Language-Relative Construal of Individuation Constrained by Universal Ontology: Revisiting Language Universals and Linguistic Relativity

Mutsumi Imai^a, Reiko Mazuka^b

^aKeio University, Japan ^bDuke University, RIKEN Brain Institute

Received 19 February 2005; received in revised form 17 March 2006; accepted 20 April 2006

Abstract

Objects and substances bear fundamentally different ontologies. In this article, we examine the relations between language, the ontological distinction with respect to individuation, and the world. Specifically, in cross-linguistic developmental studies that follow Imai and Gentner (1997), we examine the question of whether language influences our thought in different forms, like (1) whether the language-specific construal of entities found in a word extension context (Imai & Gentner, 1997) is also found in a nonlinguistic classification context; (2) whether the presence of labels *per se*, independent of the count-mass syntax, fosters ontology-based classification; (3) in what way, if at all, the count-mass syntax that accompanies a label changes English speakers' default construal of a given entity?

On the basis of the results, we argue that the ontological distinction concerning individuation is universally shared and functions as a constraint on early learning of words. At the same time, language influences one's construal of entities cross-lingistically and developmentally, and causes a temporary change of construal within a single language. We provide a detailed discussion of how each of these three ways language may affect the construal of entities, and discuss how our universally possessed knowledge interacts with language both within a single language and in cross-linguistic context.

Keywords: Language and thought; Linguistic relativity; Individuation; Ontological concepts; Language acquisition; Role of language in conceptual development

The distinction between kinds of object and substance is one of the most basic conceptual distinctions, as these two kinds of entities have fundamentally different criteria for the notion of *identity* or *sameness*. When we say that two objects are "identical" or "the same," we are referring to them in their entirety; we do not consider them the same merely because they share the same parts or are made of the same substance. In other words sameness requires objects to be individuated and to possess both a 'wholeness' and an 'identity.' In contrast,

Correspondence should be addressed to Mutsumi Imai, Keio University at Shonan-Fujisawa, 5322 Endo, Kanagawa, Japan. E-mail: imai@sfc.keio.ac.jp

when we talk about identity or sameness of *substances*, the criterion of "sameness in their entirety" cannot be applied: substances are of scattered existence, and there is no such thing as "whole sand," "whole water," or "whole clay" (cf. Quine, 1969). The sameness of a substance must be determined on the basis of the sameness of its material constituent.

Interestingly, languages differ in the ways and the extents to which they mark this important conceptual distinction. Languages like English obligatorily mark this ontological distinction concerning individuation by means of count-mass syntax. However, in some languages, this ontological distinction is not marked systematically in the grammar. Whether language affects the acquisition of the ontological distinction, and how language interacts with construal of entities with respect to individuation has been much studied in two different contexts. In one context, developmental researchers have focused on the influence of language on the formation of this ontological distinction (Bloom, 1994; Soja, Carey, & Spelke, 1991; Subrahmanyam, Gelman, & Landau, 1999). This line of research was formulated as a challenge to Quine (1969), who conjectured that the ontological distinction is acquired only by learning count-mass syntax. Soja and her coworkers (1991) tested whether English-speaking children appreciate the ontological distinction before mastery of the count-mass syntax, and showed that English-speaking 24-month-olds who have not yet acquired the count-mass syntax are able to constrain word meanings of novel words using the ontological distinction between objects and substances. Hearing a novel noun in association with a solid, discrete entity (i.e., an object), they projected the word meaning onto a shape, whereas hearing a novel noun with a nonsolid substance, they projected the word meaning onto a material, ignoring the shape. From these results, it was argued that children are endowed with an innate and universal appreciation of the ontological distinction between objects and substances. Here, the authors thus concluded that language does not influence the formation of the ontological distinction, as the ontological distinction is present prior to and independent of language.

Also in the first context, Subrahmanyam, Gelman, and Landau, (1999) approached the relation between language and the formation of ontology-based categories with English children, but from a different angle than Soja et al. (1991). They compared children's classification performance in linguistic versus nonlinguistic contexts, and demonstrated that English-speaking children classified novel entities in accord with the ontological distinction when asked to extend novel labels, but they failed to do so when asked to classify the same entities freely when novel labels were not presented. Thus, their results suggest that language influences children in forming principled, ontology-consistent categories (e.g., Markman & Hutchinson, 1984; Waxman & Gelman, 1986; Imai, Gentner, & Uchida, 1994).

In the second context, researchers approached the relation between language and the notion of individuation by way of cross-linguistic comparisons, asking whether the grammatical difference in marking the ontological distinction with respect to individuation leads to different *construals* of the same entities and hence different patterns of dividing the individuated/nonindividuated continuum (e.g., Lucy, 1992; Lucy & Guskins, 2001). According to Lucy, English (and other Indo European languages with the count-mass syntax) and Yucatec Mayan (and other classifier languages) divide the world differently along the continuum of individuation (Lucy, 1992; see also Gentner & Boroditsky, 2001). Both types of language treat animals as inherently individuated, and nondiscrete substances as inherently nonindividuated. However, the two types of language treat discrete inanimate objects differently: English treats them as individuated (by referring to them using the count syntax) while Yucatec treats them as nonindividuated since nouns referring to these entities cannot be pluralized and require a classifier, i.e. a unit of individuation, in order to be quantified (see also Aikhenvald, 2000 and Senft, 2000). Lucy asserts that the difference between the two types of languages in the treatment of inanimate discrete entities (e.g., cardboard box) is directly reflected in the way the speakers construe these entities and classify them in nonlinguistic contexts: English speakers construe them as inherently individuated and group them together with animals, while Yucatec speakers construe them as inherently non-individuated and group them together with non-discrete substances.

Although the two lines of research reviewed above both deal with the question of how language interacts with our construal and categorization of entities in the world regarding individuation, they were more or less conducted independently without much effort to connect the findings from one context to the other. Imai and Gentner (1997) attempted to integrate the two contexts of research, examining the relations among language, the ontological appreciation of individuation, and the construal of individuation for a range of physical entities both developmentally and cross-linguistically: they compared English speakers and Japanese speakers across a wide range of ages, including four age groups: early 2-year-olds, late 2-year-olds, 4-year-olds, and adults. Japanese is a classifier language and hence does not grammatically distinguish the noun's status of individuation. Thus, if Quine (1969) is correct, Japanese children should not naturally appreciate that objects and substances are of different ontological kinds.

Following Soja et al.'s (1991) procedure, Imai and Gentner (1997) introduced a novel label in association with an unfamiliar entity that children had never seen before. The structure of Japanese does not reveal the noun's status of individuation, so no special presentation was required in introducing novel labels. But for English speakers, care was taken so that the labels were introduced in such a way that the noun's syntactic count-mass status was not revealed (e.g., *Look at this dax. Can you point to the tray that also has the dax on it?*).

In constructing the stimulus materials, Imai and Gentner (1997) set up three different types of entities so that the stimuli reflected the graded nature of the individuation continuum within the realm of inanimate concrete entities, including both solid objects and non-solid substances. Unlike Lucy (1992), Imai and Gentner thought that even within this domain (i.e., –animate, +discrete in Lucy's terminology), some entities, such as those that have complex and cohesive structures, are more naturally individuated than are others that have simple structures (see also Gentner & Boroditsky, 2001; Parasada, Fenz, & Haskell, 2002). Thus, the first type, the *Complex-Objects*, was real artifact that had fairly complex shapes and distinct functions, although the functions were unknown to the children in the studies. In contrast, the second type of entity, the *Simple-Objects*, had very simple structures with no distinct parts. They were made of solid substances such as clay or wax and were formed into very simple shapes (e.g., the shape of a kidney) in such a way that the shape of the entity did not suggest a function. The third type of entity, the *Substances*, were non-solid substances such as sand or hair-setting gel and were arranged in distinct, interesting shapes.

Not only English speakers but also Japanese speakers in all age groups showed clear differentiation in projecting word meanings across the complex objects and the non-solid substances. At the same time, a noteworthy cross-linguistic difference was found in the Simple-Object and Substance trials. In the Substance trials, although Japanese speakers extended the

label on the basis of material, English speakers did not show a clear preference between the shape choice and the material choice. In the Simple-Object trials, while both child and adult English speakers projected word meaning on the basis of shape, just as they did for the complex-objects, Japanese adults projected the word meaning on the basis of material at a rate significantly above chance, and Japanese children projected word meanings on the basis of shape and material in about equal proportions. Imai and Gentner (1997) interpreted the results as evidence for the universal ontology position and as a refutation of Quine's (1969) conjecture, based on the fact that Japanese children showed differentiated word meaning projection patterns for at least clearly individuated typical objects (Complex-Objects) and for clearly nonindividuated non-solid substances. At the same time, in accounting for the crosslinguistic differences between English speakers and Japanese speakers in the Simple-Object trials, they suggested that language might influence the construal of entities in the middle zone of the object-substance continuum.

However, Imai and Gentner's (1997) results leave us with several questions unanswered. First, does the cross-linguistic difference observed in Imai and Gentner's word-meaning projection task hold for a general, nonlinguistic classification context, or does it emerge only in the context of linguistic classification (Slobin, 1987; Malt, Sloman, Gennari, Shi & Wang, 1999)? Second, does language play any role in fostering ontology-based classification? Third, does the cross-linguistic difference in the construal of perceptually ambiguous entities (i.e., the Simple Objects) reflect qualitatively different construal of these things and hence qualitatively different criteria for object kinds and substance kinds across English and Japanese speakers, or does it merely reflect a difference in the preferred construal?

The goal of this article is to go beyond Imai and Gentner's (1997) broad conclusion—that a commitment to a distinction between objects and substance is universally shared, but the construal of entities is somewhat malleable across different language communities in order to address the above questions and provide a clearer and more concrete picture of how language interacts with the construal of physical entities and apprehension of the ontological distinction.

Three studies were conducted to deal with these questions. Study 1 tested English and Japanese children's classification behavior in a no-word context, using exactly the same stimuli as Imai and Gentner (1997), to address the first and second questions above. Study 2 further examines the second question as well as the third question with Japanese children using a paradigm that allows us to specify the meaning of the chance level performance in the Simple Object trials. Study 3 addresses the second and third questions with English speakers by examining whether and to what degree the English speaking children's and adults' construal of the entities is malleable, being able to be shaped by cues from the count-mass syntax.

1. Study 1: Cross-linguistic Comparison in a No-word Categorization Task

In Study 1, we conducted a no-word classification task with English speaking and Japanese speaking children and adults. Given the cross-lingistic difference observed in Imai and Gentner (1997) in the context of novel label extension, English and Japanese speakers' classification behavior in a nonlinguistic context is important in thinking about the relation between language

and thought. Importantly, the literature of lexical development and that of adult cognition may lead us to make somewhat different predictions. It has been well documented that children are more likely to form adult-like, consistent categories when asked to determine the extension of a novel label than when they are asked to determine the "same" or "most similar" object without the invocation of any labels (e.g., Landau, Smith, & Jones, 1988; Markman & Hutchinson, 1984; Waxman & Gelman, 1986; Imai, Gentner, & Uchida, 1994).

Dissociation between categorization in the naming and non-naming contexts is also found in adults. Malt et al. (1999) conducted a series of categorization tasks with English speakers, Spanish speakers, and Chinese speakers. They found that the categorization behavior across the three language groups was diverse across different language groups when participants were asked to categorize a variety of containers by name, but that when participants were asked to categorize on the basis of overall similarity or functional similarity, the cross-cultural agreement was much higher. These authors argued that the fact that speakers of different languages show similar behavior in classification and similarity judgment in a nonlinguistic domain (despite differences in linguistic categorization) can be taken as evidence for the presence of universally shared conceptual organization. Taking this view would lead to the prediction that the cross-linguistic difference found in the Imai and Gentner (1997) would not be generalized in classification contexts that do not involve label extension.

In any case, given the pattern of results in the literature, it is an open issue whether the crosslinguistic differences found in Imai and Gentner's (1997) study should be expected to hold for categorization in a context that does not involve language. One possibility is that we will see language-specific ways of classification in the context of no-word classification as well in both children and adults, which follows if we assume that our nonlinguistic classification of the entity is a direct reflection of how we classify the world in language (cf. Quine, 1969). A second possibility is that the cross-linguistic difference in the context of word meaning projection will not be seen in a no-word classification task (probably in either adults or children), which follows if we believe that our concepts are strongly constrained by universally shared cognitive architecture and that the influence of language should be seen only in linguistic contexts (Malt et al., 1999). A third possibility is to expect a word/no-word difference in children but not in adults. Children may start out with a universally shared conceptual space. Through language learning, from a very early age, they become sensitive to the way in which their own language divides the world. For example, Choi and Bowerman (1991) suggested that Korean and English-speaking 2-year-olds were already sensitive to some of the semantic features that are important in diving linguistic categories in the domain of spatial relations. Likewise, Imai and Gentner (1997) demonstrated that Japanese and English-speaking 2.5-year-olds showed the pattern of word meaning projection that was in accord with that of the adults in their own language. However, this sensitivity to the language-specific way of dividing the world may appear only in linguistic contexts. Later on, this sensitivity may develop into a general bias toward particular ways of classification that would be consistent with linguistic categorization and manifest even in nonlinguistic contexts. In fact, Lucy and Guskins (2001) reported that Yucatec children showed the language-specific preference for material-based categorization at 9 but not at 7 years of age in a nonlinguistic categorization task. Given this, we may not see cross-linguistic difference in Japanese and English-speaking children in a no-word classification context at four years of age. In adults, however, we may see the language-specific

bias not only in the context of word meaning projection but also in the context of no-word classification.

1.1. Method

1.1.1. Participants

Participants came from four language/age groups; 14 monolingual Japanese-speaking 4year-olds (M = 4; 2; range = 3; 4–4; 6), 14 monolingual English-speaking American 4-yearolds (M = 4; 2; range = 3; 6–4; 6), 15 monolingual Japanese adults, and 15 monolingual English-speaking adults. The Japanese 4-year-olds were from a suburban city in the greater Tokyo area, and the American 4-year-olds were from a suburban city in the greater Chicago area. Children of both language groups were from middle-class families. The demographic background of the children in this study was comparable to that of the participants in Imai and Gentner's (1997) study. The Japanese adult participants were undergraduate or graduate students at Ritsumeikan University or Keio University. The American adults were undergraduate students at Northwestern University. There were approximately equal numbers of males and females within each age/language group.

1.1.2. Materials

The stimuli were identical to those used in Imai and Gentner's (1997) word meaning projection study. There were three trial types: Complex-Object trials, Simple-Object trials, and Substance trials. The materials for the Complex-Object trials were factory-made artifacts with complex structures and distinct functions, although the functions were unknown to the children. The materials for the Simple-Object trials had very simple structures with no distinct parts. They were made of a solid substance such as clay or wax and were formed into a very simple shape (e.g., the shape of a kidney). The materials for the Substance trials were non-solid substances such as sand or hair-setting gel and were arranged in distinct, complex shapes. There were four sets in each trial type. Thus there were 12 trials (see Fig. 1 for sample sets and Table 1 for the list of the stimuli).

1.1.3. Procedure

The procedure was exactly parallel to that in Imai and Gentner (1997) except that no invocation of labels was made. The participant was presented with a standard entity and two alternatives and was asked to select something that *is the same* as the standard entity. In constructing the instruction sentence, we tried as hard as possible not to give a clue about the entity's status of individuation. We thus decided to use *Show me what's the same as this* rather than *Show me the same thing as this*, because in English, the word "thing" may imply "object." The corresponding Japanese instruction was completely neutral about the entity's status of individuation, as the word "mono" can refer to either an object or a substance: *Kore* [this] *to* [with] *onaji-mono* [same]wa [topic] *docchi* [which] *desuka* [is-question]? Each participant received 12 trials, and we randomized the presentation order of the 12 sets across participants with the constraint that participants would receive trials of the same type (Complex-Object trials, Simple-Object trials, Substance trials) no more than three times in a row. A native speaker of Japanese tested Japanese participants in Japan, and a native speaker of English



Fig. 1. A sample material set for (a) a complex object trial; (b) a simple object trial; (c) a substance trial in Study 1. (*Continued on next page*)



(c)

Fig. 1. (Continued from previous page).

| Standard | Shape alternative | Material alternative | | |
|--|--|--------------------------------|--|--|
| Complex object | | | | |
| Clear plastic clip | Metal clip | A clear plastic piece | | |
| Porcelain lemon juicer | Wood lemon juicer | A porcelain piece | | |
| Wood whisk | Black plastic whisk | Three pieces of wood | | |
| Ivory plastic T joint | Copper T joint | Two pieces of ivory plastic | | |
| Simple object | | | | |
| Cork pyramid | White plastic pyramid | A chunk of cork | | |
| Dylite UFO | Wood UFO | A dylite piece | | |
| Red Super Sculpy half egg | Gray Styrofoam half egg | Two pieces of red Super Sculpy | | |
| Orange wax kidney | Purple plaster kidney | Three pieces of orange wax | | |
| Substance | | | | |
| Lumpy Nivea (angular C-like shape with the opening on the reverse side) | Dippity-Do (angular reverse C) | A Nivea pile | | |
| Crazy Foam (Gamma-like shape) | Clay (Gamma-like shape) | A pile of Crazy Foam | | |
| Sawdust (Omega-like shape) | Leather (tiny pieces, Omega-like shape) | Two piles of sawdust | | |
| Decoration sand (elongated and angular S-like shape) | Glass pieces (elongated, angular S-like shape) | Three piles of sand | | |

 Table 1

 Materials used for Study 1 and Study 3

| | | Complex | Simple | Substance |
|-------------|--|---|--|--|
| 4-year-olds | No-word (Study 1) | 0.63(0.44) | 0.30(0.38) | 0.089(0.27) |
| Adults | No-word (Study 1) | 0.80(0.36) | 0.27(0.35) | 0.17(0.29) |
| 4-year-olds | No-word (Study 1) | 0.57(0.43) | 0.45(0.45) | 0.32(0.43) |
| 6 | Count(Study 3) | 0.89(0.16) | 0.84(0.23) | 0.41(0.42) |
| | Mass (Study 3) | 0.59(0.48) | 0.46(0.44) | 0.20(0.26) |
| Adults | No-word (Study 1) | 0.95(0.14) | 0.73(0.33) | 0.50(0.41) |
| | Count (Study 3) | 0.93(0.27) | 0.79(0.29) | 0.50(0.35) |
| | Mass (Study 3) | 0.48(0.43) | 0.15(0.26) | 0.13(0.35) |
| | 4-year-olds Adults 4-year-olds Adults | 4-year-oldsNo-word (Study 1)AdultsNo-word (Study 1)4-year-oldsNo-word (Study 1)Count(Study 3)Mass (Study 3)AdultsNo-word (Study 1)Count (Study 3)Mass (Study 3)AdultsSolution (Study 3)Mass (Study 3)Mass (Study 3) | 4-year-olds No-word (Study 1) 0.63(0.44) Adults No-word (Study 1) 0.80(0.36) 4-year-olds No-word (Study 1) 0.57(0.43) Count(Study 3) 0.89(0.16) Mass (Study 3) 0.59(0.48) Adults No-word (Study 1) 0.95(0.14) Count (Study 3) 0.93(0.27) Mass (Study 3) 0.48(0.43) | Complex Simple 4-year-olds No-word (Study 1) 0.63(0.44) 0.30(0.38) Adults No-word (Study 1) 0.80(0.36) 0.27(0.35) 4-year-olds No-word (Study 1) 0.57(0.43) 0.45(0.45) Count (Study 3) 0.89(0.16) 0.84(0.23) Mass (Study 3) 0.59(0.48) 0.46(0.44) Adults No-word (Study 1) 0.95(0.14) 0.73(0.33) Count (Study 3) 0.93(0.27) 0.79(0.29) Mass (Study 3) 0.48(0.43) 0.15(0.26) |

Mean proportion and standard deviation of the shape response as a function of language, age, and contexts

tested American participants in the United States. Children in both language groups were tested individually in a quiet room in the preschool they attended. After each response, children were thanked and encouraged, but no feedback was given regarding whether they had responded "correctly." The adult participants were also tested individually in a university laboratory.

1.2. Results

Table 2

Table 2 shows the mean proportion of the shape responses for English-speaking and Japanese-speaking adults and children. As in Imai and Gentner (1997), people's classification patterns differ greatly across the three types of the entities. The adults in both language groups matched the shape-matching alternative to the standard in the Complex-Object trials (English speakers: 95% shape; Japanese speakers: 80% shape, both ps < 0.01). As in Imai and Gentner's word meaning projection task, English and Japanese speakers showed different patterns of classification behavior in the Simple-Object trials: whereas the adult English speakers selected the shape alternative to the standard entity significantly above chance (73.3% shape, t(14) = 2.71, p < 0.02), the adult Japanese speakers selected the material-matching alternative as the same significantly above chance (26.5% shape, t(14) = -2.06, p < 0.03). In the Substance trials, whereas the adult Japanese speakers showed a strong bias for the substance construal (16.7% shape, t(14) = -4.39, p < 0.01), the adult English speakers showed no preference between the shape choice and the substance choice (50% shape, t(14) = 0.00, p = 1.0).

Four-year-olds' performance in this nonlinguistic classification task was quite different from that of the adults in the same language group. In particular, the English-speaking children showed chance-level performance in all three types of trials (Complex-Object trials: 57% shape, t(13) = 0.62; Simple-Object trials: 44.5% shape, t(13) = -0.44; substance trials: 32% shape, t(13) = -1.55, all ps > 0.1). Japanese children also showed chance-level performance in the Complex-Object trials (62.5% shape, t(13) = 1.07, p > 0.1) and Simple-Object trials (30.2% shape, t(13) = -1.82, p > 0.05). Only in the Substance trials did they show reliable substance construal (8.9% shape, t(13) = -5.68, p < 0.001).



Fig. 2. Subjects' classification behavior in the no-word context in Study 1 plotted against the behavior in the (neutral-syntax) word meaning projection context by Imai and Gentner (1997): (a) American 4-year-olds, (b) American adults, (c) Japanese 4-year-olds, and (d) Japanese adults.

The interaction between language-specific classification preference and the entity type was supported by the significant Trial Type X Language interaction, F(2, 108) = 4.40, p < 0.05 in a 2 (Language) ×2 (Age) ×3 (Trial Type) ANOVA. Subsequent analyses revealed a significant effect of Language on the Simple-Object trials, F(1, 54) = 9.33, p < 0.01 and on the Substance trials, F(1, 54) = 9.14, p < 0.01, but not on the Complex Object trials.

1.3. Discussion

As in Imai and Gentner's (1997) word extension task, we found cross-linguistic similarities as well as differences in adults. Adult English speakers and Japanese speakers were similar in that they showed ontological differentiation between objects and substances. At the same time, although adult English speakers showed a bias toward the *object* construal for the entities in the Simple-Object trials, Japanese adult speakers were biased toward the *material* construal for them. Also, although Japanese speakers showed a strong bias toward the material construal for the non-solid substances that had been shaped into distinct, complex forms,

English-speaking adults did not show a preference in construing these entities as individuated or non-individuated. It is important to note that, for both language groups, the adults' classification behavior in this no-word classification task was almost identical to what they exhibited in the word meaning projection task in Imai and Gentner (1997). (For comparison, we plotted the participants' performance (separately for each language/age group) against the performance in the word meaning projection task based on Imai and Gentner (1997).

While young children in Imai and Gentner's word meaning projection task showed the classification behavior that was very similar to that of the adults in their own language group, the 4-year-olds's performance in this study was quite different from the adults. The dissociation between the two classification contexts was particularly marked among the English-speaking children, and different from the ontology-based word meaning projection behavior in the previous study. In this study, their classification was quite indifferent to ontology: for all three-entity types, the children did not show as clear a preference for shape choice or material choice as they had shown in Imai and Gentner's study (1997). This pattern is in accord with a view that the presence of labels fosters adult-like, principled classification behavior in young children (e.g., Landau, Smith, & Jones, 1988; Markman & Hutchinson, 1984; Waxman & Gelman, 1986; Imai, Gentner, & Uchida, 1994; Subrahmanyam, Gelman, & Landau, 1999; but see Diesendruck & Bloom, 2003).

Japanese 4-year-olds' performance was somewhat unclear in this light, as they did not show as clear a dissociation across the word meaning projection and the no word classification as the English-speaking children did. Does this mean that the label effect is specific to Englishspeaking children? One possibility is that Japanese children do in fact exploit different classification criteria across linguistic (i.e., word extension) and nonlinguistic classification contexts, but the forced-choice paradigm failed to reveal it. This possibility is worth pursuing, especially given the chance-level performance in the Simple-Object trials in both the word-extension and no-word classification contexts. Imai and Gentner (1997) interpreted the Japanese children's pattern of performance in their word-extension task—highly above-chance shape response in the Complex-Object trials, highly above-chance material response in the Substance trials, and at chance performance in the Simple-Object trials-as evidence of their appreciation for the ontological distinction. They reasoned that the fact that Japanese children projected word meanings differently (and ontologically correctly) across the Complex-Object and Substance trials indicated that they honored the ontological principles governing the object kinds and substance kinds; membership of the same object category is determined by the sameness of the entirety of the object, whereas membership of the same substance kind is determined by the sameness of the material constituents but not by the configuration. However, on reflection, another possibility that cannot be entirely ruled out is that Japanese children may have selected the match on the basis of the most salient perceptual property of the target entity, be it color, texture, or shape. They may have selected the shape choice in the Complex-Object trials simply because shape was more salient than color and/or texture in the entities presented in these trials and vice versa for the substances they saw in the Substance trials. They may have responded at chance in the Simple-Object trials because neither shape nor color-texture stood out in those entities. With these two possible accounts for the Japanese children's pattern of performance in the forced-choice task, and given the thesis that children exhibit more adult-like, principled categorization with the presence of words, we conjectured that it may be possible that the Japanese children's performance in the word extension task reflected the observance of the ontological principles, whereas their performance in the no-word classification task reflected the use of mere perceptual salience. Study 2 was conducted to test this possibility.

2. Study 2: Revisiting Japanese Children's Construals of Physical Entities in Linguistic and Nonlinguistic Contexts: Do Japanese Children Really Honor the Ontological Distinction?

In Study 2, we reexamined Japanese 4-year-olds' classification in the word extension and no-word contexts using a paradigm in which children were allowed to select more than one choice item instead of being forced to select only one. This paradigm is possible because not only does Japanese lack a count–mass distinction, it also lacks a singular–plural distinction. The instruction *X* o totte [Give me X] does not provide the hearer with a clue about whether one or more than one item should be selected (see Imai & Haryu, 2001; Haryu & Imai, 2002).

The logic of the experiment is as follows. If Japanese children's chance-level performance in the Simple-Object trials in the previous studies using the forced-choice paradigm reflected the lack of an ontological concept of individuation, they might happily select both the shape item and the material item in this paradigm. Note that selecting both the shape and the material items at the same time yields a disjunctive category such as "things of same shape OR things of same material (e.g., a category including pyramid-shaped objects made of any material and things of any shape made of plastic)," which severely conflicts with the ontological principle. On the other hand, if Japanese children indeed honor the ontological distinction between individuals and nonindividuals in classifying entities and/or generalizing labels, even though they may have a hard time determining whether a simple-shaped, bounded entity made out of a solid substance should be construed as an object or as a portion of substance, once they determine the construal, they should not form a disjunctive category. They should select only the shape-matching item if they decide to construe the entity as an object; likewise, they should select only the material-matching item if they decide to construe it as a portion of a substance. Of particular interest is whether Japanese children show different patterns of performance across the word-extension and no-word classification contexts. Specifically, we wished to see whether they show more ontology-sensitive classification in the word-extension condition than they do in the no-word classification condition.

2.1. Method

2.1.1. Participants

Twenty-eight 4-year-old (M = 4; 3; range = 3; 11–4; 10) monolingual Japanese children participated in Study 2. As in Study 1, the Japanese 4-year-olds were from a suburban city in the greater Tokyo area and were mostly from middle-class families. They were tested individually in a quiet room at the preschool they were attending. Two additional children were tested but were excluded from the final sample because they did not complete the task.

2.1.2. Stimuli

As in Study 1, the stimulus material included three types of entities: real artifacts with complex structures (*Complex-Objects*), simple-shaped, bounded entities made out of a solid substance (*Simple-Objects*), and non-solid substances formed in distinct shapes (*Substances*). We prepared three sets for each type of entities. Thus, there were nine trials.

Unlike the stimuli in Study 1, each set in this study consisted of three test items instead of two. Specifically, in addition to a shape-matching item and a material-matching item, a third test item, which was different from the standard in both shape and material, was included. As in Study 1, the shape item matched the standard in shape but not in material; the material item matched the standard in shape (see Table 3 for a list of materials).

2.1.3. Procedure

The children were randomly assigned to either the word-extension condition or the no-word classification condition. In the word-extension condition, the instruction was the same as that used for the Japanese children in Imai and Gentner's (1997) study, with the exception that the children were asked to select *all* of the items to which the label could refer. The experimenter said to the child, pointing to the standard item: *Kore* [this] *wa* [topic particle] X [novel name] *dayo* [is] [This is X.]. The children were then shown the three test items (the shape item, material item, and distractor) in front of them. The relative location of the three test items was counterbalanced across the nine sets. The experimenter said, *X wo* [accusative particle] *totte* [get] [Can you find X?]. As we mentioned earlier, because there is no count-mass marking

| ····· , | | | |
|--|--------------------------------------|------------------------------------|--|
| Standard | Shape alternative | Material alternative | Distractor |
| Complex object | | | |
| Porcelain lemon juicer | Wood lemon juicer | A porcelain piece | Silver metal pipe |
| White plastic honey dipper | Wood honey dipper | A white plastic piece | Green metal clip |
| Ivory plastic T joint | Copper T joint | A piece of ivory plastic | Round plastic hook |
| Simple object | | | |
| Blue plastic clay UFO | White dylite UFO | A piece of blue plastic clay | Clear plastic cube |
| Red Super Sculpy half egg | Gray Styrofoam half egg | A piece of red Super Sculpy | Angular-shaped wood |
| Orange wax kidney | Purple plaster kidney | A piece of orange wax | House-shaped styrofoam |
| Substance | | | |
| Pink hair-setting gel (hat shape) | Yellow decoration sand (hat shape) | A pile of pink hair-setting gel | Gray mud foam soap (circle shape) |
| Charcoal face foam soap (Gamma shape) | Green face cream (Gamma shape) | A pile of charcoal face foam soap | Tiny rubber pieces (donut shape) |
| Tiny cork pieces (Omega shape) | Tiny leather pieces (Omega shape) | A pile of cork pieces | Light blue hair cream (the shape of a pair of glasses) |

| Table 3 | |
|-------------------------|---|
| Materials used in Study | 2 |

in Japanese, one cannot tell whether X is an object name or a substance name. Furthermore, children cannot determine whether they are expected to select only one item or more than one item because there is no grammatical number marking in Japanese. When the child selected, regardless of whether he or she selected one or more items, he or she was asked whether there was any more X. When the child said "no" to the prompt, the experimenter proceeded to the next set. We acknowledge that this instruction may slightly bias children toward selecting more than one item. However, in previous research using this paradigm and instruction (Imai & Haryu, 2001), Japanese children as young as 2.5 years of age restricted their selection to only one item, saying clearly "no" to the "Is there any more X" prompt when they believed that the label was a proper name of the object.¹ The nine sets were presented in a random order, and the location of the three test items relative to the standard was counterbalanced within children across different sets, as well as within each set across different children.

The procedure for the no-word classification condition was identical to that for the wordextension condition except for the instruction. The experimenter said to the child, *kore* [this] *to onaji* [same] *mono* [thing] *o* [accusative particle] *totte* [get-imperative]. This instruction is roughly translated to as *Find the same thing as this*, but as mentioned earlier, in Japanese, the word *mono* [thing] could refer to both objects and substances, so this sentence would not bias children toward either the object or the substance construal. When the child had selected, he or she was asked whether there were any more that were "the same" as the standard.

2.2. Results

2.2.1. Choice pattern for each trial type: How often did the children form disjunctive categories?

We first examined whether children would make a disjunctive category by selecting both the shape item and the material item within a single trial. If they did not appreciate the ontological distinction and formed a category on the basis of only perceptual salience, they might select *both* items at the same time. In contrast, if Japanese children indeed honored the ontological distinction, they would not select both items simultaneously, as selecting both items at the same time (i.e., on the same trial) severely violates the ontological principle.

The mean number of times for each test item having been selected as a function of Classification Context (word-extension versus no-word classification) and Trial Type is given in Fig. 3. There were 3 material sets for each trial type, and the children were allowed to select more than one test item for each set. Thus, the number of times each of the three test items was selected in each trial type ranged from zero to three.

In the word-extension context, the children made the disjunctive response on an average of only 0.36 times in the 9 trials (4%) in the word-extension context. In contrast, they did so on an average of 2.86 times (31.8%) in the no-word classification context. The difference between the two contexts was significant, t (26) = 2.52, p < 0.05.

The response patterns for the Simple-Object trials were of particular interest, as discussed earlier. On the Simple-Object trials, the children in the word-extension context selected the shape item on an average of 38% of the time and the material item on an average of 66% of the time. Neither number was significantly different from what would be expected by chance (50%),² t(13) = -1.15, and t(13) = 1.59, both ps > 0.10. In the no-word context, the children



Fig. 3. The number of times each type of test items (shape, material, and distractor) was selected for each trial type in Study 2: (a) Complex Object trials, (b) Simple Object trials, and (c) Substance trials.

selected the shape item on an average of 73.7% of the time, which was marginally different from chance, t(13) = 2.14, p = 0.052, and the material item 66.6% of the time, which was not different from chance, t(13) = 1.51, p > 0.1. What should be noted, however, is that the children almost never selected the shape and material items within the same trial to form a

disjunctive category in the word-extension context (the average of 0.29 times in the 3 trials), but they did so in about half of the times in the no-word context (1.30 times). The number of disjunctive responses in the Simple-Object trials differed significantly across the two contexts, t(26) = 2.56, p < 0.05.

To further confirm the possibility that Japanese children exhibit adult-like, "ontologically consistent" classification more often in the context of word extension than in the context of nonlinguistic classification, their responses in each trial were coded in terms of whether they were consistent with the ontological constraint. For a Complex-Object trial, the response was coded as ontologically consistent if a child selected only the shape item. For a Substance trial, the selection of the material item only was considered ontologically consistent.

As we discussed earlier, the stimuli for the Simple-Object trials may be construed as either an individuated object or a portion of a solid substance, and the construal might vary not only across different individuals but also across the three target stimuli within a single individual, depending on the perceptual nature of the entity. Thus, the response in a Simple-Object trial was considered ontologically consistent either when the child selected the shape item only or when he or she selected the material item only for a single trial.³ The "object-substance" construal for the three target objects did not have to be the same throughout the three sets; for some test sets, the material may have appeared more salient to the child, whereas in other sets, the shape may have been more salient. What is important is that once they decided to construe the entity as an object, they must have selected the shape item only. Of course, when the child selected "both" items within the same set, this response was considered to be ontologically inconsistent.

Table 4 shows the mean proportion of "ontologically consistent" responses for each trial type within each classification context. In the word-extension context, 87% of the responses were coded as ontologically consistent, averaged across the three trial types. By contrast, only 49% of the responses were coded as ontologically consistent in the no-word classification condition. We conducted a 2 (Classification Context) × 3 (Trial Type) mixed ANOVA on the proportion of the "ontologically consistent" responses with Trial Type as a within-subject variable. The effect for Classification Context was strongly significant, F(1, 26) = 21.15, p < 0.001. No effect for Trial Type or the interaction between Classification Context X Trial Type was detected, both Fs < 1. The results of this ANOVA thus indicated that Japanese 4-year-olds

Table 4

Mean proportion and standard deviation of "ontologically consistent" responses as a function of classification contexts in Study 2

| | Complex | Simple | Substance | Average across three trial types |
|-------------------------------------|-------------|-------------|-------------|----------------------------------|
| Word extension | 0.91(0.20) | 0.86 (0.31) | 0.85 (0.17) | 0.87(0.17) |
| No-word classification ^a | 0.55 (0.50) | 0.57 (0.44) | 0.36 (0.42) | 0.49(0.26) |

^aonaji-mono wo sagashite [Find what's the same as this]

formed ontology-constrained categories more often in the context of word extension than they did in the context of no-word classification across all three types of trials.

2.3. Discussion

The results of Study 2 showed that labels influence not only English-speaking children but also Japanese children. Like English-speaking children, Japanese-speaking children classify physical entities in accord with ontological principles in the context of word extension. In contrast, when asked to classify entities without invocation of labels, they often resort to perceptual salience of the entity. Thus, when shape and material are equally salient, they tended to form a disjunctive category, which severely violates the ontological principle, selecting both the shape and material items at the same time. Given a rather dramatic difference in the classification behavior across the two conditions, we were slightly concerned that the children might have taken the phrase *onaji mono* [same thing] to mean "same in appearance." We thus tested an additional twelve children using an instruction that explicitly asked them to select what was or were the "same kind" as the standard entity (see Diesendruck & Bloom, 2003). The experimenter said to the children, Kore [this] to [with] onaji [same] shurui [kind] no [genitive particle] wo [Accusative particle] totte [get-imperative]. [Get me what is/are the same kind as this]. The results were virtually the same as they had been in the previous "same thing" instruction.⁴ Taken together, the results of Study 2 confirmed the well-known word/no-word difference in young children's categorization.

The results of Study 1 and 2 together suggest that language can affect our construal of physical entities in two ways. The first way was manifested by differences in the default construal of perceptually ambiguous entities across speakers of different languages. The fact that adults showed cross-linguistic differences in the construal of the entities in the Simple-Object and Substance trials in the no-word classification context provides more direct evidence than what was presented by Imai and Gentner (1997) that the influence of structural differences across different languages can yield different construals of the same entities, as this cross-linguistic difference was observed even in the realm of non-linguistic classification contexts (Lucy, 1992). At the same time, the difference across the word-extension and no-word classification contexts in both English-speaking and Japanese-speaking children suggests that the presence of language (labels in particular) per se, even within a single language community, influences thought in that it fosters young children's classification based on ontological kinds rather than on mere perceptual salience (see Markman & Hutchinson, 1984; Waxman & Gelman, 1986; Landau, Smith, & Jones, 1988; for similar findings). Thus, there are at least two ways in which language influences thought. First, it shapes children's perception-based, fragmental categories into adult-like, principle kind-based organization. Second, language biases speakers of a given language toward a language-specific construal of entities whose perceptual affordance with respect to individuation is weak.

Given the results suggesting that the presence of language itself (even within a single language) might influence one's construal of things in the world, another interesting question regarding the language and thought issue is how the default construal of a given entity interacts with syntax when syntax provides a cue for the referent entity's status of individuation. We explore this question in Study 3.

3. Study 3: Word Extension with Syntactic Information

When the speakers' default construal for a given entity conflicts with the syntactic information, is the syntax powerful enough to change the construal (Gordon, 1985), or does the person's default construal of the entity take precedence over the syntactic information (Soja, 1992)? This question is important in that it is deeply related to the interpretation of the crosslinguistic differences in the Simple-Object and Substance trials found in Study 1. Should they be interpreted as showing that English speakers and Japanese speakers have incompatible construals for the same entity? This is possible if one takes an extreme view of linguistic relativity such as that advanced by Quine (1969) and Lucy (1992). However, one thing to keep in mind is that, despite the difference in the performance in the Simple-Object and Substance trials, Japanese children did indeed honor the ontological principle that names for a physical entity cannot be generalized across the two ontological kinds, just as English-speaking children did. How do we explain this paradox?

One account we offer is that the ontological distinction between objects and substances is universally shared, but that language influences the preferred construal of entities that are located around the boundary of the two ontological classes on the individuated-non-individuated continuum (cf. Gentner & Boroditsky, 2001). This means that the criteria for determining the membership for the two ontological kinds may be influenced by a bias developed as a result of learning a particular language. Nonetheless, people appreciate the ontological distinction whether the language grammatically marks it or not, and people can take the alternative, nondefault construal if some cue is provided.

To explore this possibility, in Study 3, we presented nonsense labels embedded in either a count noun syntactic frame or a mass noun syntactic frame. It is known that English speakers are aware of how the count-mass syntax maps onto the corresponding ontological classes from a very young age (e.g., Gordon, 1985; Soja, 1992; Bloom, 1994; Wisniewski et al., 1996; Subrahmanyam, Gelman, & Landau, 1999). We thus wished to examine how English speakers' default construal of a given entity interacts with syntactic information. If English speakers construe the Simple-Object stimuli only as individuated objects and cannot entertain the possibility that they can also be construed as arbitrary lumps of nonindividuated substances, they would have difficulty in shifting their construal in accord with the syntactic information when a noun's syntactic status strongly conflicts with their construal of the denoted entity. In contrast, if English speakers are aware that the simple-shaped discrete entities used for the Simple-Object trials could be construed as portions of substances and that the entities used for the substance trials are really non-individuated substances, they should be able to change their construal very easily for these entities according to the syntax.

3.1. Method

3.1.1. Participants

Twenty-four monolingual English-speaking 4-year-olds (M = 4; 4; range = 4;0–5; 0), who were from the middle- to upper-middle class attending a preschool in a suburban city in North Carolina, participated in Study 3. The number of boys and girls was equal. Twenty-four undergraduate students at Northwestern University, all of whom were monolingual native

English speakers, also took part in the study. The participants were randomly assigned to the count syntax condition or to the mass syntax condition.

3.1.2. Materials

Materials were identical to those used in Study 1 as well as to those used in Imai and Gentner's (1997) study.

3.1.3. Procedure

Participants were asked to select one of the two alternatives that matched the standard. However, in this study, a novel noun was associated with the standard using an explicit syntactic frame. The participants in the count-noun condition heard novel nouns used with count syntax throughout the 12 trials. Likewise, in the mass-noun condition, novel nouns were presented in the mass syntax for all 12 trials. The instruction used in the count syntax condition was: "Look! This is *a* X (pointing to the standard). Can you point to *another* X?" The instruction for the mass noun condition was: "Look! This is *some* X. Can you point to *some more* X?," where X was a nonsense noun.

3.2. Results

The participants' performance (the mean proportion of the shape response) in the count- and mass-syntax conditions was shown in Fig. 4. At the top of Fig. 4, we show the English speakers' performance in the word meaning projection task for comparison, borrowing from Imai and Gentner (1997). English speakers, both adults and children, largely shifted their original construal for the presented entities according to the syntax, suggested by a strongly significant effect for this factor, F(1, 53) = 29.105, p < 0.001. In contrast with the large difference between adults and children in the no-word classification in Study 1, no developmental difference was found here, F(1, 53) = 0.90, p > 0.1, or Syntax X Age interaction, p > 0.1.

When the nonsense labels were embedded in the count noun syntactic frame, the Englishspeaking adults showed a strong "object" construal for both the complex-objects and the simple-objects, selecting the shape alternative over 90% in both cases; this, of course, is significantly different from the chance level, both ps < 0.001. However, their responses in the Complex Object trials fell to the chance level when labels were given in the mass noun syntax (48% shape response, p > 0.1). In sharp contrast, in the Simple-Object trials, the adults showed a strong material construal with the mass noun syntax (85% material response, significantly different from chance, p < 0.001) in spite of the fact that they strongly showed the object construal in the no-word classification in Study 1 as well as in the word meaning projection task (with ambiguous syntax) in Imai and Gentner (1997). This suggests that even though English-speaking adults prefers to construe these solid, bounded, simple-shape things as individuated objects, they are fully capable of construing these entities as a portion of substance when given the mass syntax. In the mass-syntax condition, they again selected the material alternative highly above chance for non-solid substances (87%, p < 0.001).

The 4-year-olds' performance in the Complex- and Simple-Object trials was overall similar to that of the adults. Like adults, they unanimously selected the shape item for the complex objects and the simple objects in the count-syntax condition, p < 0.001. When labels were



Fig. 4. English speakers' classification behavior in the (a) neutral-syntax condition, (b) count-syntax condition, and (c) mass-syntax condition.

presented in the mass syntactic frame, the rate of shape response sharply dropped. Like adults, they showed chance level response in the Complex-Object trials (59% shape response, *ns* from chance, p > 0.1). Different from adults, however, they were also at chance in the Simple-Object trials (46% shape response, p > 0.1).

When hearing mass noun labels for the non-solid substances, both the adults and 4-yearolds dominantly made material responses (87% and 81.4% material response, respectively, both ps < 0.001) even though their performance was at chance level in the word meaning projection task in Imai and Gentner (1997). Interestingly, neither children nor adults showed above-chance "object" construal for the non-solid substances with the count noun syntax (adults: 50%; children: 41.1% shape response, both ps > 0.1). This is noteworthy given that both adults and children in Imai and Gentner's word meaning projection task (and in the no-word classification in Study 1) showed chance-level responses in the substance trials.

3.3. Discussion

Several important points can be made on the basis of the results. First, both 4-year-old and adult English speakers flexibly shifted their construal of physical entities according to cues from syntax. This echoes an established finding in the literature that English-speaking children are sensitive to the mapping between the count-mass syntax and individuation (e.g., Gordon, 1985; Soja, 1992; Bloom, 1994; Subrahmanyam, Gelman, & Landau, 1999). Another interesting finding from Study 3 is that there was little developmental difference in this study, which is in sharp contrast with the very large developmental difference found in a no-word classification task in Study 1.

However, it is important to note that, although syntactic information had a strong impact on English speakers' construal of physical entities, syntax did not turn over their default construal entirely. When the syntax and the ontological status of the entity strongly conflicted with each other (i.e., when labels for the complex-objects were given in the mass syntax, or when labels for the non-solid substances were given in the count syntax), English speakers showed chance-level responses. Thus, when the syntactic cue severely conflicts with the speaker's default construal of the entity, it seems that neither of the two dominates the other; rather, the two balance each other, and this yields chance-level responses on average. It is only when the entity's perceptual affordance toward individuation is ambiguous and hence allows two alternate construals that syntax makes the strongest impact on people's construal of the entity, as in the case of the Simple-Objects in our experiment.

Unlike adults, English-speaking children's performance in the Simple-Object trials was still at chance level even when labels were given in the mass noun syntactic frame. However, recall that the rate of their shape responses had been very high (91%)—in fact, almost as high as that for the complex object case (95%), when the syntax was ambiguous. This suggests that, unlike adults, 4-year-olds construed these simple structured bounded entities only as individuated objects (see Shipley and Shepperson, 1990); hence, even when mass noun labels were used, they could not entirely overcome the object construal bias.

Also of great interest was that the response pattern in the count syntax condition was almost identical to the pattern found in the word meaning projection case by Imai and Gentner (1997) for both age groups. This is no surprise for the Complex-Object and Simple-Object

trials, because the rates of shape responses in these two trial types were already very high in the ambiguous syntax case. For the Substance trials, however, we had expected to see an increase of the shape response in the count syntax condition, as their performance had been hovering around 50% in the ambiguous syntax word meaning projection case. However, surprisingly, the English-speakers were still at the chance level in extending labels for the non-solid substances when labels were embedded in the count-syntax. This suggests that the English speakers had assumed that the novel nouns presented in the ambiguous syntactic frame were indeed count nouns. Because the count-mass syntax is obligatory in English, perhaps the English speakers in Imai and Gentner's study did not (or perhaps more accurately, could not) encode the noun as having a "neutral" syntactic status. Rather, they determined the noun's syntax status on their own, using whatever cues and knowledge that were available to them. In this case, the English-speaking participants seem to have assumed that the nouns were count nouns rather than mass nouns. In general, people hear count nouns more frequently than mass nouns (Samuelson & Smith, 1999), and this might mean that the count interpretation is the unmarked interpretation of the phrase "the/this/that X," even though articles such as "the," "this," and "that" can appear with either a count noun or a mass noun.

4. General Discussion

4.1. Three ways in which language might affect our construal of things

The three studies reported in this paper clarify some questions that arose from Imai and Gentner's (1997) research and give us important insights into our understanding of the relation among language, the ontological distinction between objects and substances, and construal of things in the world with respect to individuation. In particular, we argue that the ontological distinction between kinds of object and substance is universally shared and functions as a constraint on early learning of words. At the same time, we also demonstrated that language affects our construal of some entities, and we suggest that there are at least three different ways doing so. We first discuss each of the three ways and then discuss how the universal ontological position and cross-linguistic differences in the default construal of some entities can be compatible with each other.

4.2. Cross-linguistic differences due to the structural difference among languages, and how the difference might emerge

First, it appears that language-specific structures can influence the default construal of entities that are located around the boundary of the two ontological kinds. The structure of English seems to bias English speakers toward the object construal, whereas the structure of Japanese seems to bias Japanese speakers toward the substance construal. English requires its speakers to determine whether a given entity is individuated and should hence be denoted by a count noun or whether it is nonindividuated and should hence be denoted by a mass noun, even when the entity's perceptual properties do not strongly afford a particular construal. Thus, English speakers may develop simple perceptual heuristics, which can be instantly applied even when they have very little knowledge about the target entity. Because solidity and boundedness are in general very good indicators for individuation, English speakers may also develop a bias toward construing any solid, bounded entity (including simple-structured entities that could as well be construed as chunks of rigid substances) as an individuated object. Also, because complex shape is another good indicator of individuation (Gentner & Boroditsky, 2001), English speakers may form a strong sensitivity to shape, and this may have led the English speakers in our studies to think that the complex shapes in which the non-solid substances were configured indicated individuation, even though they could see that those entities were indeed portions of non-individuated substances. Another factor that is probably relevant to the higher sensitivity to shape in English speakers even for the non-solid substances (when they were formed into distinct shapes) is the fact that count-nouns predominate over mass nouns in terms of their distribution in everyday conversational language (Samuelson & Smith, 1999). In fact, the results of Study 3 provide some support for this possibility. We observed that the performance of the English-speaking adults in the count-syntax condition was almost identical to that of the English-speaking adults in Imai and Gentner's (1997) word meaning projection task with ambiguous syntax. This suggests that English speakers cannot encode a noun without the count-mass assignment, and that the count syntax is the unmarked interpretation when the noun's syntactic status is ambiguous, as long as the entity denoted by the noun allows some degree of individuated construal.

In contrast with English, Japanese does not specify the entity's status of individuation in grammar and, hence, Japanese speakers may not have developed such special attention to solidity and shape in determining whether a given entity should be construed as individuated or nonindividuated. Thus, when the entity's perceptual affordance for object–substance class membership was weak and ambiguous (and, hence, when two alternative construals were possible), as was the case with the entities used in the Simple-Object trials, Japanese children did not show a systematic bias toward one construal over the other.

We observed an interesting developmental pattern of the language-specific bias in this research. English-speaking children's performance was very similar to that of English-speaking adults in the linguistic (word-extension) context, but their performance in the no-word classification context was more similar to that of the Japanese children than it was to the adults in their own language group. In contrast with children, adults within each language group showed virtually identical response patterns in the classification behavior across the word extension (with ambiguous syntax) and the no-word classification contexts. This pattern suggests that children first become sensitive to conceptual/semantic features that are relevant to making language-specific categories in the realm of language, and this sensitivity gradually forms into a language-specific bias that is habitually applied even in situations that do not directly involve language.

4.3. Influence of words on forming ontology-constrained categories

A second way in which language might influence our thought was manifested in the difference in classification behavior across the word-extension and no-word classification contexts in children. Specifically, both English- and Japanese-speaking children showed principled, ontology-constrained classification in the context of word extension while classifying entities based on salient perceptual properties in a no-word classification context. This is perfectly in accord with results in the body of developmental literature (e.g., Markman & Hutchinson, 1984; Waxman & Gelman, 1986; Landau, Smith, & Jones, 1988; Imai, Gentner, & Uchida, 1994; Subrahmanyam, Gelman, & Landau, 1999). However, does this mean that adult-like categories magically emerge with the presence of words when there is no ontological concept? Of course not. Without *some form* of the understanding that objects and substances are existences that are governed by different principles, children's word learning could not be constrained by the ontological principles (Soja, Carey, & Spelke, 1991; Huntley-Fenner, Carey, & Solimando, 2002; see also Clark, 2001).

However, the rudimentary conceptual understanding that objects and substances have different natures does not always lead to the ability to forming categories on the basis of ontological principles, just as the rudimentary knowledge that animals and artifacts are of different kinds does not always lead to adult-like taxonomic categorization and inductive inference of properties (e.g., Keil, 1989; Markman, 1989). Things can be similar in many ways, and thus there is more than one way of grouping them. For example, we can classify things on the basis of similarity in one particular perceptual dimension such as shape, texture, or color. Alternatively, we can group things on the basis of a thematic relation or on the basis of non-perceptual, deeper similarity based on ontological/ taxonomic kinds. In the presence of multiple kinds of similarity, even though children have rudimentary understanding of the ontological distinction between objects and substances, they may have not yet learned which way of grouping is the way adults in their community (culture) classify things in the world by default when a special goal or context is not specified. Language is one driving force for children to pay attention to the kinds of categories that are the norm in their culture, that is, categories that are agreed to signal deeper commonalities (Imai, Gentner, & Uchida, 1994; Gentner & Namy, 1999).

4.4. Temporary on-line shift of construal by language

Language may also influence our on-line construal of entities, as linguistic labels or grammatical categories can lead us to construe the same thing differently or lead us to pay attention to different aspects of information in the environment at the moment (Hunt & Agnoli, 1991). For example, in the classic experiment by Carmichael, Hogan and Walter (1932), people were shown a series of ambiguous line drawings, (e.g., an object of two rings connected by a line). For half of the subjects, the drawing was labeled as "glasses," and for the remaining half, it was labeled as a "dumbbell." After some delay, the subjects were asked to draw the pictures they had seen. The subjects deformed the pictures in accord with the given label when they drew them. The pictures drawn by the subjects who were given the "glasses" label looked much more like glasses, and the pictures drawn by those who were given the "dumbbell" label looked much more like dumbbells, than did the original ambiguous picture. Also, in learning grammatical categories in a new language, people may construe objects that they learn to be in the same grammatical category as "more similar" than they normally would in their own language (Boroditsky, Schmidt, & Phillips, 2003).

In our case, we demonstrated that English-speaking 4-year-olds and adults change the default construal with labels embedded in the count-mass syntax. This form of influence of language on our construal of entities seems to be more direct than the other two forms

discussed earlier, as the count-mass syntax directly indicates the status of individuation for the Entity in question. At the same time, it should be distinguished from the first form—the cross-linguistic difference of default construal of the entities in the middle zone of the objectsubstance—continuum because in many cases, this temporary influence does not develop into a habitually-applied bias in entity construal. For example, we would not expect that the shift of construal of the ambiguous picture of two connected rings with the labels "glasses" or "dumbbells" to result in any long-term consequences. The case of the English count-mass syntax is interesting in this respect. The fact that English speakers must always decide on the status of individuation of an entity together with the distributional nonequality between count nouns and mass nouns seems to cause a long term bias toward the object construal for ambiguous-looking entities that is applied even in no-word cognitive domains. In contrast, although the mass noun syntax leads the speakers to a temporary shift from the default object construal toward the substance construal at the moment in which the label is produced, this shift does not seem to develop into a long-term bias in English speakers' construal of entities.

4.5. The ontological concept is universally present, but language can influence the preferred construal of entities

The results reported in this paper indicated that language could influence our construal of entities (especially those located in the middle zone of the object-substance continuum) either temporarily or habitually. However, at the same time, we do not intend to argue that Japanese and English speakers have fundamentally different "concepts" of object kinds and substance kinds. On the contrary, we propose that the ontological distinction between object kinds and substance kinds is universally present from very early stages of development and that it functions as one of the most basic constraints for word learning regardless of whether the ontological status of words (nouns) is explicitly marked by syntax. The fact that Japanese children extended the label within the boundary of the ontological kind even when the task allowed them to cross the ontological boundary (Study 2) strongly suggests that Japanese speakers appreciate the ontological distinction regarding individuation, contrary to Quine's (1969) conjecture that the ontological distinction between object kinds and substance kinds can be learned only through the learning of a grammatical apparatus that distinguishes the two kinds. However, the statement that the ontological distinction is universally shared in itself does not have to imply that speakers of all language construe all entities in the world exactly the same fashion, or that language plays no role in shaping adult-like ontological concepts. Likewise, the notion of universally shared conceptual categories should not be rejected simply because some instances are construed in cultural/language specific ways. Here, it is useful to distinguish the conceptual core from categorization (Armstrong, Gleitman, & Gleitman, 1983). Even though the ontological distinction is dichotomous, how likely each particular entity in the world is construed as "inherently individuated" or "inherently nonindividuated" can be continuous with a gray zone in the middle. The world is structured to form natural clusters, inviting humans to categorize entities according to these natural divisions (e.g., Rosch, 1978; Berlin, 1992). Entities that lie at the center of each cluster are considered "better members" than others that are located near the boundary of an adjacent cluster (Rosch & Mervis, 1975). In our case, the objects used in the Complex-Object trials are better members of the class of "object kinds" than those used in the Simple-Object trials (Prasada, Ferenz, & Haskell, 2002), and indeed, people's classification behavior was affected by how strongly the perceptual nature of the target entity invites humans to place it into a particular category. Also, rudimentary appreciation of the basic ontological distinctions (e.g., the distinction between objects and substances and between animate beings and inanimate beings, etc.) does not mean that young children can always form adult-like categories. In this sense, language can influence construal of entities as well as categorization both cross-linguistically and developmentally, just as the count-mass syntax can shift English speakers' default construal temporarily but only to a limited degree.

5. Conclusions: How Language Can Affect Thought

In this paper, we asked whether language influences our thought, and if so, then how. Our answer is two-fold. If one asks whether structural differences among different languages result in concepts that are different enough to be incommensurable, our answer is definitely no. However, this in itself does not mean that there is no room for language to play a role, both cross-linguistically and developmentally, and both habitually and temporarily. The results of this research suggest that there are at least three ways in which language affects the ontological categories and construal of entities in the world. First, the structural differences among different languages in marking individuation can affect the default construal for entities that are located in the middle of the individuation continuum. Second, learning labels leads children to classify physical entities on the basis of ontological principles. Third, when a language does have a syntactic device marking individuation (such as the count-mass syntax in English), this syntactic marking can move the speaker's default construal of entities temporarily, though only to a restricted degree.

Human cognition is neither absolutely universal nor absolutely diverse (Malt, 1995; Medin, Lynch, Coley, & Atran, 1997; Gentner & Boroditsky, 2001). To fully understand human cognition, we need to investigate how our universal cognitive architecture and/or universally possessed knowledge interacts with language both within a single language and cross-linguistic contexts, and, furthermore, how universal cognitive constraints and language interact with the way the world is structured and presents itself to humans (see Saalbach & Imai, in press, for relevant discussion).

Notes

1. This was when a novel label was associated with a familiar animal (e.g., a bear). The same age Japanese children selected multiple objects and hence indicated that they interpreted the label to be a common (category) name when a label was associated with a novel animal or artifact, or a familiar artifact. This pattern of behavior suggests that Japanese children are able to either restrict their selection to only one item or select multiple items in accord with their interpretation of what concept the label refers to.

- 2. Because a child was allowed to select either one particular item or more than one item, the child has an option of selecting or not selecting the shape item (the material item), for example, and hence, the chance probability for selecting the shape item (the material item) was set as 50% here.
- 3. It should be noted that, as a consequence of this, the base probability for making a ontology-consistent response within a Simple-Object trial is twice as high (2/8) as that in a Complex-Object or a Substance trial (1/8). This difference in the chance probability would be problematic if we were interested in comparing the performance across the three entity types. However, our interest here is to compare the word-extension condition and no-word classification condition, and for this purpose, it should not be a problem.
- 4. There was no statistically significant difference in the rate of ontologically correct responses across the "same thing" and "same kind" instructions (49% versus 55%), F(1, 24) <1.

Acknowledgments

This research was supported by the Ministry of Education Grant-in-aid for Scientific Research awarded to Mutsumi Imai (#15300088). We are indebted to three anonymous reviewers for thoughtful comments on earlier version of the manuscript. We thank the children and their parents for their participation in this research.

References

- Aikhenvald, A. Y. (2000). *Classifiers: A typology of noun categorization devices*. New York: Oxford University Press.
- Armstrong, S. L., Gleitman, L., & Gleitman, H. (1983). What some concepts might not be. Cognition, 13, 263–308.
- Berlin, B. (1992). *Ethnobiological classification: Principles of categorization of plants and animals in traditional societies*. Princeton, NJ: Princeton University Press.
- Bloom, P. (1994). Possible names: The role of syntax-semantics mappings in the acquisition of nominals. *Lingua*, 92, 297–329.
- Boroditsky, L., Schimidt, L. A., & Phillips, W. (2003). Sex, Syntax, & Language. In D. Gentner & S. Goldin-Meadow (Eds.), *Language in mind: Advances in the study of language and thought* (pp. 61–80). Cambridge, MA: MIT Pess.
- Carmichael, L., Hogan, H. P., & Walter, A. A. (1932). An experimental study of the effect of language on the reproduction of visually perceived form. *Journal of Experimental Psychology*, *15*, 73–86.
- Clark, E. (2001). Emergent categories in first language acquisition. In M. Bowerman, & S. Levinson (Eds.), *Language acquisition and conceptual development* (pp. 379–405). Cambridge, UK: Cambridge University Press.
- Choi, S., & Bowerman, M. (1991). Learning to express motion events in English and Korean: The influence of language-specific lexicalization patterns. *Cognition*, 42, 83–121.
- Diesendruck, G., & Bloom, P. (2003). How specific is the shape bias? Child Development, 74, 168-178.
- Gentner, D., & Boroditsky, L. (2001). Individuation, relativity and early word learning. In M. Bowerman, & S. Levinson (Eds.), *Language acquisition and conceptual development* (pp. 215–256). Cambridge, UK: Cambridge University Press.
- Gentner, D., & Namy, L. (1999). Comparison in the development of categories. *Cognitive Development*, 14, 487–513.

- Gordon, P. (1985). Evaluating the semantic categories hypothesis: The case of the count/mass distinction. *Cognition*, 20, 209–242.
- Haryu, E., & Imai, M. (2002). Reorganizing the lexicon by learning a new word: Japanese children's inference of the meaning of a new word for a familiar artifact. *Child Development*, 73, 1378–1391.
- Hunt, E., & Agnoli, F. (1991). The Whorfian hypothesis: a cognitive psychology perspective. *Psychological Review*, 98, 377–389.
- Huntley-Fenner, G., Carey, S., & Solimando, A. (2002). Objects are individuals but stuff doesn't count: Perceived rigidity and cohesiveness influence infants' representations of small groups of discrete entities. *Cognition*, 85, 203–221.
- Imai, M., & Gentner, D. (1997). A cross-linguistic study of early word meaning: Universal ontology and linguistic influence. *Cognition*, 62, 169–200.
- Imai, M., & Haryu, E. (2001). How do Japanese children learn proper nouns and common nouns without clues from syntax? *Child Development*, 72, 787–802.
- Imai, M., Gentner, D., & Uchida, N. (1994). Children's theories of word meaning: The role of shape similarity in early acquisition. *Cognitive Development*, 9, 45–75.
- Keil, F. C. (1989). Concepts, kinds, and cognitive development. Cambridge, MA: MIT Press.
- Landau, B., Smith, L. B., & Jones, S. S. (1988). The importance of shape in early lexical learning. *Cognitive Development*, 3, 299–321.
- Lucy, J. A. (1992). *Grammatical categories and cognition: A case study of the linguistic relativity hypothesis.* Cambridge, UK: Cambridge University Press.
- Lucy, J. A., & Gaskins, S. (2001). Grammatical categories and the development of classification preferences: A comparative approach. In S. Levinson, & M. Bowerman (Eds.), *Language acquisition and conceptual development* (pp. 257–283). Cambridge, UK: Cambridge University Press.
- Malt, B. C. (1995). Category coherence in cross-cultural perspective. Cognitive Psychology, 29, 85–148.
- Malt, B. C., Sloman, S., Gennari, S., Shi, M., & Wang, Y. (1999). Knowing versus naming: Similarity and the linguistic categorization of artifacts. *Journal of Memory and Language*, 40, 230–262.
- Markman, E. M. (1989). *Categorization in children: Problems of induction*. Cambridge, MA: MIT Press, Bradford Books.
- Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology*, 16, 1–27.
- Medin, D. L., Lynch, E. B., Coley, J., & Atran, S. (1997). Categorization and reasoning among tree experts: Do all roads lead to Rome? *Cognitive Psychology*, 32, 49–96.
- Prasada, S., Ferenz, K., & Haskell, T. (2002). Conceiving of entities as objects and as stuff. Cognition, 83, 141–165.
- Quine, W. V. (1969). Ontological relativity and other essays . New York: Columbia University Press.
- Rosch, E. (1978). Principles of categorization. In E. Rosch, & B.B. Lloyd (Eds.), Cognition and categorization (pp. 28–46). Hillsdale, NJ: Lawrence Erlbaum.
- Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology*, 7, 573–605.
- Saalbach, H. & Imai, M. (in press). The scope of linguistic influence: Does a classifier system alter object concepts? Journal of Experimental Psychology: General.
- Samuelson, L. K., & Smith, L. B. (1999). Early noun vocabularies: Do ontology, category organization, and syntax correspond? *Cognition*, 73, 1–33.
- Senft, G. (2000). What do we really know about nominal classification systems? In G. Senft (Ed.), Systems of nominal classification (pp. 11–50). Cambridge, UK: Cambridge University Press.
- Shipley, E. E., & Shepperson, B. (1990). Countable entities: Developmental changes. Cognition, 34, 109–136.
- Slobin, D. (1987). Thinking for speaking. Berkeley Linguistic Society, 13
- Soja, N. N. (1992). Inferences about the meanings of nouns: The relationship between perception and syntax. *Cognitive Development*, 7, 29–45.
- Soja, N. N., Carey, S., & Spelke, E. S. (1991). Ontological categories guide young children's inductions of word meaning: Object terms and substance terms. *Cognition*, 38, 179–211.

- Subrahmanyam, K., Gelman, R., & Landau, B. (1999). Shape, material and syntax: Interacting forces in the acquisition of count and mass nouns. *Language and Cognitive Processes*, 14, 249–281.
- Waxman, S. R., & Gelman, R. (1986). Preschoolers' use of superordinate relations in classification and language. *Cognitive Development*, 1, 139–156.
- Wisniewski, E., Imai, M., & Casey, L. (1996). On the equivalence of superordinate concepts. *Cognition*, 60, 269–298.