel labels were given to instances of *bear*, *penguin* and *monkey* in the animal condition. In the *inanimate object* condition, novel labels were given to instances of *ball*, *cup*, and *spoon*. As in the unfamiliar-object case, Japanese 2- and 4-year-olds were examined; half of them were assigned to the *animal* condition, and the other half were assigned to the *inanimate object* condition.

What pattern was predicted in this study? Because children already knew the basic level names, the mutual exclusivity bias predicted that it would be difficult for them to accept the novel labels. If this would be the case, we might then expect the children to have behaved inconsistently, often showing the "unclassifiable" response or failing to show a distinct preference in response patterns. Note that the principle of contrast (Clark, 1987) did not predict difficulty in learning novel names for objects that already have a name. Rather, it predicted that children should think that the extension of the novel label would not exactly overlap with that of the extension of the basic-level category that they already know. However, since this principle would not tell children what other solutions are available and which one should be employed, Japanese children would face three possibilities to choose from: (1) the extension of the novel noun may be restricted to the named object; (2) the extension

may be broader than the basic level category; (3) the extension may be narrower than the basic level category, but not restricted to the named object.

It turned out that even 2-year-old Japanese children did not have much difficulty in accepting novel labels given to the familiar objects. Consistent with the principle of contrast, the children rarely showed a basic-level kind interpretation in either condition. Furthermore, the children's interpretation was not equally distributed across the three possible interpretations. Rather, they converged into a single interpretation, but quite interestingly, the selected interpretation differed greatly depending on the animacy status of the named object. The children who heard a novel label in association with a familiar animal interpreted the noun as a proper name 59.1% of the time, whereas those who heard a novel label in association with a familiar inanimate object made a proper name response only 9 % of the time. The children in the inanimate object condition interpreted the new noun as a subordinate category name (53%). (Remember that the base probability for making the proper noun interpretation or the subordinate interpretation was 0.03125 (1/32)).

Imai and Haryu's research thus presented a fairly comprehensive picture of how Japanese children assign meanings to novel nouns. When a novel label is given to an object that does not yet have a label, children assume that the label is a name for an object category whether the referent is an animate or inanimate object. If the named object already has an established name, and if the object is an animal, children interpret the label as a name for the particular individual rather than interpreting it as a name for a narrower or a broader category. When a novel label is given to an inanimate object, they do not interpret it as a name for a particular instance any more. Instead, they map the noun to a narrower category, i.e., a subordinate category.

Importantly, in our study (Imai & Haryu, 2001, Study 3), the Japanese 2-year-olds were able to map a novel word for a familiar animal to a subordinate category when it was presented as a compound noun (e.g., X-pengin (penguin)), consistent with results from English-speaking children (Gelman, Wilcox, & Clark, 1989). This means that Japanese children are able to utilize a linguistic clue that is available in their language to modify a default interpretation.

CONTROLLING THE MUTUAL EXCLUSIVITY BIAS

Among proposed word learning biases, the mutual exclusivity bias has been most controversial (e.g., Clark & Svaib, 1997; Merriman & Bowman, 1989; Mervis, Golinkoff, & Bertland, 1994; Waxman & Senghas, 1992). The mutual exclusivity bias is helpful if children only need to learn basic-level category labels that are mutually exclusive to one another. However, many words are not basic-level category terms, nor are mutually exclusive to one another. Thus, the bias could potentially block learning of a substantial part of lexicon. Nonetheless, as mentioned earlier, children's early vocabulary includes words that are not basic level terms (L. Bloom et al., 1993; Nelson et al., 1993). Furthermore, there is much empirical evidence that children as young as 2-year-olds accept multiple labels referring to the same object (e.g., Clark & Svaib, 1997; Gelman & Taylor, 1984; Imai & Haryu, 2001; Mervis et al., 1994; Waxman & Senghas, 1992).

On the other hand, in certain situations, the mutual exclusivity bias may actually foster word learning. It has been known that children have difficulty in learning names of solid materials such as 'wood' and 'plastic', since they (particularly English-speaking children) have a strong bias toward construing a solid, discrete

entity as a individuated object rather than a substance (Dickinson, 1988; Soja et al., 1991; Imai & Gentner, 1997; but see Prasada, 1993). However, when a child hears a new word in association with an object whose first label has already been learned, because she is unwilling to accept the new word as an another label for the object itself, she may turn her attention to the material kind and willingly interpret the word as a material name (Markman & Wachtel, 1988; Markman, 1990). Another situation in which the mutual exclusivity bias may foster word learning is when a child has overgeneralized the word. In this case, the mutual exclusivity bias might be beneficial for restructuring the overextended category. In this section, we consider under what conditions children are likely to show the bias and under what conditions they are likely to override it. Following that, we discuss how this bias might interact with other factors, and then what the true nature of the bias might be.

When is the mutual exclusivity bias most likely to be observed?

Evidence for the mutual exclusivity bias has been most clearly obtained by showing children a familiar object whose label has been already learned and an unfamiliar, novel object at the same time. Markman and Wachtel (1988) showed 3-year-old American children a familiar object (e.g., a cup) and another object unfamiliar to children of this age (e.g., tongs). Then the experimenter asked the children,"Show me the *dax*". To this request, the children tended to select the unfamiliar object. Markman and Wachtel further demonstrated that children tended to map a novel word to the unfamiliar object over the property of the familiar, already named object even if the noun was given in a mass noun syntactic frame ("Show me *pewter*"). Markman and Wachtel argued that the children selected the unfamiliar object even in the face of contradicting clue from syntax because selecting the object

whose name had been already known as the referent of the novel word would violate the mutual exclusivity bias.

Further strong evidence for the mutual exclusivity bias has been reported in a study with Japanese children. Haryu (1991; see also Haryu & Imai, 1999) presented Japanese 3- and 5-year-old children with two objects, a familiar object (e.g. an apple) and an unfamiliar object (e.g., a lipstick holder). The children were assigned either to the *word only* condition or to the *word+pragmatic context* condition. In the *word only* condition, each child was presented with two objects, one familiar object and the other unfamiliar, and was asked to identify the referent of a new word. In the *word+pragmatic context* condition, a new word was presented in a context suggesting that the experimenter intended to refer to the familiar object. For example, the experimenter introduced a puppet named Mary, and said to the child, "Mary is hungry now. I would like to give Mary (the) *heku*.", where '*heku*' was a nonsense word. Then the experimenter placed two objects, a familiar object (e.g., an apple) and an unfamiliar object (e.g., a lipstick holder), in front of the child, and asked her to select the *heku*. In this situation, the child faced a dilemma, if they indeed had the mutual exclusivity bias. The context suggested that the puppet wanted the familiar object, not the unfamiliar, nameless object.

There was a large interaction between *condition* and *age*. The children in the *word only* condition, regardless of their age, tended to select the unfamiliar object as the referent of the new word, replicating the finding by Markman and Wachtel (1988). However, in the *word+pragmatic context condition*, the 3-year-olds and 5-year-olds responded very differently. The 5 year-olds accepted the new word as another name for the familiar object, respecting the contextual information and overriding the

mutual exclusivity bias. In contrast, the 3-year-olds selected the unfamiliar object. That is, they gave the mutual exclusivity bias priority over the pragmatic-contextual information. Note that this response behavior of the 3-year-olds was not due to an inability to understand the pragmatic information given. In a control study, different 3-year-old children were asked to select between the same familiar and unfamiliar objects with the same contextual cue, but without the invocation of novel words (e.g., "Mary is hungry. Which one do you think Mary wants?"). This time, the 3-year-olds selected the familiar object, incorporating the pragmatic-contextual information. These results seem to indicate that, at least for children aged three and under, the bias toward mapping a novel label to a novel, nameless object is very strong--in fact, strong enough to override social/pragmatic information provided in the discourse.

Overriding mutual exclusivity to establish lexical hierarchies

On the other hand, the literature suggests that children as young as 2-years of age do possess different words referring to the same object in their vocabulary (Clark and Svaib, 1997), and that under certain conditions, young children are able to establish lexical hierarchies (Gelman & Taylor, 1984; Imai & Haryu, 2001;Taylor & Gelman, 1989; Waxman & Senghas, 1992). Below, we consider in what circumstances young children are able to learn that there are multiple labels sharing the same referents.

Gelman and Taylor (1984; Taylor and Gelman, 1989) taught 2-year-old English-speaking children a new noun for a familiar object, and assessed their interpretation of the relationship between the new noun and the familiar name. They found that the children often interpreted the new word as referring to a category that was subordinate to the category denoted by the familiar name. In particular, English-

speaking children utilized both clues from syntax and semantic knowledge. When a new noun was provided as a common name ("This is *a* X"), the children interpreted it to be a subordinate category name regardless of whether the named object was a toy animal or an inanimate object. When a new noun was introduced in a proper name syntax ("This is X"), the children interpreted it to be a proper name as long as the named object was a toy animal; however, when the named object an artifact object such as a ball, their responses became random.

As reported earlier, Japanese 2- and 4-year-olds mapped a new noun associated with a familiar artifact object to a subordinate category (Imai & Haryu, 2001). When a novel noun was associated with a familiar animal, they preferred the proper name interpretation to the subordinate category interpretation. Thus, results from studies with English-speaking and Japanese-speaking children both suggest that young children are willing to accept more than one label for one object, especially when the named object is explicitly pointed to.

Learning material names via the mutual exclusivity bias?

Imai and Haryu's study described above provides evidence that young children are able to override the mutual exclusivity bias. However, this may have been due to the particular way the stimulus set was constructed in their study. That is, in their stimulus materials, the artifact objects that were identified as referents of the novel word were made out of the same material kind. It is possible that Japanese children prefer to interpret the label to be a name of the material when they were put in a situation where two interpretations were pitted against each other. This possibility needs to be examined especially given that Japanese does not syntactically distinguish the two interpretations. Imai and Gentner's (1997) study demonstrated

that the material name interpretation is unlikely to be made by Japanese children (nor by English-speaking children) when the named entity is a solid and complex-shaped *novel* object. However, when the child knows the first label of the newly named object, the story may be different. In fact, this is exactly what Markman and her colleagues predicted (Markman & Wachtel, 1988; Markman, 1990). According to them, the mutual exclusivity bias helps children override the whole object bias and fosters learning of material names. Thus, if we set up a situation in which children can map a new word for a familiar object either to the material of the object or to a subordinate category, children should prefer the former option, especially given that the syntax does not provide any clue for either option.

In our recent research (Haryu & Imai, in press), we examined this question. Monolingual Japanese 3-year-old children were tested on five sets of stimuli. Each set consisted of a standard object and 4 test objects: a standard, a subordinate item, a material item, and a distractor. The standard object was an object even three-year-old children could easily name, but made out of a material whose name had not yet been learned by the children of this age (e.g. a plate made out of cork). The subordinate item was identical to the standard object in shape, size, and material but distinguishable from it by the color of the pattern painted on the surface. The basic-level item was very similar (but not identical) in shape to the standard, but was different from it in material and overall color (e.g. a metal plate). The material item was a portion of the material the standard object was made out of (e.g., a chunk of cork). The distractor item came from a different ontological category from the standard (e.g., a stuffed animal).

We first confirmed that the children would name the standard and the subordinate item with the familiar basic-level name. To ensure this, before test trials, the children were shown the objects in each set, and asked to select all the referents of the familiar name. For example, in the plate-set, the child was asked, ("Osara wo totte (Get me (a) plate)," and this question was repeated until she said that there was no more plate. All the children met this prerequisite, using the familiar name to refer to the standard object, the subordinate item and the basic-level item in all the sets.

The experimenter then presented a child with a standard object and named it with a novel word, saying, for example, "Kore wa *heku* desu." As mentioned before, in the sentence "Kore(This) wa (Topic/ Subject marker) *heku* (a novel word) desu(is)," it is not clear whether the novel word *heku* is a name for an object category, a name for a material, or a name for a particular individual, although the last interpretation would be very unlikely for the type of objects used in this study, as demonstrated by Imai & Haryu (2001). After learning the new word, the child was shown the four choice objects and asked to indicate which she thought was (were) the referent(s) of *heku*. As stated earlier, because Japanese does not make the singular/plural distinction, the child could select either a single object or multiple objects at one time. She was then asked whether there was/were any more *heku(s)*, and this prompt was repeated until the child said "no". This procedure was repeated on each of the five sets.

The child's response in each trial was classified into one of the four mutually exclusive categories: *Synonymous* response, *Subordinate Category* response, *Material* response, and *Other* response. A child's response was coded as a Synonymous response if a child chose both the subordinate item and the basic level item but not the

material item or the distractor item, while it was coded as a Subordinate Category response if she selected only the subordinate item. If a child selected the subordinate item and the material item, but not the basic-level item or the distractor item, the response was coded as a Material response. Any other response patterns were put into the Other response category.

The children did not show the mutual exclusivity bias in this situation. That is, even though they had a clear option of mapping the new word to the material of the named object to avoid allowing multiple labels for it, the Japanese children did not choose this option. Instead, they interpreted it to be a subordinate category name. This suggests that, although children have a bias toward mapping a new word to a novel object when a novel, nameless object is present, this does not mean that they have a belief that nouns denote mutually exclusive categories. When a familiar object receives a novel name, children by default assume that the noun refers to the object in its entirety rather than a material, and look for a category that has a different boundary from the old, familiar category to map the new noun. To interpret it to be a material name perhaps requires additional pragmatic/contextual clues (cf. Prasada, 1993).

In any case, when a familiar artifact was named with a novel noun, the Japanese children did not interpret it to be a proper name or a material name. Rather, they mapped it to a subordinate category. However, this solution is not the only possible one available to children under this circumstance. As mentioned earlier, when a child has overgeneralized the word, a new label may be interpreted as a co-hyponym of the familiar category (i.e., as a word contrastive to the familiar word at the same level of lexical hierarchy), and this would subsequently result in restructuring the old category. For example, suppose a child who has originally

included sheep in the "dog" category. Hearing a new word "sheep" might narrow down the over-extended "dog" category by establishing the category "sheep" (Clark, 1987). In the next section, we discuss under what situations this restructuring process may occur.

Narrowing down overextended categories

Evidence for spontaneous restructuring of overextended category by the introduction of a new word has been limited in diary studies (Clark, 1973; Leopold, 1939-1949, cited in Clark, 1987). Several researchers investigated whether young children were able to modify an overextended category by the introduction of a novel word in experimental settings and failed to find clear evidence that children, especially those under 4 years of age, spontaneously modify the overextended category and establish a new category that is contrastive to the existing one (Banigan & Mervis, 1988; Merriman, 1986; Taylor & Gelman, 1989).

Thus, the results to date seem to suggest that restructuring of overextended categories does not take place easily by simply introducing a new word to an object whose first label had been already learned. In contrast, as reviewed above, there is ample evidence that children do not have much difficulty mapping a new noun to a subordinate category. Does this mean that, when a new noun is associated with a familiar artifact object, children only consider the subordinate category interpretation and do not spontaneously consider the possibility that the word is contrastive to (hence *co-hyponym of*) the old word at the same level of the lexical hierarchy?

We asked whether there are cases when children interpret a new noun as a co-hyponym of the already existing word and restructure the meaning of the old word, and if so, under what conditions (Haryu & Imai, in press). As stated earlier, most of

previous research has indicated that this process does not easily take place in young children (Banigan & Mervis, 1988; Merriman, 1986; Taylor & Gelman, 1989). However, a finding by Waxman and Senghas (1992) suggests that young children may sometimes establish a lexical hierarchy and sometimes establish a new category that is mutually exclusive to the old one by using similarity as a clue.

Waxman and Senghas (1992) examined two-year-olds' interpretation of two new nouns given to two unfamiliar objects both of which were members of the same superordinate category. Three pairs of objects were used for their study: (1) a horn and a flute; (2) a hook and a clip; and (3) a whisk and a pair of tongs. In each pair, they introduced each of the two words only in association with one object each. For example, they taught the word "flute" when presenting only a flute, and " horn" when presenting only a horn. They then examined whether the children would spontaneously extend one of the words (or both words) to the other object in the set. In doing this, they used two measures: children's spontaneous production of these words and their response patterns in a comprehension test.

Waxman and Senghas found intriguing patterns in children's spontaneous production. When two labels ("horn" and "flute") were given to the horn -flute pair, the children produced one word for both the flute and horn, and the other word only for one of them, suggesting that they interpreted the two words as having an inclusion relation in the lexical hierarchy. Similar results were found with the hook-clip pair. However, importantly, this pattern was observed in only these 2 sets, in which the two paired objects were relatively similar to each other. When two words were introduced for the whisk-tong pair, which turned out to be less similar than the other sets in adult judgments, the children tended to restrict each word only to the object with which

each word was originally associated. This latter production behavior suggests that the children interpreted the two words as mutually exclusive.

The findings from Waxman and Senghas' study (1992) thus indicates that similarity plays an important role for children in determining whether to map the new word onto a category subordinate to the familiar category or to narrow down the old, overextended category and establish a new category that is contrastive to the old category. Taylor and Gelman (1989) also manipulated similarity, but did not find evidence for the latter process even when the newly labeled object was 'dissimilar' by their definition. However, the 'dissimilar' test items in their studies were made such that color, size, and material were different from the named objects, and consequently, the shape of the named objects and the test objects were still fairly similar. In contrast, the items in the whisk-tong pair in Waxman and Senghas' (1992) study were quite different from each other in both shape and function.

We thus conducted two studies to examine whether children are able to shift between the two solutions using similarity as a clue. Since previous research suggests shape similarity is weighed most heavily among different perceptual dimensions in label generalizations (e.g., Landau, Smith, & Jones, 1988; Smith, Jones, & Landau, 1992), we first manipulated shape similarity.

Two sets of stimuli were used in this study, a ball-set and a spoon-set. Each set consisted of a standard object and three types of choice objects: a subordinate item, typical exemplars of the familiar category, and out-of category distractors (see Figure 1a for the contents of the spoon-set used in the typical shape condition). The standard object was an object even three-year-old children could easily name, and that had a distinct property (e.g., a spoon with notches on the edge of its bowl-like part).

The subordinate item was identical to the standard object except for color (of the dots in the ball-set, and of the sticker in the spoon-set). As typical member items, two other instances of the familiar category, differing in size from one another, were included. They did not have the distinct property of the standard object, but had the same typical shape of the familiar category. In addition, three objects were used as out-of-category distractors. The three objects were from two types: (a) two objects from the category thematically related with the familiar category (that is, two pairs of shoes for the ball-set, and two cups for the spoon-set) and (b) one object from the category used in the other set (that is, a spoon for the ball-set, and a ball for the spoon-set).

---------- Insert Figures 1a and 1b around here ----------

Japanese 3-year-olds were assigned to one of two conditions, the *typical-shape* condition and the *atypical-shape* condition. The structure of the stimuli was identical across the *typical shape* and the *atypical shape* conditions. The only difference between the two conditions was in the use of different types of objects as the standard and the subordinate item (See Figure 1b). In the *atypical shape* condition, the standard object and the subordinate item in both of the ball set and the spoon set had an atypical shape for balls and spoons. However, these objects were manufactured and sold as balls (or spoons), and adults indeed recognize them as such.

Since this study examined how Japanese children mapped a new noun when there was an already known, familiar name for the named object, it was necessary that the children had considered the standard item and the subordinate item as referents of the familiar basic-level name prior to the introduction of the new word. To ensure

this, the children were screened, and only those who called the original object with the familiar basic-level name for both sets were retained for the main test.

In the main test, the original object was labeled with a novel word (e.g., *heku*). Then it was once taken out of the child's view, and again presented with the three types of choice objects in the set. To examine how the child extended the novel word and the familiar name, the experimenter, pointing to each of the objects in the set, asked the child whether it was a referent of the novel word. After that, the experimenter asked the child whether each object was a referent of the familiar name (e.g., '*bouru*' (*ball*)).

The children's response patterns on each trial could be classified into one of the following four categories: (1)*Subordinat*e *response*: A child may use the new word to refer only to the original object and the subordinate item and may use the familiar name to refer to the original, the subordinate item, as well as the typical exemplars of the existing familiar category. If the child showed this behavioral pattern, we interpreted this as indicating that the child understood the new words as having a *subordinate* relation with respect to the category denoted by the familiar word; that is, the child interpreted the new word '*heku*' as denoting a particular subtype of the larger category of '*bouru*(*ball*)'. (2) *Synonymous response*: If the child used both the new word and the familiar name exactly in the same way, selecting the original, the subordinate item and the two typical exemplars as referents for both the familiar word and the novel word, then she was regarded to have interpreted the new word as being *synonymous* with the familiar name. (3) *Co-hyponym response*: If the child applied the new word to the original and the subordinate item, and excluded these objects from the extension of the familiar word,

this response behavior was taken that the child excluded the original and the subordinate item from the old, familiar category and established a new category that was *co-hyponym* of the old familiar category. (4) *Others*: All other response patterns were placed into the *other* category. This response category included both uninterpretable responses (e.g., accepting the original object and the typical exemplars of the familiar category, but rejecting the subordinate item, as the referents of the novel word) and interpretable, but implausible responses (e.g., restricting the novel word only to the original object and would not extend it to the subordinate item, indicating a proper name interpretation).

Japanese children's response behavior was largely different across the two similarity conditions, in a way that was consistent with Waxman and Senghas' (1992) results with English-speaking children. In the *typical shape* condition, the children made the *subordinate* interpretation (41.7%) rather than the co-hyponym interpretation (12.5%). In contrast, in the *atypical shape* condition, the children made the *co-hyponym* interpretation (68.8%) more often than the *subordinate* interpretation (8.3%). Thus, typicality of shape of the newly-labeled object for the old familiar category greatly affected children's interpretation of the novel word as well as the familiar word. When the shape of the named object was atypical for the old category, children excluded the named object from the old category and established a new category that was a co-hyponym of, and hence mutually exclusive to, the old category. On the other hand, if the newly-labeled object had a typical shape for the familiar category, the children interpreted the word as denoting a new category subordinate to the existing category.

Haryu and Imai (in press) then conducted a follow-up study to see whether the originally preferred interpretation could be altered when a child received explicit information that the newly named atypical member of the old category shared the same function as other members of the old category. As stated earlier, the standard objects in the atypical shape condition (the oval-shape ball and the spoon whose bowl was square-shaped) in fact were manufactured as balls and spoons, respectively, to serve the function of these artifact objects. We thus wished to see whether explicit functional information would alter Japanese children's tendency to exclude the named object from the old category when the named object had dissimilar shape to other typical members of the familiar category.

It turned out that the children were able to consider this external information to some extent, in that the children who received the common function information made the subordinate interpretation more often than who did not (27.1 % vs. 8.3%). However, the effect of the functional information was not strong enough to turn over their default preference: the co-hyponym interpretation still dominated the subordinate interpretation (43.7% vs. 27.1%, respectively).

In summary, Haryu and Imai's research demonstrated that Japanese children who just turned 3 years old are able to determine whether to map a novel noun given to a familiar object to a subordinate category or to exclude the named object from the old category to establish a new category at the same level as the old one flexibly and reasonably. It should be emphasized that the children did so by spontaneously utilizing the shape of the named object, a clue available in the situation (in fact in *any* situation) even when the adult did not provide other explicit clues in the input. When the adult did provide explicit information about common function, the children were

able to use it also, but this information was not given priority over the shape information.

SUMMARY: HOW DO JAPANESE CHILDREN ASSIGN MEANINGS TO NOUNS IN DIFFERENT SITUATIONS?

The goal of this paper was to draw insight for the mechanism of lexical development in light of the findings from Japanese children. Before this, however, we summarized how Japanese children assign meanings to novel nouns in different conditions, comparing similarities and differences between Japanese-speaking and English-speaking children.

First of all, Japanese children spontaneously generalized a newly learned noun to other "like" objects when it was associated with an unfamiliar object, even though the syntax of Japanese did not indicate whether a given noun is a common noun or proper noun. This, together with findings from English-speaking children (e.g., Hall, 1991; Hall & Waxman, 1993; Markman, 1990), suggests that children universally expect that a novel noun refers to a category rather than a unique individual.

Also consistent with previous results from English-speaking children, Japanese children generalized a newly learned label associated with an unfamiliar object on the basis of shape similarity, ignoring the color, size, and material dimensions (Landau et al., 1988; Smith et al., 1992). As a result, they formed a category that approximates a basic-level category (Golinkoff, Mervis, & Hirsh-Pasek, 1994; Hall & Waxman, 1993).

A bias toward mapping a novel noun to a novel object, which has been characterized as *the mutual exclusivity bias* (Markman & Wachtel, 1988), or *the*

Novel-Name-Nameless-Category (N3C) principle (Golinkoff et al., 1994), also seems to be present in Japanese children (Haryu, 1991). Furthermore, the results from our recent studies (Haryu & Imai, in press) provide additional insights into the nature of this bias. The fact that the Japanese children interpreted a novel noun to be a new name for the familiar object rather than to be a material name when both options were available (and the noun's syntactic status was neutral for either interpretation) suggests that children are not unwilling to accept multiple labels for a single object, contrary to what was predicted by the mutual exclusivity bias. Note that N3C simply predicts that children would map the new label to a category different from the old, familiar category in this situation. In this sense, it may appear that the term N3C better characterizes the bias than mutual exclusivity.

However, importantly, N3C is inconsistent with the fact that Japanese children interpreted a novel noun given to a familiar animal to be a proper name, rather than a category name, although it is still consistent with the principle of contrast (Clark, 1987). The principle of contrast is thus most likely to be universally shared by children speaking different languages. However, as discussed earlier, this principle can hardly narrow down the possible meaning of a new word, as it does not specify what meaning the noun should be mapped onto.

Nonetheless, Japanese children in our studies (Imai & Haryu, 2001, Haryu & Imai, in press) did not go standstill facing multiple competing possibilities. Although Japanese syntax does not mark the proper noun vs. common noun distinction, Japanese children interpret a novel label given to a familiar animal to be a proper name of the animal, recruiting the semantic/pragmatic knowledge that animals are good candidate for referents of proper nouns, as just English-speaking children (Katz,

Baker, & Macnamaraa, 1974; Gelman & Taylor, 1984; Hall, 1994). However, Japanese children are able to learn subordinate category names for familiar animals, as they showed this interpretation when a novel name was given to the same familiar animal in a compound noun form, quite similar to English-speaking children (Gelman, Wilcox, & Clark, 1989). This indicates that Japanese children are able to consider linguistic information in inferring word meaning *when it is available*.

For a novel noun associated with a familiar artifact object, Japanese children ruled out the proper noun interpretation, again, just like English-speaking children (Gelman & Taylor, 1994). However, the children were still to determine the single best solution out of multiple possibilities. In this situation, they had at least three options: (1) mapping it to a subordinate category; (2) mapping it to a superordinate category; (3) excluding the named object from the old, familiar category to establish a new category at the same level as the old category.

Although these three solutions were all possible and plausible, the Japanese children showed particular preference in a particular condition, and this preference was largely affected by typicality of shape of the named object for the old category. When the newly named object had a typical shape for the old familiar category, they chose option (1) above, while when the shape was atypical, they selected option (3). It appears that the children selected a particular solution in such a way that the resulting category would be coherent and cohesive whose members all share high similarity. In other words, the shape bias helps children constrain the inference about the extension of a word not only for a first label of an unfamiliar object but also for a second label of a familiar object whose first label has been learned.

IMPLICATIONS FOR A GENERAL THEORY OF LEXICAL DEVELOPMENT

Coordination among multiple resources of constraints

The patterns of word learning in Japanese children summarized above suggest that children are extremely flexible word learners, able to recruit whatever useful resources are available in a given situation. However, it should also be noted that different resources must be appropriately weighed and coordinated so that children's inference about word meanings will not halt when some of the factors are in conflict. For example, while semantic/pragmatic knowledge of animals and inanimate objects and syntactic cues (if available) do help children relax the noun category bias for learning proper names, the suspension of this bias is difficult unless the labeled object is unfamiliar: when the syntactic information is in conflict with the noun object category bias for an *unfamiliar* object (i.e., a novel label for an unfamiliar object appears in the proper noun syntactic frame), this bias is likely to be given priority over the syntactic information (e.g., Hall, 1991; Hall, Waxman, & Hurwitz, 1993; Markman & Wachtel, 1988).

The bias toward mapping a novel noun to a novel object also naturally interacts with other clues, most notably, social pragmatic information. Direct pointing seems to be one of the most powerful ways for indicating that the object pointed to is the referent of the label. In such a case, even when the named object already is familiar, children seem to accept the novel word as another label for the named object and look for a category containing the object as a member but one that has a different extension boundary from that of the familiar category. Here, children are unlikely to interpret the label as a material name, presumably because they have a

strong perceptual bias toward construing a solid, bounded entity with a complex structure as an individuated object rather than as a portion of a substance (cf. Imai & Gentner, 1997; Imai & Mazuka, in press).

In contrast, when no direct pointing is provided, children's disposition toward mapping a novel word to a novel object leads them to look for a novel object in order to map the label, and this bias appears to be fairly strong. In fact, Haryu's study (1991) described earlier demonstrated that it could sometimes override discourse pragmatics in children younger than 3-years of age, if not older. Thus, it seems that all social-pragmatic cues are not weighted equally by young children. A cue such as direct pointing is strong enough to override the bias toward mapping a new word to a novel object, whereas discourse pragmatics may be weaker as a constraint for young children.

Likewise, the bias toward generalizing nouns on the basis of shape (Baldwin, 1992; Golinkoff et al., 1994; Imai, et al., 1994; Landau et al., 1988) interacts with, or is constrained by, other types of clues. At one level, ontological knowledge takes precedence over this bias. For example, Japanese children do not generalize a label associated with a substance on the basis of shape, honoring the ontological principle that similarity in shape in its entirety only matters for individuated objects, and not for substances, even though the syntactic cue distinguishing the two ontological classes is not available in their native language (Imai & Gentner, 1997). However, at another level, shape similarity is often weighed more heavily than taxonomic relatedness or functional commonality, especially when the named object is not familiar to children and hence little prior knowledge is available (Gelman et al, 1998; Imai et al., 1994; Landau et al., 1996). The results of our research (Haryu and Imai, in press) provide

additional support for this in that the explicit demonstration of common function did not overturn the children's default bias toward excluding a shape-dissimilar member from the old category when the member was given a different label.

Are word learning biases necessary for efficient word learning?

We have argued that children recruit multiple sources of information in making inferences about the meanings of new (and sometimes also familiar) words, and that word learning biases can not be characterized as sole force that propels word learning. Like other theorists, we believe that word learning is most successful when multiple sources of information are redundantly available and converge to a single solution (L. Bloom, 1993; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Woodward & Markman, 1998). On the other hand, we disagree with the view that word learning biases are not necessary (P. Bloom, 1994; L. Bloom, 1993; Nelson, 1988; Tomasello, 1997). 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 little prior knowledge about the named object or few external resources to rely on are available 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. In other words, these internal biases about word meanings make it possible for young children to make the single most plausible inference about the meaning of a given word even when other resources are sparse. This device is particularly needed for Japanese children, since one very useful source of constraint, i.e., the noun's form class information, is always lacking in the input.

The studies we have reviewed above showed that word learning biases may sometimes override other sources of constraint that are provided externally, such as discourse pragmatics (Haryu, 1991), syntactic form-class information (Hall, 1991; Markman & Wachtel, 1988) and functional information (Smith et al., 1996; Haryu & Imai, in press). Again, this does not mean that young children cannot spontaneously utilize these sources of information. But it is reasonable for very young children to weigh internal assumptions more heavily than externally provided information when they do not have much prior knowledge about the newly named object. In other words, it appears that word learning biases are typically overridden by externally provided clues when the named object is novel to the child. In contrast, when the named object is familiar, children in general are able to relax the biases by flexibly coordinating externally provided clues (e.g., Hall, 1991; Imai & Haryu, 2001). We speculate that children gain flexibility in the use of the biases as they mature and become more experienced word learners; eventually, they become able to override the biases easily when other sources of information such as syntax or social-pragmatic cues indicate otherwise even when a named object is novel.

The nature of word learning biases

We thus conclude that children possess internal assumptions about how words should be mapped to their referents and how they should be generalized, and that these word learning biases indeed play an important role in efficient word learning. However, let us note that such a conclusion does not lead to a commitment to view these biases as being innately endowed constraints. The studies reviewed in this paper mainly dealt with 2-year-olds or older children who were already fairly experienced word learners. We thus do not know at all whether 10-12 month-olds

who are learning their first words have the same biases exhibited by 2-year-old children. However, given how children flexibly and reasonably control the application of word learning biases by other types of internal knowledge and external cues, we speculate that word learning biases are better characterized as a part of rich, interconnected body of knowledge about the world and the lexicon children have built up in the course of linguistic as well as non-linguistic learning experiences than domain-specific innate leaning principles.

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Figure captions.

Figure 1. Sample stimulus sets used in Imai & Haryu's (2001) study: a) unfamiliar animal set; b) unfamiliar artifact set.

Figure 2. Sample stimulus sets used in Haryu & Imai's (in press) study: a) the ball set used for the typical shape condition; b) the standard and the subordinate item in the ball set used for the atypical shape condition.