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ARTICLE WITH PEER COMMENTARIES AND RESPONSE

Shifting ontological boundaries: how Japanese- and English-speaking children generalize names for animals and artifacts

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Abstract

Past research shows that young language learners know something about the different category organizations of animals, objects and substances. The three experiments reported here compare Japanese-speaking and English-speaking children's novel name generalizations for two kinds of objects: clear instances of artifacts and objects with ambiguous features suggestive of animates. This comparison was motivated by the very different nature of individuation in the two languages and by the boundary shift hypothesis that proposes that entities that straddle the individuation boundary of a language are assimilated toward the individuated side. The results of the three experiments support the hypothesis. An explanation in terms of mutually reinforcing correlations among language, perceptual properties and category structure is proposed.

Our perceptions and our interactions with objects tell us that there are different kinds of things in the world. There are animate things that react and intentionally move; there are discrete things with stable forms that we move; and there are substances, masses with less regular and more variable forms. This partition of things into animals, objects and substances is sometimes considered an ontological partition, in two senses: in the Aristotelian sense that these are three different kinds of existence and in the psychological sense that these are distinct psychological kinds that provide a foundation for human category learning.

In this paper, we propose that the language one learns influences – perturbs slightly but measurably – the boundaries between the psychological categories of animal, object and substance. We present evidence for this idea in three studies of how young children learning Japanese and young children learning English generalize names for things with ambiguous perceptual properties. We concentrate on ambiguous forms not because there are many such entities in the world, but because children's conceptualizations of ambiguous forms provide insight into their expectations about categories and the mechanisms that create these expectations. Similarly, we study children acquiring two different languages, not solely because of an interest in cross-cultural effects, but primarily as a window onto the mechanisms of development. The larger idea behind this work is that ontological kinds may be the product of statistical regularities among perceptual properties and among these properties and language. We specifically consider this idea in the General discussion.

Two issues that have generated much interest and evidence in the literature motivate the experimental hypotheses: (1) the different ways various languages mark individuals and (2) children's expectations about lexical categories.

Individuation

Lucy (1992) proposed an individuation continuum that is intimately related to ontological distinctions among animates, objects and substances. This continuum, with animates at one end and substances at the other, orders kinds by the degree to which instances are marked as individuals with devices such as the plural and indefinite articles.

English with its count/mass distinction is said to partition the continuum between objects and substances. Count nouns are nouns that can take the plural (e.g. dogs, cups); mass nouns are not pluralized (e.g. milk)

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but take continuous quantifiers such as *some* and *much*. Conceptually, then, count nouns seem to refer to entities that are discrete; one can have *one cup* or *two cups*, but not *much cup* as a portion of a cup is not a cup. Conceptually, mass nouns seem to refer to entities that are continuous and unbounded. One can have *much milk* or *little milk*, and either way it is milk.

Importantly, the likelihood that a particular entity is conceptualized as bounded and discrete, and thus is referred to by a count noun, varies systematically across the continuum from animates to substances. Animates and most complex objects are referred to by count nouns, virtually without exception. However, some entities, for example, muffin, can be conceptualized either as a bounded entity or a continuous mass and thus may be referred to using count (*a muffin*) or mass (*some muffin*) syntax. Finally, other entities such as water and milk are typically conceptualized as continuous masses and thus are referred to by mass nouns. But substances can also be conceptualized in discrete portions and in these cases discrete quantifiers are added (e.g. *a cup of milk*, *a puddle of water*) to indicate the boundedness of the referred to entity. The two key points are these: First, the ontological continuum is not partitioned into equivalent categories of individuals and nonindividuals. Instead, some kinds are always treated as bounded and discrete and others only sometimes accorded this privilege. Second, English treats animates and complex objects in the same way, as individuals, and the likelihood of being treated as an individual falls sharply as one moves on the continuum from objects to substances.

Japanese also includes lexical and syntactic devices relevant to individuation that are intimately related to the continuum from animates to substances. The nature of this relation, however, is different from English. First, Japanese nouns that refer to multiple entities are not obligatorily pluralized. Thus *inu-ga-ita* could be used to mean either 'there was a dog' or 'there were many dogs'. Second, nouns referring to multiple humans or young animals are optionally pluralized with the suffix *-tachi*. Thus, *koinu-tachi-ga-ita* is 'there were some puppies'. The plural suffix appears not to be used on inanimate nouns. Third, animates, objects and substances can be referred to as discrete and bounded by adding discrete quantifiers, just as English does for substances. There are unique quantifiers for animates but the quantifiers used for objects and substances form an overlapping set. Thus the Japanese system of pluralization and quantifiers contrasts with that of English in that it distinguishes animates from complex objects and substances.

There is an additional distinction in Japanese that appears closely related to individuation and that is also organized by the continuum from animates to substances. This is the distinction between *iru* and *aru* in locative constructions. For the fundamental notion of existence ('there is') and spatial location ('be located'), Japanese has separate verbs for animates and inanimates: *aru* is 'inanimate object exists/is located' and *iru* is 'animate object exists/is located'. Contexts in which one uses *iru* overlap with contexts in which one uses the plural *-tachi.* Thus, both the plural, *-tachi*, and *iru* privilege animate forms. Both are also sometimes extended to inanimates. For example, dolls are normally conceptualized as inanimate objects but they also can be conceptualized as pretend animates. In these contexts, *iru* is used and the noun may be pluralized by *tachi* (e.g. *ningyou-tachi ga ippai iru* – there are many dolls). It is rare (but possible) for other artifacts to take these forms (e.g. *taxi ga iru* – there is/are taxi(es) – may be used when referring to a taxi *and* its driver). These forms do not appear to be used for substances. Again, then, we see a graded function relating individuation to ontological kinds. However, the function is different for Japanese than for English; the likelihood of treating an object as an individual drops markedly between animates and objects in Japanese whereas in English it drops markedly between objects and substances.

Both Quine (1969) and Lucy (1992) have suggested that such language differences influence the ontological distinctions made by speakers of the language. The evidence from children's formation of new lexical categories suggests they may be partially right.

Children's expectations about lexical categories

One task that has been used to study children's expectations about ontological distinctions is the novel noun generalization task. In this task, experimenters present children with an entity and name it with a novel name, for example, *this is the mel*. The experimenter then presents other test stimuli and asks the child which of these is called by the same name, for example, *show me the mel*. This is an interesting task because the naming event itself provides the child with few constraints on the class to which the name applies. Thus, children's generalizations from this minimal task input provide insights into children's expectations about how nouns map to categories.

In an important series of experiments, Soja and colleagues (Soja, Carey & Spelke, 1991; Soja, 1992) used this task to investigate English-speaking children's expectations about object and substance categories. When a novel solid and rigidly shaped thing was named, 24- and 30-month-old children generalized the name to new instances by shape. In contrast, when a novel nonsolid substance was named, children were less likely to attend to shape and more likely to extend the name to new instances by material. Although Soja (1992) found that the children were sensitive to whether the novel noun was presented in a count frame (*a mel*) or a mass frame (*some mel*), the solidity of the named substance was the dominant force on children's extensions of the name. Soja and colleagues interpreted these results as supporting a prelinguistic basis to the ontological distinction, a distinction, then, that does not rest entirely on syntactic knowledge.

This conclusion was also supported but refined in important ways by a subsequent cross-linguistic study conducted by Imai and Gentner (1997). Using a task similar to that used by Soja, they compared Japanese-speaking and English-speaking children's generalizations of names for novel objects and novel substances. However, they used three kinds of exemplars: solid and complexly shaped things, solid but simply shaped things, and nonsolid and thus simply shaped substances. Simple solids present an interesting case because they are ambiguous, like complex objects in their solidity but like nonsolid substances in the uniformity of their material and simplicity of their shape.

Imai and Gentner's results are consistent with the idea that English- and Japanese-speaking children conceptualized these ambiguous forms – the simple solids – in different ways. That is, if name extensions by shape indicate that children saw the entity as bounded and discrete, then English-speaking children conceptualized both the complex and simple solids as discrete objects. Specifically, English-speaking children consistently generalized the names for solid complex and solid simple forms by shape (but generalized the names for nonsolid substances equally often by shape and material). In contrast, and again if shape extensions indicate the conceptualization of the entity as discrete and bounded, the Japanese-speaking children conceptualized only the complex solid objects as discrete things. They consistently generalized names for complexly shaped solids by shape but generalized names for simply shaped solids equally often by shape and material and they generalized names for nonsolids mostly by material. Thus English-speaking children seem to accept a broader range of things (complex and simple solids) as named by shape where Japanese speakers accept a narrower range (complex but not simply shaped objects). In this way, the boundary between objects and substances seems to be in different places for children learning the two languages.

The boundary shift hypothesis

We propose that this shift is the product of interactions among three layers as illustrated in Figure 1. The bottom

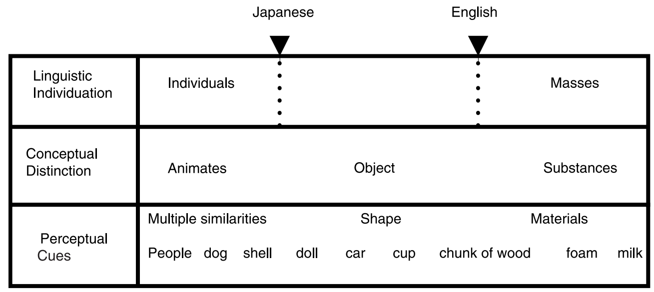

Figure 1 *Three mutually dependent layers: linguistic, conceptual and perceptual organization.*

layer is a continuum of objects, ordered by their perceptual properties, from those exhibiting properties most characteristic and diagnostic of animacy to those characteristic of rigid and complex artifacts to those characteristic of nonsolid substances. The perceptual properties presented by these entities correlate with and are predictive of the conceptual distinctions between animate, inanimate and substance at the next level. Evidence from Soja (Soja *et al.*, 1991; Soja, 1992) and Imai and Gentner (1997) as well as others (Massey & Gelman, 1988; Mandler, Bauer & McDonough, 1991; Yoshida & Smith, 2001) indicates that young children are aware of these correlations between perceptual properties and ontological kinds. Finally, at the top, is the linguistic layer which represents the likelihood function with which linguistic devices mark entities as individuals.

We propose that these layers influence each other and more specifically that linguistic knowledge may alter how perceptual information is weighted and conceptualized. We suggest that English-speaking children treat simply shaped solids as objects namable by shape whereas Japanese-speaking children do not because the two groups of children attend differently to the properties of simply shaped solids. We specifically suggest that English-speaking children attend to the solidity and thus conceptualized the simple solids as objects whereas Japanese-speaking children attend less (or less consistently) to the solidity (and perhaps more to the simplicity of the shape) and thus were more likely than English-speaking children to conceptualize simple solids as substances. This then is the boundary shift hypothesis: the likelihood function relating things in the world to the conceptual categories of object and substance is shifted slightly in Japanese relative to English.

There are two ways to think about this hypothesized shift. One possibility is that the structure of Japanese increases the likelihood that simple objects are treated as substances. The other possibility is that the structure of English shifts the function and causes solid substances to be objectified. We favor the second alternative, that English shifts the boundary. Our reasoning is this: As illustrated in Figure 1, simply shaped solid entities such as a chunk of wood fall near the individuation boundary in English but far from it in Japanese. Accordingly, we propose that solid substances are conceptualized as objects by English speakers *because* they fall near the individuation boundary, that is, correlations between perceptual properties and linguistic devices relevant to individuation enhance those perceptual properties characteristic of individualized entities and make them more perceptually potent. Thus, cues associated with complex objects (such as solidity) are more potent cues to ontological kinds for speakers of English *because* solidity is associated with entities that are typically treated as discrete individuals. Put another way, we propose that entities presenting ambiguous perceptual cues that fall near the boundary will be assimilated to the more individualized kind. In the General discussion, we will discuss this idea and the mechanisms that may be responsible for such a phenomenon more thoroughly. The purpose of the present study is to test the generality of such an assimilation effect.

We ask: Is the assimilation of kinds near the individuation boundary to the individualized side a general principle? If it is, then we should see a similar phenomenon at the individuation boundary for Japanese. The individuation boundary in Japanese is between animates and inanimates. Thus, we ask about Japanese children: Are objects that are ambiguous with respect to animacy assimilated toward the individuated end of the continuum? Put another way, are ambiguously animate things more likely to be conceptualized as animates by Japanese-speaking children than by English-speaking children?

Animal-like and artifact categories

Our approach to answering this question is based on past proposals and evidence that animal and artifact categories differ in their perceptual organization. This has been suggested by a number of researchers, including Markman (1989), Jones, Smith and Landau (1991), Gelman and Coley (1991), Keil (1994) and Jones and Smith (2002). Each of these investigators has suggested that animal categories are richly structured by being based on multiple similarities, whereas artifact categories are more simply structured and are based principally on shape. In support of this idea, Jones and Smith (2002) found that adults judged animal categories to be well organized by similarities in shape and texture whereas they judged artifact categories to be well organized by shape alone. Jones *et al.* (1991; also Jones & Smith, 1998) showed that English-speaking children respect these regularities in their novel noun generalizations. They presented 3-year-olds with novel objects with and without properties typical of animate things such as eyes, and they named these objects with novel names. Three-year-olds systematically generalized the names for objects without animacy features by shape but just as systematically generalized the names for objects with animacy features by multiple similarities (in the Jones *et al.* studies, by joint similarity in shape and texture). In other words, the children formed narrower animal categories than object categories, extending names for things with animacy features only to objects that matched the exemplar on multiple properties.

More recently Yoshida and Smith (2001) showed that Japanese-speaking children's novel noun generalizations also honor these differences in the similarity structures of animal and artifact categories. Specifically, Japanese-speaking children like the English-speaking children in Jones *et al.* (1991) generalized names for novel forms with eyes to new instances that matched the exemplar on multiple similarities. Interestingly, Yoshida and Smith also reported that Japanese-speaking children showed this 'eye-effect' at a younger age than did English-speaking children. This last finding fits the idea that Japanese-speaking children might show a heightened sensitivity to cues indicative of animates.

We use this same task in the present experiments. However, unlike the earlier studies, we present Japanese-speaking and English-speaking children with objects that present ambiguous cues. The rationale behind the experiments is this: If children conceptualize an object as depicting an animate thing, they should generalize the name for that object to new instances narrowly, requiring matches on multiple dimensions, not just shape. In contrast, if children conceptualize a named thing as an artifact, they should generalize the name broadly to anything that matches the original in shape. The key prediction is that Japanese- and English-speaking children should differ in the range of things they conceptualize as animate. If forms close to the individuation boundary in a specific language are assimilated toward the individuated side of the boundary, then ambiguous objects with features suggestive of animate things should be near the individuation boundary and treated as animates by Japanese-speaking children just as simply shaped solids are near the individuation boundary for English-speaking children and treated as objects.

If simple solid forms are ambiguous entities that could be thought of as either objects or substances, what are ambiguous entities with respect to animacy? We suggest that dolls, toy animals and statues are ambiguous in that in some contexts we treat them as clearly artifacts and in others as the animate things they depict. Indeed, past research using the novel name generalization task has examined only artifactual representations of animate things. And from these studies we know features such as eyes that are strongly correlated with animacy cause children to form categories based on multiple similarities and not just shape. Accordingly, in the present studies we use objects with cues suggestive of animacy, but cues much more subtle and ambiguous than eyes.

Experiments and rationale

In sum, we test the boundary shift hypothesis by examining young Japanese-speakers' and young English-speakers' novel noun extensions. We present the children with novel entities presenting ambiguous perceptual cues. If the children conceptualize a novel thing as depicting an animate entity, they should generalize its name to new instances conservatively, requiring multiple similarities. If, however, they conceptualize the novel thing as depicting an artifact object, they should generalize its name broadly to all new instances that match the exemplar in shape. Our prediction is that Japanese- and English-speaking children will differ in how they generalize names for ambiguous depictions of animate things. If forms close to the individuation boundary in a specific language are assimilated toward the most individuated side of the boundary, then ambiguously animate things should be near the individuation boundary and treated as animates by Japanese-speaking children just as simply shaped solids are near the individuation boundary for English-speaking children and treated as objects.

This prediction requires, however, that Japanese-speaking children have sufficiently acquired the linguistic distinctions that privilege animates as individuals. Of all the distinctions in Japanese that focus on animacy, we chose to concentrate on the *iru/aru* distinction in locative constructions. Based on the fundamental notions of existence ('there is') and spatial location ('be located'), this distinction seems a likely powerful force on the way Japanese-speaking children think about objects. In English we use the same verb 'be' for both a dog and a cup, saying: *there is a dog* and *there is a cup*. However, the Japanese verb *iru* should be used for a dog, and *aru* should be used for a cup. *Iru* implies being in a place by one's own will. *Aru*, on the other hand, implies 'having been left' at a place. Importantly, *iru* is used whenever one attributes intention or/and self-controllability, for example, for dolls and stuffed toys in play and for people and animals (Arai, 1997; Kinsui, 1984). Thus every time a Japanese-speaking child refers to the location of an object, the child must decide if the object is to be conceptualized as animate or inanimate.

We test young Japanese-speaking children's understanding of the implications of *iru/aru* in Experiment 1 and also show that our ambiguous entities are ambiguous – that they can be conceptualized by Japanese-speaking children as either animate or inanimate. We compare Japanese- and English-speaking children's name extensions for these ambiguous things in Experiment 2 and for unambiguous things (clear artifacts) in Experiment 3. In all the experiments, we used a 'yes/no' version of the novel name generalization task. In this task the child is shown an exemplar, and told its name. Then the child is presented with test objects individually and asked about each one 'Is this a ___?' Although this 'yes/no' procedure has been used in previous studies (e.g. Jones *et al.*, 1991, Jones & Smith, 1998) it is not the form of the task most commonly used. Instead most studies employing the novel noun generalization task use a forced-choice procedure in which children must pick between test objects – between one that matches the exemplar in shape only, for example, and one that matches in material only (e.g. Soja, 1992; Imai & Gentner, 1997). The problem with the forced-choice procedure is that it forces the child to choose between two objects that may both be acceptable or unacceptable instances of the category. This is particularly problematic for studying differences among kinds of categories across languages since some of the relevant differences may lie in the narrowness versus breadth of generalization to new instances.

Experiment 1

Experiment 1 has two purposes. The first is to demonstrate Japanese children's sensitivity to one potentially powerful lexical distinction that partitions animate from inanimate things: the *iru/aru* distinction in locative constructions. The second is to show that the stimulus objects do present ambiguous perceptual cues that could be seen as depicting either animate or inanimate things. To these ends, we presented Japanese-speaking children with a novel entity with protruding pipe cleaners vaguely suggestive of arms and legs. We named the object with a novel name using a construction that required either *iru* or *aru*: 'There is a ___.' If children are sensitive to the implications of *iru*, then the children in that condition should conceptualize the exemplar as animate and generalize the novel name to new instances narrowly, requiring similarities across several dimensions and perhaps, as Jones *et al.* (1991) found, particularly across shape and texture. If children are sensitive to the implications of *aru*, then children in that condition should conceptualize

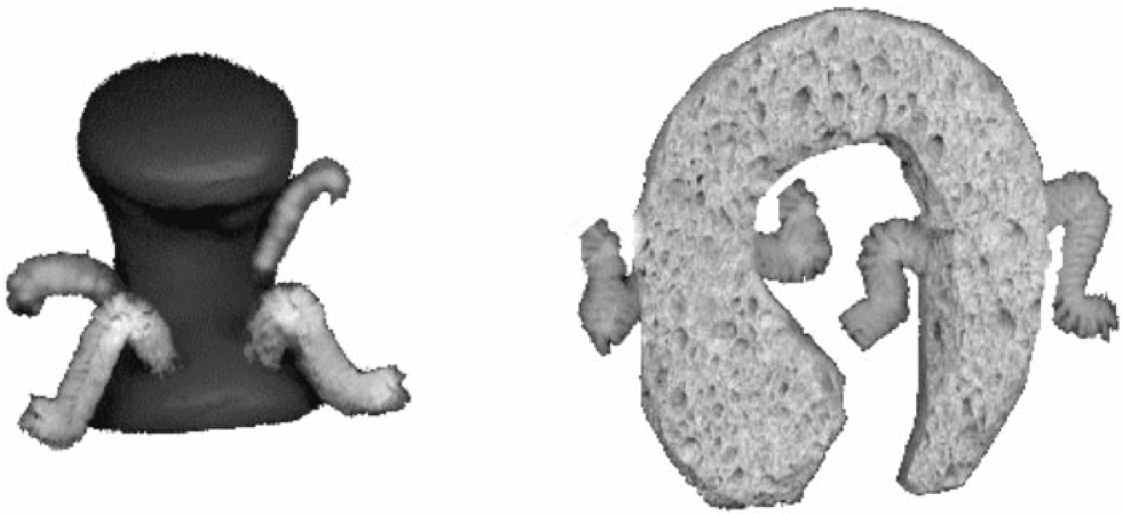

Figure 2 *Test objects used in Experiments 1 and 2.*

the exemplar as inanimate and they should broadly generalize its name to all objects that match the exemplar in shape. Such a result would demonstrate both the children's knowledge of one linguistic form that privileges animates and also the ambiguity of the stimulus objects.

Method

Participants

We recruited 20 monolingual Japanese-speaking children from nurseries in Niigata, Japan. There were two conditions between subjects: the Iru condition and the Aru condition. There were 10 children in each condition, with an equal number of male and female participants. Children's mean age in the Iru condition was 35.01 months, range 27.56 to 39.70 months; and children's mean age in the Aru condition was 34.17 months, range 26.16 to 39.80 months.

Stimuli

There were three stimulus sets, a pre-training set and two test sets. Each set contained one exemplar, unique to that set, which was named with a novel name. The exemplar for the pre-training set was made of orange cardboard shaped in a cone and named 'mobito'. Four test stimuli were used during pre-training; two were identical in all respects to the exemplar, two were different in all respects from the exemplar. One of these was a blue sponge in a trapezoidal shape, and the other was plastic mesh roughly in the shape of a U.

The two experimental sets consisted of an exemplar and six test objects. The examplars are illustrated in Figure 2. The keppuru exemplar was made of red clay, and the tema exemplar was made from pink sponge. Six test objects were constructed for each exemplar. Three matched the exemplar on multiple dimensions: (1) shape, color and texture (sh+tx+co), (2) shape and texture (sh+tx) and (3) shape and color (sh+co). Three matched the examplar on a single dimension: (1) shape (sh), (2) texture (tx) and (3) color (co). The constrasting shapes, colors and textures differed significantly from the exemplar and included objects made out of tinsel, paper and straw as well as sponge and hardened clay. All objects in the pre-training set, the keppuru set and the tema set had four appendages made of pipe cleaners. All objects were 3-dimensional, approximately 7 cm × 7 cm × 7 cm in size.

Design and procedure

The experimental session began with the pre-training set to help children understand that they may say 'yes' to some items and 'no' to others and to ensure the children understood the task. The pre-training sets were structured so as not to bias attention to any particular property (that is, one test object in the pre-training set was identical to the pre-training exemplar and the other two differed from the exemplar substantially on all other properties). The pre-training exemplar was named, 'There is a mobito' using either *iru* or *aru* according to the condition to which the child was assigned. The child was given the object to hold and examine for approximately 30 sec. The experimenter then took the exemplar back and named it again. The child was presented with test objects individually that either were identical to the pre-training exemplar or differed from it on all properties and the child was asked, 'Is this a mobito?' Children were allowed to handle these items before making their judgments and handed them back to the experimenter after responding. This continued until the child answered three questions correctly or for a maximum of eight trials. Feedback was provided on all pre-training trials and only children who passed these pre-training trials proceeded to the experiment proper. All but two children who were replaced did so.

The experimental trials were identical in structure to the pre-training trials with the exception that no feedback of any kind was provided and each exemplar was named with a unique name. The exemplars were presented in the following sentence frames in the Iru and Aru conditions, respectively: 'Koko-ni____-ga iru-yo' and 'Koko-ni____-ga aru-yo.' Test objects were queried as follows in the Iru and Aru conditions respectively: 'Koko-ni____-ga iru-kana?' and 'Koko-ni____-ga aru-kana?'

Each of the six test objects for each of the two exemplars was queried twice for a total of 24 trials (four trials for each kind of test object). All the questions about the name of one exemplar were asked in a block. The order of the blocks (keppuru exemplar and tema exemplar) was counterbalanced across children and the questions within each block were presented in one of two randomly determined orders.

Results and discussion

Figure 3 shows the proportion of 'yes' responses to the questions as a function of condition and test objects. These responses were submitted to an analysis of variance for a 2 (Condition) × 2 (Multiple × Single property match) mixed design. The analysis revealed a main effect of Condition, $F(1, 18) = 6.93$, $p < 0.02$. As predicted, children in the Aru condition (which implies an inanimate exemplar) generalized the name to more test objects than children in the Iru condition (which implies an animate exemplar). The analysis also revealed a main effect of Multiple- versus Single-property matches, $F(1, 18) = 243.92$, $p < 0.001$. As expected, children overall were more likely to generalize the name to new instances that matched on multiple properties than to new instances that matched on just one property.

The meaning of this pattern of results is clarified by comparing children's proportion of 'yes' responses, the name of the exemplar applies to the test object, to the proportion of 'yes' responses expected by chance ($p < 0.05$, two-tailed) for each kind of test object. As indicated in Figure 3, children in the Iru condition generalized the exemplars' names conservatively – only to objects that

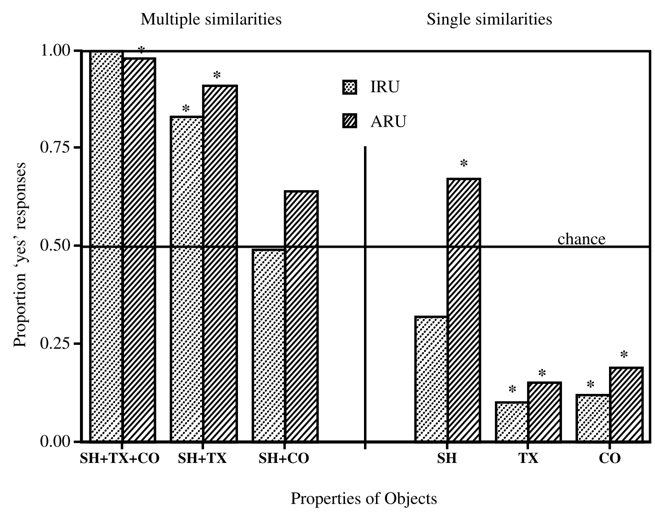

Figure 3 *Proportion of 'yes' responses by Japanese-speaking children to test objects that matched the exemplar on multiple and single properties in the Iru and Aru conditions. On the x-axis, test objects are labeled by properties matching the exemplar. Proportions reliably different from chance (*p *< 0.05, two-tailed) are marked by asterisks.*

matched the exemplar in all properties and to objects that matched in both shape and texture. In contrast, children in the Aru condition more broadly generalized the exemplars' names to objects that matched the exemplars in shape regardless of whether they matched on other properties. The one exception to this in the Aru condition was with the test objects matching in shape and color. Children in the Aru condition did not generalize the name to that test object reliably more often than expected by chance. This is due to two children who rejected the shape + color matching test object on nearly every trial (our best explanation of these two individuals' behaviors is that they found the surface textures of particular shape + color test objects to be too different from the exemplar to be acceptable). The remaining eight children in the Aru condition accepted these test objects as instances of the lexical category over 75% of the time.

Overall, then, children's performance in the Iru condition fits what is expected if children interpret the named exemplar as depicting an animate thing and if they generalize names for animate things conservatively, by joint similarity in texture and shape. And Japanese-speaking children's performance in the Aru condition fits what is expected if they view the named object as an artifact and if they generalize names for artifacts by shape. Japanese-speaking children's categorization of these objects by texture and shape in the context of *iru* and by shape in the context of *aru* extends Jones and colleagues' (1991) and Yoshida and Smith's (2001) previous findings that the perceptual cue of eyes causes children to form categories based on multiple similarities. These results show this effect. Whether an object is conceptualized as an animal, does not depend on perceptual properties alone but is also influenced by linguistic cues.

Before accepting this conclusion, however, we considered another possibility suggested by the fact that Japanese does not distinguish proper from common nouns. *Mobito* in *koko-ni mobito-ga iru- yo* (*There is a mobit*) could be either the name of the kind of thing (a chair) or a proper name (John). Perhaps, then, Japanese-speaking children as a group in the Iru condition did not interpret the exemplar as depicting an animal and generalize the name by multiple similarities. Rather, some children in the context of *iru* might have interpreted the name as a proper name generalizing it only to the item that matched the exemplar in all properties. Other children might have interpreted it as a common name of an artifact and generalized that name by shape. The group pattern then would misleadingly fit our expectations. Accordingly, we examined the performances of individual children. We counted the number of children who said 'yes' more than 75% of the time to items matching the exemplar on all properties, but said 'no' more than 75% of the time to all other test objects ($p = 0.011$ that an individual child would show this pattern by chance alone). This is the pattern expected if children interpret the name as the proper name of the exemplar. There was one child who fit this possible interpretation in the Iru condition and one in the Aru condition. We also counted the number of children who said 'yes' more than 75% of the time only to the items matching the exemplar in shape and texture, the pattern consistent with the conceptualization of the exemplar as a depiction of an animate thing (again, $p = 0.011$ that an individual child would show this pattern by chance alone). Seven of the ten children in the Iru condition generalized the name to test objects in this manner, but no child in the Aru condition did so. Thus, the pattern of group performances in the two conditions appears to characterize individuals as well as groups. Overall the results support our conclusion that *iru* implies an animal category and leads children to generalize the name by shape and texture whereas *aru* implies an object category and leads children to generalize the name by shape.

These results provide three important pieces of information. First, the linguistic cues of *iru*/*aru* alter the way Japanese-speaking children categorize novel objects. This work thus adds to past findings showing that older Japanese-speaking children use *iru* in sentences when talking about the locations of people (Maeda & Maeda, 1996). The present results show that young Japanese-speaking children understand the broader implications of both *iru* and *aru*. Thus young Japanese-speaking children do have knowledge of at least one linguistic device that privileges animate kinds. More specifically, young Japanese-speaking children understand the implications of *iru* and *aru* as they generalize names presented in carrier sentences with these verbs differently. Second, the results tell us that linguistic cues, at least explicitly presented ones, can alter how the same perceptual entity is conceptualized – as a depiction of an animate or artifact kind. Third, this experiment provides evidence for the ambiguity of these stimulus objects, a crucial fact for Experiment 2. Japanese-speaking children can 'see' these objects with pipe-cleaners in two ways, as animals in the linguistic context of *iru* and as artifacts in the linguistic context of *aru*. Indeed, the differing impact of *iru* and *aru* on children's conceptualizations of these objects may depend critically on the ambiguity of the perceptual properties. Previous work shows that *iru* and *aru* do not alter Japanese-speaking children's conceptualization of less ambiguous objects. Yoshida, Swanson, Drake and Gudel (2001) presented Japanese-speaking children with objects with more potent cues to animacy, eyes, and named them in the context of *iru* or *aru* just as in this experiment. Japanese-speaking children generalized the names for these eyed things in the same way in both linguistic contexts, that is, to objects similar to the named exemplar in both shape and texture. Thus, the stimulus objects used in Experiment 1, and also in Experiment 2 are, at the least, more ambiguous than ones with eyes.

Experiment 2

The primary question for Experiment 2 is whether English- and Japanese-speaking children differ in their conceptualization of these ambiguous stimuli when the carrier sentence is neutral and suggests neither the animacy nor the inanimacy of the named object. If learning a language which ties individuation to animacy fosters the conceptualization of ambiguous kinds near the animacy/inanimacy boundary as individuals (and thus animates), then Japanese-speaking children more than English-speaking children should view our ambiguous exemplars as depicting animate kinds. Put another way, we ask: Does a history of using *iru*/*aru* and not simply the presence of these explicit linguistic cues in the task influence Japanese-speaking children's conceptualization of these ambiguous stimuli? If speakers of a language are biased to treat ambiguous forms as the most individualized possibility, then the default interpretation of these vaguely animate-like forms may be as animals for Japanese-speaking children but not for English-speaking children.

Method

Participants

Ten monolingual English-speaking children between the ages of 25 and 39 months and 10 Japanese-speaking children between the ages of 25 and 37 months participated. The English-speaking children's mean age was 33.41 months, and the Japanese-speaking children's mean age was 32.29 months. The English-speaking children were tested in Bloomington, IN and the Japanese-speaking children were tested in Niigata, Japan. No child had participated in Experiment 1 and all children met the pre-training criterion.

Stimuli, materials, design and procedure

All aspects of the stimuli, procedure and design were identical to Experiment 1 with the exception of the sentence frames in which the novel names were presented. The sentence frames used in Japanese were non-locative constructions that did not require *iru*/*aru* but rather the same sentence frame could be used with both animates and inanimates. When naming the exemplar, the experimenter said 'Kore-wa____da-yo', roughly 'This ____ is'. When asking children whether the object could be called the same name as the exemplar, the experimenter said 'Kore-wa____-kana?' which is roughly, 'This ____ is?' In English, when naming the exemplar, the experimenter said 'This is a ____' and when asking about the test objects, the experimenter said 'Is this a ____?' The novel words employed to name the exemplars in Experiment 2 were also slightly altered for the English-speaking children to sound natural in English (e.g. mobito/mobit; keppuru/kipple; tema/teema).

Results and discussion

The number of 'yes' responses was submitted to an analysis of variance for a 2 (Language) × 2 (Multiple- versus Single-property matching test objects) mixed design. The analysis revealed a main effect of Language, $F(1, 18) = 20.63$, $p < 0.001$. English-speaking children said 'yes' more often than did Japanese-speaking children, generalizing the exemplars' names more broadly to more test objects than did the Japanese-speaking children. The analysis also revealed a reliable main effect of Multiple- versus Single-property matches, $F(1, 18) = 165.40$, $p < 0.001$. Both groups of children generalized the name more to test objects that matched the exemplar in multiple properties than to test objects that matched the exemplar in just one. Finally, the analysis yielded a non-reliable interaction between Language and Multiple- versus Single-property matches, $F(1, 18) = 2.99$, $p < 0.15$.

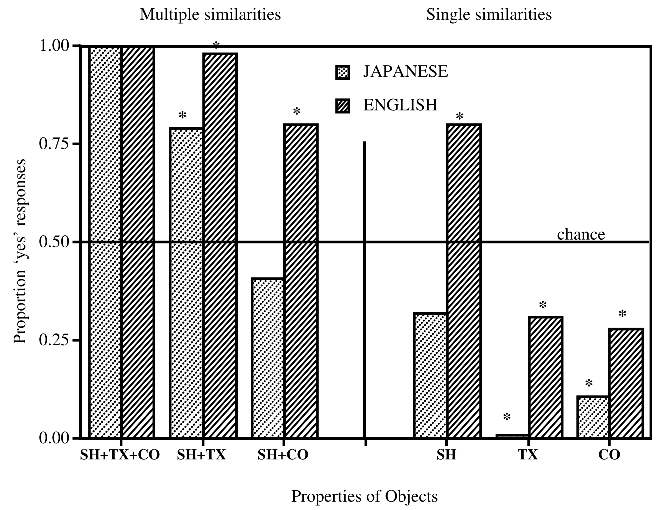

Figure 4 *Proportion of 'yes' responses by English- and Japanese-speaking children to test objects that matched the exemplar on multiple and single properties. On the x-axis, test objects are labeled by properties matching the exemplar. Proportions reliably different from chance (*p *< 0.05, two-tailed) are marked by asterisks.*

Figure 4 shows the mean proportion of 'yes' responses as a function of age and individual test objects. As is apparent, when presented with ambiguous objects named with novel names in a neutral sentence frame, Japanese-speaking children generalized the names in the same way they did in Experiment 1 when the name was presented in the context of *iru*, a context that unambiguously implies animacy. That is, Japanese-speaking children generalized the exemplar's name only to items that matched the exemplar in both shape and texture and rejected all other test objects as instances of the lexical category. In contrast, the English-speaking children generalized the novel names in the same way that Japanese-speaking children had in Experiment 1 when the name had been presented in the context of *aru*, a context that unambiguously implies an inanimate thing. English-speaking children like Japanese-speaking children in the Aru condition of Experiment 1 generalized the name to all objects that matched the exemplar in shape – both when that object matched in other properties as well as when it did not.

Given objects with features vaguely suggestive of animal limbs, Japanese-speaking children formed a narrower category based on multiple similarities. This suggests that the Japanese-speaking children interpreted the objects as depictions of animals. In contrast, English-speaking children formed a broader category based on shape, a pattern consistent with the interpretation of these things as artifacts. We predicted these effects as a consequence of the differences in the English and Japanese systems of individuation. One might question, however, whether the effect derives not from differences in the children's history of language learning but rather from differences in their history of visual experiences, perhaps in the iconography with which animates are depicted in the two cultures. Although it is impossible to rule out cultural effects that are independent of language, we know of no cultural differences in iconography that seem relevant to pipe-cleaner protrusions. Further, Experiment 1 clearly shows that Japanese-speaking children *can* 'see' these objects as artifacts in the context of a relevant linguistic cue. Finally, this pattern of results is consistent with earlier findings by Yoshida and Smith (2001): they found that young Japanese-speaking children show an earlier sensitivity than do English-speaking children to the more potent animacy cues of eyes in novel noun generalization tasks. In brief, the present results support the idea that Japanese-speaking children have a heightened sensitivity to potential animacy cues. The consequence of this heightened sensitivity is that Japanese-speaking children treat objects near the animate-object boundary differently than do English-speaking children. As such, the results are comparable to Imai and Gentner's (1997) finding that English-speaking and Japanese-speaking children treat objects near the object–substance boundary differently. Together, the two sets of results suggest that the individuation boundary in a language exerts a force on children's conceptualizations of ambiguous kinds. More specifically, ambiguous kinds appear to be pulled toward the more individuated form.

Experiment 3

Before we accept this conclusion, however, we need to make sure that Japanese- and English-speaking children only differ given suggestive animacy cues and not given any kind of stimulus object. That is, one possible interpretation of Experiment 2 is that Japanese-speaking children are just more conservative in their generalizations, and say 'no' more often than do English-speaking children, thus the observed language difference would be due to our choice of the 'yes/no' task procedure rather than real differences in the children's conceptualizations. Accordingly, in Experiment 3, we presented English- and Japanese-speaking children with objects that were unambiguously artifacts. The prediction is that both groups of children will generalize the names for unambiguous artifacts broadly by shape.

Method

Participants

Ten monolingual English-speaking children who were 30.83 to 38.8 months old and 10 Japanese-speaking children who were 30.43 to 38.13 months old participated. The English-speaking children's mean age was 34.42 months, and the Japanese-speaking children's mean age was 34.31 months. The English-speaking children were recruited from the population in Bloomington, IN. The Japanese-speaking children were recruited from the population in Niigata, Japan. No child had participated in Experiments 1 and 2 and all children passed the pre-training criterion.

Stimuli, materials and procedure

All aspects of the experiment were identical to Experiment 2 except for the stimuli. Neither the exemplars nor test objects had appendages of any kind attached, and the exemplars were more angularly and more complexly shaped than the more rounded forms used in Experiment 2. The same pre-training set was used with the same procedure as in Experiment 1 and 2 except that the appendages (pipe-cleaners) were removed. The two experimental sets consisted of an exemplar and five test objects. The two exemplars are illustrated in Figure 5. The tego exemplar was made of cardboard and painted with sand which gives the object the appearance of being carved from sandstone. The zeebee exemplar was made from plastic mesh. Five test objects were constructed for each exemplar: (1) a shape, color and texture match, (2) a shape and texture match, (3) a shape match, (4) a texture match, and (5) a color match. We included only two kinds of test objects that presented multiple property matches – a shape, color and texture match and a shape and texture match to reduce the number of trials and because matches on shape and texture appear the most diagnostic of animate-like categories. Thus, there were five test objects for each of two exemplars. Each test object queried twice for a total of 20 trials. All objects were 3-dimensional, approximately 7 cm × 7 cm × 7 cm in size.

Results and discussion

Children's proportion of 'yes' responses were submitted to an analysis of variance for a 2 (Language) × 2 (Multiple-match versus Single-property match) mixed design. The main effect of Language, $F(1, 18) = 0.53$, $p < 0.48$ was not reliable. Both English-speaking and Japanese-speaking children generalized names for these artifacts in the same way. The analysis revealed a reliable main effect

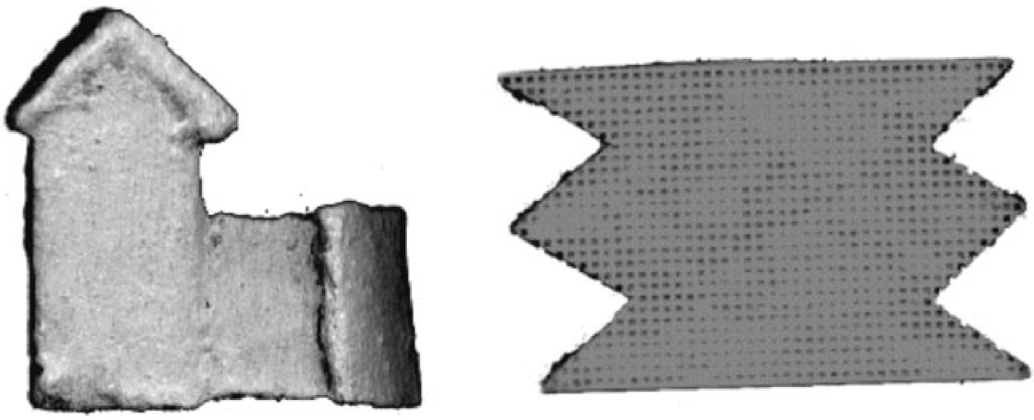

Figure 5 *Test set objects used in Experiment 3.*

of Multiple- versus Single-property matches, $F(1, 18) = 240.93$, $p < 0.001$. Both groups of children generalized the name more to test objects that matched the exemplar in multiple properties than to test objects that matched the exemplar in just one. Finally, the analysis revealed no interaction between Language and Multiple-versus Single-property matches, $F(1, 18) = 1.73$, $p < 0.21$. Figure 6 shows children's 'yes' responses for each test object. Both Japanese-speaking children and English-speaking children generalized the exemplar's name to all instances that matched the exemplar in shape more often than expected by chance and they did not generalize the names to new instances that differed from the exemplar in shape. Clearly, Japanese-speaking children are not more conservative than English-speaking children in their generalizations of names for all kinds of things.

The results confirm those of Imai and Gentner (1997) using our procedure. Given objects that are clearly artifacts both English-speaking children and Japanese-speaking children generalized the exemplar's name in the same way by shape. This fact suggests that the findings in Experiment 2 reflect the effect of the different language histories on children's interpretations of ambiguous things.

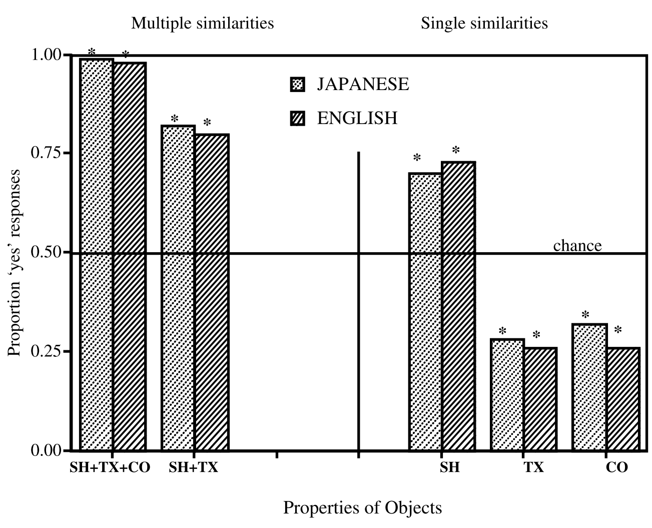

Figure 6 *Proportion 'yes' responses by English- and Japanese-speaking children to test objects that matched the exemplar on multiple and single properties. On the x-axis, test objects are labeled by properties matching the exemplar. Proportions reliably different from chance (*p *< 0.05, two-tailed) are marked by asterisks.*

General discussion

Young Japanese-speaking children understand the implications of *iru/aru*. They generalize names for novel ambiguous objects presented in sentence frames using *iru* narrowly, to instances like the exemplar in both shape and texture – a pattern consistent with the conceptualization of the named thing as depicting an animal. When the name is presented in sentence frames using *aru*, however, they generalize the name broadly to objects that match the exemplar in shape – a pattern consistent with the conceptualization of the named thing as an artifact. These results from Experiment 1 show an on-line effect of language on children's categorizations.

More crucially, the results of Experiment 2 suggest that a history of treating animates as individuals changes the default interpretation of ambiguously animate depictions. As predicted by the boundary-shift hypothesis, objects with perceptual properties straddling the individuation boundary are assimilated to the more individualized side. That is, in neutral linguistic contexts, Japanese-speaking children interpret ambiguous objects with vaguely limb-like appendages as depictions of animals, and generalize their names narrowly to new instances. In contrast, English-speaking children interpret these same things as artifacts, generalizing their names broadly to new instances by shape. Japanese-speaking children and English-speaking children, however, do not differ in their interpretations when the named object presents unambiguous cues that place it clearly in the artifact category. In Experiment 3, children learning English and children leaning Japanese both generalized names for these things by shape.

On one level, these results show that both language and perception matter in how children form lexical categories from ostensive definition. But perhaps more profoundly, they also show that the phenomenon reported by Imai and Gentner – cross-linguistic differences in the interpretation of perceptually ambiguous entities – may reflect a general psychological consequence of linguistic individuation. There appears to be a universal bias toward individuation such that entities presenting perceptual properties that place them near the ontological boundary are assimilated toward the more individualized side.

We consider the implications of this idea in three steps: First, we suggest that the linguistic devices relevant to individuation may be broader than quantification. In this context, we discuss the several ways that Japanese segregates animates from objects and substances. The number and pervasiveness of these cues suggests developmental effects beyond those found here. Second, we propose a mechanistic explanation of Japanese-speaking children's interpretations of ambiguous animal depictions as animates and English-speaking children's interpretations of solid substances as objects. We suggest that these boundary shifts are the consequence of mutually supporting and reinforcing correlations among linguistic devices, perceptual properties and category structure. In brief, we propose they are the consequence of phenomena similar to gang effects in associative learning. Third, we consider the question of why conceptualizations of ambiguous kinds are assimilated toward the individualized side rather than away from it. We suggest that this is a general fact about language use.

Marking individuals

Languages differ in how they quantify, in their particular linguistic devices and also in the kinds of entities they treat as discrete and countable as opposed to those they treat as continuous masses. This distinction between 'how many' versus 'how much' may be at the center of linguistic individuation, and certainly seems to be when one reflects on the structure of languages with devices such as the count–mass distinction in English. However, individuation may be fundamentally broader than quantification. At a perceptual and conceptual level, an individual is a bounded form that retains its unitary structure over movement and other transformations. For these reasons and also because of the extensive evidence that *perceptual* individuation rests primarily on coherent movement (see e.g. Spelke, Vishton & Von-Hofsten, 1995), Gentner and Boroditsky (2000) suggest that how objects move is important to children's developing concepts of objects and individuals. Specifically, they suggest on perceptual grounds, that entities with self-movement – people and animals – are particularly salient individuals to children. By their analysis, small objects that are easily moved about and acted on by people also present good perceptual cues for individuation.

From this perspective, it is interesting that a language such as Japanese that quantifies animates and inanimates differently also pervasively marks their differences in self-movement. The *iru*/*aru* distinction in locative constructions is one such device. *Iru* implies intention and the possibility of self-movement, of being at a location by one's own will (or against one's will). *Aru,* in contrast, implies being put or left at a location by an intentional force that is external to and operates on the object. So, *iru* is about objects that can move on their own, *aru* is about objects that cannot (Arai, 1997). For these reasons, we believe this distinction may be closely related – perceptually, conceptually and linguistically – to individuation in Japanese.

Consistent with this idea, Japanese lexicalizes the distinction between self-movement and being moved in many verbs with meanings concerning changes in position. For example, *tsureteiku* (bring) is used only when objects are animate while *motteiku* (bring) is used when the object is inanimate. *Tsureteiku* is consistent with the agency and self-movement of that which is brought. *Tsureteiku* suggests a 'going with' relationship between subject and object as in *Mary brought her little sister to the party*. In contrast, *motteiku* suggests a meaning more like 'carry' as in *Mary brought her radio to the party*. This type of alternation in Japanese characterizes a number of verbs concerned with moving objects. We list some in Table 1. In each case, English uses the same verb, *put*, *bring*, *pick up* and *hold* – for animate and inanimate things. Japanese contrasts different verbs for animate things that move on their own as opposed to things that do not. However, it is not that Japanese makes a distinction with these contrasts that English never does. English does provide verbs more specific to animates such as 'hug' versus 'hold' or 'lead' versus 'pull'. But these different verbs do not form a contrastive, pervasive and obligatory system. Crucially, the pattern of alternation in Japanese also coincides with individuation in Japanese and may do so precisely because self-movement marks animates.

Table 1 *English verbs and the corresponding pairs of verbs in Japanese*

Word	English	Japanese
put	I put the cup down I put the little girl down	Watashi-wa koppu-wo shitani-*oku* Watashi-wa onnaoko-wo shitani-*orosu*
bring	I bring the cup to class I bring the little girl to class	Watashi-wa koppu-wo kurasu-ni *motteiku* Watashi-wa onnanoko-wo kurasu-ni *tsureteiku*
pick up	I pick up the cup I pick up the little girl	Watashi-wa koppu-wo *mochiageru* Watashi-wa onnanoko-wo *dakiageru*
hold	I hold the cup I hold the little girl	Watashi-wa koppu-wo *motsu* Watashi-wa onnanoko-wo *daku*

Thus, Japanese appears to present the young learner with many lexical contrasts that segregate animates from objects and substances. The pervasiveness of this focus in Japanese seems likely to have developmental consequences beyond children's interpretation of ambiguous depictions of animal-like things. The many mutually supporting linguistic contrasts concerning self-movement may help Japanese children discover the bundles of perceptual properties that characterize animate things. Yoshida and Smith (2001) provide data to support this idea. They found that Japanese-speaking children generalize names for novel objects with eyes by multiple similarities earlier in the course of noun learning than do English-speaking children. These eyed objects were also ambiguous – they were artifacts with only one cue suggestive of animacy – but they were less ambiguous than the objects used in Experiment 1 and Experiment 2 in that eyes are a strong and perceptually salient feature of animates.

Although these experiments provide evidence of language's effect on perception, we do not predict large cross-language differences given real animates with their full complement of static (eyes, mouths, limbs, heads, shape, textures) and dynamic (movement, reaction) properties. The differences reported here may be evident only as short-lived developmental differences – an acquisition that is a little earlier or later in one language as compared to another as in Yoshida and Smith (2001) or differences evident only with ambiguous forms as in Experiment 2. Universality is expected because with real animates and inanimates there are many correlated perceptual cues that organize objects into ontological kinds independently of language, and because the differences between animates and inanimates are relevant to speakers of all languages. However, by examining the special case of ambiguous things we have found that Japanese-speaking children are more sensitive to the animate–inanimate distinction than are English-speaking children and that this appears to be due to the structure of the language. As such, these results provide insight into the developmental processes that create universals as well as those that create subtle differences: correlation between the perceptual properties, categories and language may be the basis of ontological distinctions. Further, the results fit Lucy's (1992) claim that languages that more systematically and obligatorily mark a distinction lead the speakers of those languages to attend more habitually to that distinction. Imai and Gentner's (1997) earlier results make this same point: English obligatorily marks the distinction between object and substance and English speakers are more attentive to one cue, solidity, that is relevant to that distinction. In the next section, we propose a mechanistic account of the boundary shifts at both the animate–object and object–substance boundaries.

An associative basis to the boundary shift?

We propose that ontological distinctions and the boundary shifts evident in English- and Japanese-speaking children's name generalizations may be most directly explained in terms of associative processes. Ontological categories may emerge as the direct product of statistical regularities among linguistic forms, object properties and category structures. Figure 7 illustrates hypothesized correlations among perceptual properties and from perceptual properties to category structure. It is knowledge of these correlations that comprises the perceptual layer we proposed in Figure 1. Although not illustrated, it seems likely that these various connections vary in strength depending on the strength of relations in the world. For example, objects with angles and multiple parts are highly likely to be solid (since complex angular shapes cannot be readily formed from nonsolid substances). Thus angularity strongly predicts solidity and multiple parts and each of these cues and the whole cluster predicts categorization by shape. Analogously, nonsolid objects tend to be rounded and simply shaped, although many simply shaped things can also be solid. Thus, simple shape and roundedness weakly predict nonsolidity and categorization by material, but simple shape, roundedness and nonsolidity would jointly predict

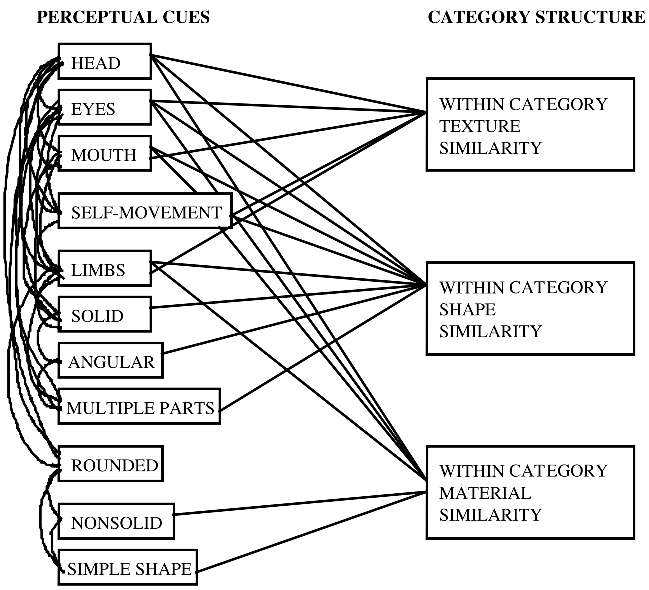

Figure 7 *Illustration of associations between perceptual cues and category structure available in the world.*

more strongly categorization by material. Finally, a strong cluster of interrelated cues would seem to characterize animate things and all these cues predict categorization by multiple similarities. The correlations in Figure 7 are perceptual and reflect the structure of the world. They are therefore available to speakers of both English and Japanese. These correlations constrain ontological categories for speakers of all languages and thus create universals.

What do the differences between English and Japanese add to these perceptual correlations? As illustrated in Figure 8, perceptual properties and category structures characteristic of animates are also associated with particular linguistic forms in Japanese, and perceptual properties and category structures characteristic of inanimates are associated with contrasting forms. Figure 9 illustrates how perceptual properties and category structures characteristic of animates and objects are also associated with particular linguistic forms in English and how perceptual properties and category structures characteristic of nonsolids are associated with contrasting forms.

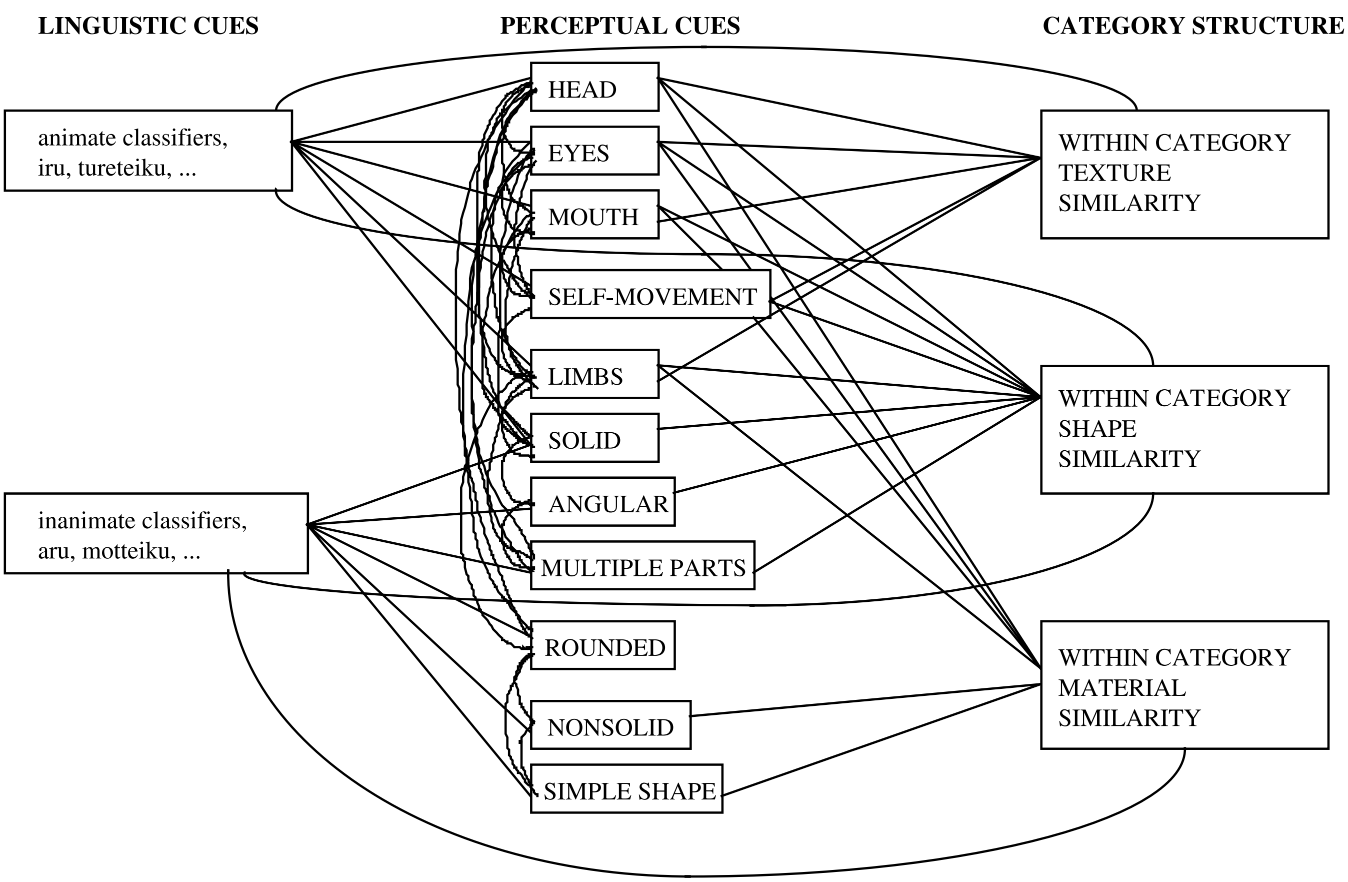

Figure 8 *Associations among perceptual cues, category structure and linguistic cues available to learners of Japanese.*

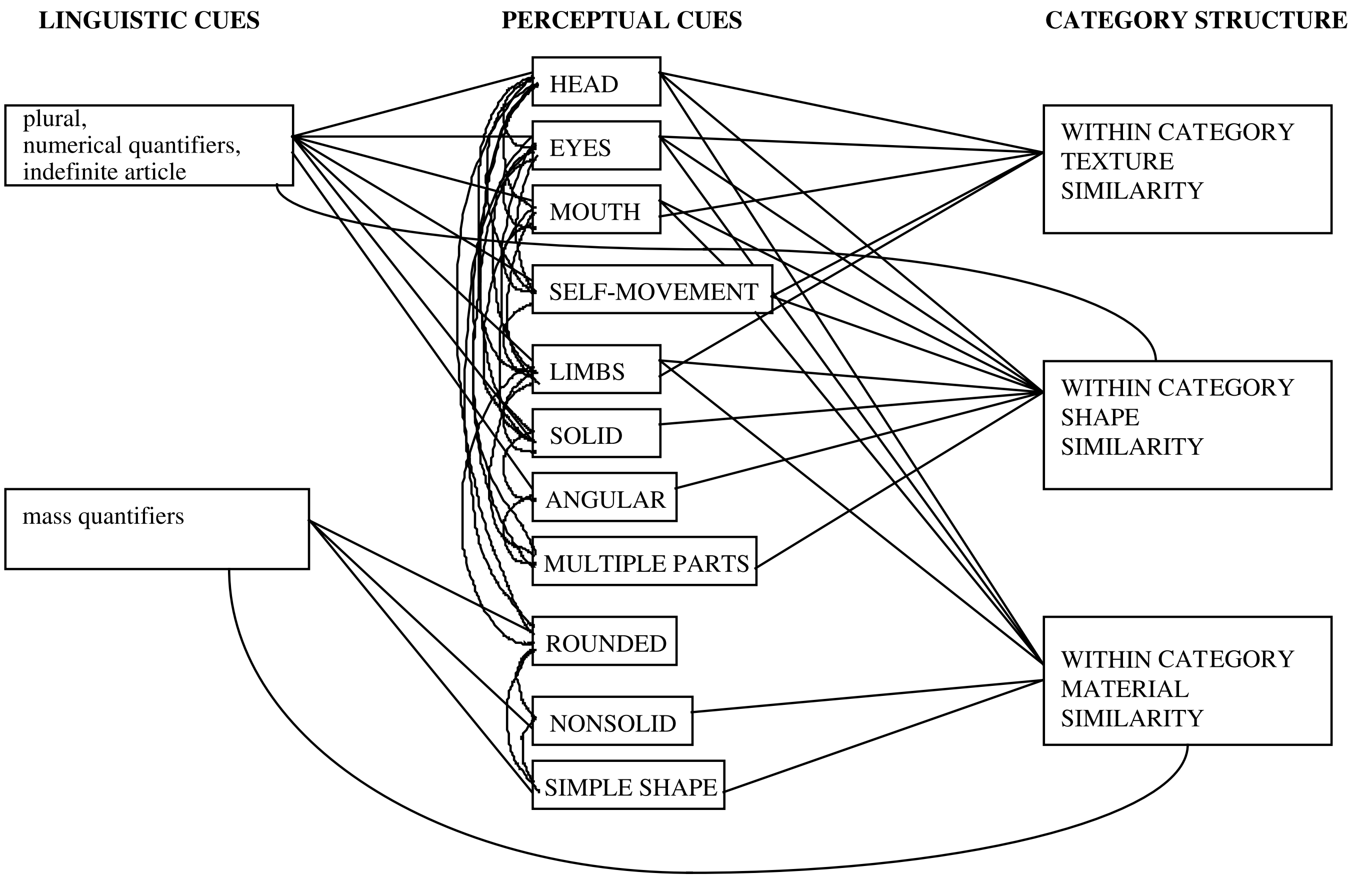

Figure 9 *Associations among perceptual cues, category structure and linguistic cues available to learners of English.*

One can see in these illustrations how linguistic cues can influence children's name generalizations, how in Soja's (1992) study, saying *a mel* increased English-speaking children's generalizations by shape, whereas saying *some mel* increased their generalizations by material and how in Experiment 1 of the present study saying *iru* increased Japanese-speaking children's generalizations by shape and texture, whereas saying *aru* increased their generalization by shape alone. Importantly, however, the systematic linguistic contrasts may do more than just add another predictive cue to the mix of correlations. They might differentially bolster and weaken perceptual correlations, changing, in a sense, how things are perceived.

Specifically, the inter-connections among perceptible cues associated with animacy – head, eyes, limbs, self-movement – may be strengthened by their joint association with linguistic forms in Japanese. Thus, because of their connections to the same cluster of linguistic cues, the feature 'limb-like appendages' may be more strongly linked to self-movement and to eyes for Japanese speakers than for English speakers. The implication is that for Japanese speakers, vaguely suggestive limbs – because of reinforcing connections provided by the Japanese language – may be more likely to bring forth ideas associated with animate things, including categorization by multiple properties. Thus, vaguely limb-like appendages may be a stronger cue suggestive of animacy for Japanese than English speakers. Analogously, the linguistic forms in English that signal discrete countable things may reinforce the connections between cues characteristic of objects and between those cues and categorization by shape. And thus, even in tasks in which those linguistic cues are not present, solidity – even in the context of a simple shape – may robustly lead to categorization by shape. Although speculative, these ideas fit the general workings of interactive-activation models (Gasser, Colunga & Smith, 2001; Kersten & Billman, 1997; McClelland & Rumelhart, 1988; Billman & Heit, 1989): overlapping connections reinforce each other such that one cue alone can bring forth activation of a whole correlated cluster. The linguistic and perceptual layers of Figure 1 are clearly evident in Figures 8 and 9. Where is the conceptual layer of ontological categories, the middle layer in Figure 1? We suggest it may be in the whole pattern of connections.

This associative learning account is clearly undetermined at present – both by data and formal modeling. However, it offers a clear theoretical framework within which to investigate children's developing ontologies. There are a number of phenomena to be explained beyond the boundary shifts on which we concentrated here. These include curvilinear patterns of developmental change in English-speaking children's attention to the material of nonsolids (Imai & Gentner, 1997; Samuelson & Smith, 1999; Colunga & Smith, 2001) and also Japanese speakers' greater attention than English speakers to the material of nonsolids.

Asymmetry

The present results on an animacy–object boundary shift and the prior results showing an object–substance boundary shift (Imai & Gentner, 1997) both suggest an assimilation of ambiguous kinds to the more individuated end of the linguistic continuum. We suspect that this is a general aspect of linguistic individuation that is evident in other aspects of language use. That is, speakers of a language may freely confer special status on nonindividuals by treating them as individuals but the inverse may not occur so freely. By our intuitions, this is the case for both English and Japanese. For example, there are contexts in which speakers of English use typically mass nouns as count nouns, saying such things as 'I will have two waters, please' and 'We need another water here.' Intuition suggests that all mass nouns that refer to concrete substances *can* be used in this way, in the right context. The use of object names as mass nouns seems more unusual and more wrong. 'I have too much cup' and 'I would like some cup' seem grammatically wrong in all imaginable contexts.

Analogously, the forms in Japanese that are used with animates can be generalized to inanimates and often are in playful contexts which attribute intentions to inanimate things. Thus one can say *toosutaa-kun-ga iru*, 'there is [animate] Mr Toaster'. But again, the reverse, *otokonoko-ga aru*, 'there is [inanimate] a boy', seems very wrong. And it is difficult to imagine a playful or metaphoric context in which such a construction could possibly be appropriate. If these intuitions are right, then, there is an asymmetry in use of individualized and nonindividualized forms; anything can be potentially, temporarily individualized, but entities on the individualized side of the boundary must be treated as individuals and cannot be de-individualized. Notice that the asymmetry in use to which we refer is not an asymmetry in type or token frequency, but an asymmetry in the allowability of exceptions: entities generally conceptualized as continuous *may* be individualized but entities generally privileged as individuals cannot so easily be treated as nonindividuals. Why is the asymmetry in this particular direction? We can only conjecture that it might originate in a perceptual system that is tuned to pick out coherent wholes segregated from the background or in a conceptual system that privileges the discrete over the continuous.

Conclusion

How children form categories depends on the language they are learning, and in particular on the way that language individuates kinds. Presented with the very same (albeit ambiguous) objects, Japanese-speaking and English-speaking children form different categories. Japanese-speaking children generalized names for vaguely animal-like things by multiple similarities, as if they were depictions of animals. English-speaking children generalized names for these very same things by shape, as if they were artifacts. These results were predicted by the boundary shift hypothesis, by the proposal that the linguistic boundary between individuals and nonindividuals influences the perceptual boundaries between ontological kinds. The present results also illustrate how categorization is the product of an integration of language, perceptual and cognitive information over the long term and in the moment. The long-term influences are the perceptual correlations in the world, the structure of lexical categories and the structure of the language being learned. The in-the-moment influences are the specific linguistic and perceptual cues present when a novel object is named. In this way, our series of experiments point to a dynamic construction of specific categories and also ontological kinds.

Acknowledgements

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COMMENTARIES

Conceptual representation of animacy and its perceptual and linguistic reflections

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Yoshida and Smith's paper contains an intriguing set of results and ideas. In this commentary, I focus on two of their proposals: (i) that our ontological knowledge may be contained in the pattern of correlations between and among perceptual and linguistic properties, and (ii) that individuation should be distinguished from discrete quantification.

Correlations, perception, self-motion and animacy

While certain patterns of motion might suggest that a moving entity is animate, self-motion is not a pattern of motion and cannot be perceived. Attribution of *self*-motion requires establishing that the thing responsible for a motion (i.e. the mover) and the thing moved are the same thing. Importantly, the absence of a perceivable entity that could play the role of the mover does not entail that the motion has to be interpreted as self-motion. Given the right circumstances, both children and adults will attribute the role of mover to invisible entities such as the wind or magnetic fields (Gelman, Durgin & Kaufman, 1995; Subrahmanyam, Gelman & Lafosse, in press; Williams, 2000). Furthermore, the interpretation of patterns of motion as self-motion does not depend on whether the language explicitly marks the animate/inanimate distinction (e.g. Japanese) or not (e.g. English).

Interpretations of animacy/inanimacy require *relational representational structures* (Gelman & Williams, 1998). We must be able to represent the fact that one thing or property is in some way responsible for, or dependent upon, another thing or property. It is not enough to represent the fact that one thing/property is correlated with another thing/property (Prasada, 2000). Attribution of self-motion requires that we represent the thing itself, and not something else, as being responsible for its motion. Furthermore, we understand the animacy of a thing to be responsible for its capacity for self-motion. The assignment of responsibility for a given property (capacity for self-motion) to another property (animacy) cannot be represented in terms of a correlation between properties, but requires an appropriate relational structure.

The animacy of an entity is understood to be responsible for various properties including its capacity for self-movement and perception. We cannot know all the perceptual properties that might signal animacy because there are indefinitely many animals, each with their specific perceptual characteristics. With experience, the range of cues associated with animates may expand and/or be refined. This could lead to a shift in the boundary in perceptual space that distinguishes cues to animacy/inanimacy. This seems to be the kind of shift Yoshida and Smith found. Note, however, that this does not imply any shift in the conception of what it is to be animate/inanimate.

The ontological distinction between objects and stuff also cannot be made with reference to perceptual terms alone. Its representation also requires an appropriate relational structure. The structure of an instance of an object kind must be represented as being dependent on its being the kind of thing it is. In contrast, the structure of an instance of a material kind must be represented as not being dependent on the kind of thing it is (Prasada, Ferenz & Haskell, 2002). This is a nonlinguistic distinction between objects and stuff that does not depend on whether a language formally distinguishes objects and stuff (e.g. English) or not (e.g. Japanese).

Considerations of the sort mentioned above demonstrate that ontological distinctions require a level of representation that is distinct from both the perceptual and linguistic levels. Furthermore, ontological and, more generally, conceptual knowledge involves relational representational structures. An important question for future

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research concerns the relation of patterns of correlation and relational conceptual structures. One possibility, which is consistent with Yoshida and Smith's results, is that correlational information can play a role in *selecting* an appropriate relational structure for conceiving a given entity.

Individuation and quantification

Finally, Yoshida and Smith suggest that individuation and discrete quantification should be distinguished. This is an important point and it immediately raises the question of how this should be done. Prasada (2001) proposed that distinguishing between individuals and instances of discretely quantified kinds requires that we distinguish two types of unity or oneness. First, there is the type of oneness presupposed by count nouns and more generally type-token representations. It is defined independently of those properties that are unique to an entity (e.g. its space-time location), and thus may be exhibited in indefinitely many instances (Prasada, 2000). Thus the oneness Fido possesses in virtue of being a dog is identical to the oneness Spot possesses in virtue of being a dog. This is the type of unity that is relevant to quantification. Each instance is quantitatively equivalent to each other instance – each is exactly one dog (a unit of quantification). Each dog possesses properties that are unique to it; however, the identity of these properties are quantitatively insignificant as they serve merely to distinguish one instance from another.

The second type of unity is a oneness that *cannot* be displayed by more than one thing because it derives in part from the properties that are unique to a given entity. This type of oneness, or *individuality*, is presupposed by proper names, and more generally by things we consider to be individuals in their own right rather than merely one of indefinitely many instances of that kind (Prasada, 2001). Only instances of kinds that are quantified discretely may possess this form of oneness. Furthermore, it is primarily human beings and instances of higher animals that tend to be conceived of as individuals rather than instances of a kind. This is because perception, memory and thought provide the means for unifying disparate unique histories of experience and creating systematic and coherent ways of acting and reacting that display a thing's individuality.

Representation of things as individuals and as instances of kinds requires formally distinct representational structures (Prasada, 2001). Specifying the nature of these relational representational structures, and their interaction with correlational structures of the sort represented in Yoshida and Smith's model promises to be a fruitful avenue for future research as all three types of representation seem to be implicated in our understanding of animate beings.

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Free association? Why category development requires something more

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Yoshida and Smith's article is a fascinating and forceful demonstration that language can influence on which side of an ontological boundary a novel object is categorized. Above all, the authors provide compelling data that support the notion that ontological categories are shaped by associative processes that extract regularities among language, the properties of objects, and the structures of categories. Given my own theoretical framework (Rakison, in press; Rakison & Poulin-Dubois, 2001), it is perhaps not surprising that I am in agreement with the position that a sensitive perceptual system and domain-general associative processes drive knowledge acquisition for different ontological kinds in the first years of life. Nonetheless there are a number of reasons why I think it is necessary to be cautious before accepting Yoshida and Smith's proposal. In particular, I will argue that it is necessary to take into account the representational foundations of ontologies formed prior to the onset of language, and it is critical to demarcate more explicitly the associative processes involved.

Ontological categorization before language

The studies presented by Yoshida and Smith are highly consistent with the work of Imai and Gentner (1997) and Soja, Carey and Spelke (1991), yet they go beyond this previous research by showing how language affects the way that preschoolers classify novel ambiguous objects. One must be careful, however, in interpreting too broadly studies that test 2- to 3-year-old children's generalization of a novel label to a novel object. Without doubt, the kind of task used by Yoshida and Smith tells us something about how children categorize novel objects – in this case, objects that are near a perceptual boundary – based on their existing ontologies. But, such studies are quite limited in the extent to which they are informative about the origins and development of ontological categories. In other words, I think that it is necessary to make a distinction between how children use their existing ontologies to categorize a newly encountered object and how those ontologies were acquired over developmental time (see also Markman & Jaswal, in press). Yoshida and Smith reveal that children's language environment plays a role in determining some aspect of their ontological boundaries, but it is necessary to examine categorization in preverbal infants in order fully to understand the organization of those ontologies and the mechanisms that produce them.

Recent research with infants has convincingly demonstrated that the underpinnings of the animate–inanimate distinction are in place within the first two years of life and almost certainly begin to form before any kind of linguistic competence emerges. For example, infants' perceptual system is sufficiently sensitive to allow them to categorize, among other things, dogs as different from cats (Eimas & Quinn, 1994), and animals as different from vehicles and furniture (Behl-Chadha, 1996; Rakison & Butterworth, 1998). More impressively, perhaps, infants begin to discriminate between the actions typical of animates and inanimates, and they start to associate certain actions, movements or functions with the appropriate ontological class. Thus, by 5 months infants recognize a point-light display of person walking (Bertenthal, 1993), by 7 months infants identify the agent and recipient in a causal event (Oakes & Cohen, 1990) and by 9 months they associate hands, but not a mechanical claw, with goal-directed action (Woodward, 1998). This is not to say that discrete ontological categories have developed within the first year of life. Rather, infants are beginning to discriminate and recognize the properties of animates and inanimates, and only later do they begin to associate these properties with distinct object kinds (Rakison & Poulin-Dubois, 2001). As Yoshida and Smith's article demonstrates, language has an important role to play later in this process; but it seems to me that much of the representational work has been done before infants are capable of producing and, perhaps, comprehending language.

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Constraints on associative processes

A second issue that I think is important to raise is that associative learning cannot, in all likelihood, act as the primary mechanism for early learning without some kind of constraints or biases. Indeed, according to Keil and others (1981; Murphy & Medin, 1985) the notion of associative learning, or any other similarity-based theory of representation, is fatally undermined by an insufficiency of constraints; that is, there are so many properties and relations among properties to which, in principle, one could attend that it is impossible to know which ones are important and which are illusory. Although recent work by Samuelson and Smith (1999) has suggested that lexical categories, at least, can be acquired through extraction of statistical regularities in the word environment, the object properties that are characteristic or defining of ontological categories are somewhat more abundant and certainly more complex. From Yoshida and Smith's framework it is not clear, for example, how the 'limb-like appendages' of animals and people would become associated with self-movement or agency yet the legs of a table would not.

Thus, although Yoshida and Smith are to be applauded for their attempt to delineate the perceptual properties of animates and inanimates that may help to build category structure, I question whether infants and preschool children could extract such properties through an unconstrained form of associative learning. I have suggested elsewhere that infants overcome this problem because they possess a number of attention biases that heighten the salience of certain aspects of the perceptual array (Rakison, in press; Rakison & Poulin-Dubois, 2002). One such bias, which is well documented in the adult as well as the infancy literature, directs attention to movement at both a local and a global level. There is evidence, for example, that infants prefer to look at moving over static objects (Slater, 1989), that common motion is necessary for 4-month-olds to perceive object unity for a partly occluded object (Kellman & Spelke, 1983), and adults and infants detect an object's properties more easily when it moves than when it is stationary (Rakison & Poulin-Dubois, in press; Washburn, 1993). Other biases that may play a fundamental role in directing infants' attention to category relevant information include the predisposition to attend to object parts (Rakison & Butterworth, 1998; Younger & Cohen, 1986), and a tendency to find large features and objects more salient than small features or objects (Slater, 1989). These biases help infants to attend to causally relevant perceptual properties – often those involved in functions or motions such as self-propulsion, agency, goal-directed action, and so on – which are consequently encoded by domain-general associative processes. Thus, a bias to attend to relatively large, moving object parts would allow infants to connect, among other things, animal legs with walking, vehicle wheels with rolling, and hands with grasping.

In concluding it should be said that the nature of a commentary requires one to impose one's own theoretical predilections on the work of others. Despite my comments, I believe that Yoshida and Smith have provided a viable, encompassing and potentially influential model of the representational structure of ontological categories. An important next step will be to integrate this model within a developmental framework that includes ontological categorization in infancy as well as in older children, and Yoshida and Smith have provided a sound foundation from which this research program can evolve.

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Shifting ontological boundaries or – how much influence does language have on perception and ontological status?

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Yoshida & Smith investigate how Japanese- and English-speaking children generalise novel names to novel, animacy-ambiguous items as well as artefacts. They expect children to assimilate ambiguous cases towards the more individuated side of the language-specific individuation boundary. Their first experiment indicates that explicit linguistic input can guide Japanese children's interpretation of ambiguous examples. Their second experiment shows differences between generalization behaviours of Japanese and American children prompted by neutral questions. The results fit their predictions except for the colour-shape similarity. Children seem to ignore colour and react in the same way as in the 'shape only' condition (see also Experiment 1). Experiment 3 validates the procedure of Experiment 2 and shows that children generalise unambiguous artefacts by shape. All in all, linguistic background seems to influence how children of around three years perceive ambiguous items and how they conceptualize their ontological status. However, there is scope for criticism.

Stimulus validation

The authors elegantly and economically validate stimulus ambiguity for Japanese children (Experiment 1). They have not done this for English-speaking children (e.g. using questions with 'him/her' versus 'it'). A validation would have clarified if stimuli were seen as equally ambiguous by both groups and if both groups were equally easy to influence by language – despite having different individuation boundaries.

Due to cultural differences, stimuli in Experiment 2 might have been perceived more clearly as (cartoon-style) animates by Japanese than by American speakers (note the vast exposure of all age groups in Japan to graphic literature: 40% of all books sold in Japan are comics (Schodt, 1996)). Iconography can well play a role in children's generalisations, especially as the experiments work only because children treat pipe-cleaners as *standing for* limbs or object parts. Possible effects of visual traditions in both cultural backgrounds could have been studied using animacy assessments or ratings with children and adults.

Stimuli

The stimuli in Experiments 1 and 2 vary on more than just the mentioned levels. Why do two 'temas' in the multiple similarity condition have five 'limbs', but the shape-colour match 'tema' and all three 'temas' in

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the single similarity condition have only four limbs while 'keppurus' always have the same number of legs? Furthermore, why do two of three 'temas', texture match and colour match, have limbs arranged in an (almost) identical manner to those in the 'keppuru' condition, but decidedly different from the limbs in the multiple similarity condition? Was an analysis performed to check whether these extra factors (namely, differing parts) have led to differences between 'keppuru' and 'tema' items and caused the pattern of results?

Developmental progression

Imai & Gentner (1997) traced developmental changes and behaviour differences between Japanese and American participants by testing four age groups. One interpretation of the results in unambiguous conditions could be that both groups react in a similar (universal?) way up to the age of two, but that differences become more pronounced from two years onwards when children know more words and use more sophisticated perceptual, conceptual and linguistic cues. Yoshida & Smith could have found further-reaching results if two age groups had been tested, e.g. under-twos (early word learners) and over-twos (more advanced word learners) – developmental changes and progression could have been discovered. Testing under-twos is possible using methods like Preferential Looking (Graham & Poulin-Dubois, 1999). Furthermore the authors' predictions should also hold for adults (Lucy & Gaskins, 2001). Including adults in Experiments 1 and 2 could have demonstrated the durability of the effects and clarified the notion 'linguistic history'.

Children's vocabulary

It is problematic that neither an American, nor a Japanese version of the MacArthur CDI was used. This might not seem important at first, considering that Yoshida & Smith tested novel items and words. However, in comparison to relatively high figures for object words (Samuelson & Smith, 1999[1]), comprehended words for animates range only between 13–16% in children between 13 and 27 months[2]. Yoshida & Smith (2001) found similar object word preferences in American compared to Japanese children, but no significant preferences for animates. As word knowledge and vocabulary size can influence children's attention to perceptual cues and their categorisation behaviour (Soja, 1992; Balaban & Waxman, 1997; Samuelson & Smith, 1999), and considering likely individual differences, it is important to investigate the *tested* children's vocabulary.

Parental input

As so often in developmental studies, the role of parental input and word frequency is difficult to assess. The question remains if there are differences between caregivers' (and children's) use of -iru and -aru. Differences in input, caused by cultural or linguistic factors, might also explain the results in Experiment 2.

The mechanistic account

The mechanistic account, as the authors state themselves, is undetermined at present. The model needs weighting between perceptual, ontological and syntactic information. Clarification is necessary as to which information is strengthened when and how the model evolves over time. The changing behaviour in naming versus non-naming tasks and the ability to use syntactic information to different degrees (Soja, 1992) also has to be considered to model the interaction between perceptual cues, ontological and other categories and linguistic influence successfully.

Influence of language on perception and ontological status

It is well established that naming can focus children's attention onto a referent's ontological status. Linguistic cues can even override the initial perception and original ontological status of ambiguous items (Soja, 1992). However, Imai & Gentner (1997) demonstrate that despite a lack of linguistic markers[3] ontological boundaries are respected. Soja *et al.* (1991) show that children have ontological knowledge before they can use relevant linguistic cues and there is evidence for count-mass distinction in 8-month-olds (Carey, 2001, for a summary). Ontological categories could emerge from statistical regularities among linguistic form, perceptual properties

[1] Samuelson & Smith found in a corpus of early-learned English words predominantly words for objects.

[2] Own calculations from words we collected in the UK with the Oxford CDI (CDI described in Hamilton, Plunkett & Schafer, 2000) from 463 children.

[3] Japanese speakers distinguished between solids and non-solids even though this ontological distinction is not linguistically marked (no count/mass syntax).

and category structure with the possibility of language changing how things are perceived, as the authors suggest. However, looking at the overall picture of results with ambiguous and unambiguous items, naming and non-naming tasks, one could also conclude that language does not *truly* influence perception or ontological boundaries, but only highlights parts of the individuation continuum under certain conditions: when the participant is exposed to a language background for a sufficient amount of time and is either primed by explicit linguistic cues (Exp. 1) or is lacking unambiguous linguistic and perceptual cues (Exp. 2). Thus, initially, a layer of perceptual cues could evoke category and ontological structure independent of language – this process can be influenced or even assisted[4] by language if deemed useful. Research with children under 2 years on word learning category organisation will help reveal the nature of this interplay (e.g. Balaban & Waxman, 1997; Meints, Plunkett & Harris, 1999).

Despite being cautious throughout the paper, the authors end with the rather strong claim that 'presented with the same (albeit ambiguous) objects, Japanese-speaking and English-speaking children form different categories'. This broad claim is not supported by the data as the above criticism demonstrates. I do understand that the authors could not investigate everything that is raised as criticism here, but some data collections (CDIs, assessing all stimuli on animacy and ambiguity, testing younger children and adults) would have been straightforward to incorporate and very rewarding. This additional information would have prevented ambiguities in the result interpretation and resolved some of the remaining questions. What can be concluded from the experiments as they stand, is, that under a naming condition with ambiguous stimuli, 3-year-old Japanese- and English-speaking children focus their attention on different aspects of an individuation continuum and highlight different ontological categories. Only more evidence will show how strong – or how weak – the influence of language on perception and ontological status really is.

[4] Naming seems to help focus on certain aspects of objects that in turn can help build categories and ontologies.

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Cross-linguistic differences, individuation and concepts

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Yoshida and Smith report a set of experiments investigating how the language one learns may influence – 'perturbs slightly but measurably' – category boundaries. Specifically, they examined the Boundary Shift Hypothesis, that is, languages tend to assimilate ambiguous cases to the individualized side. They were thorough and meticulous in devising experiments to test this hypothesis empirically. Their results suggest that Japanese-speaking children are more likely to construe a set of ambiguous stimuli as animates in a word extension task than English-speaking children, and this tendency is specific to ambiguous stimuli. Two of the general claims made by Yoshida and Smith are that (1) ambiguous cases tend to be assimilated to the individuated side by speakers of a particular language and (2) cross-linguistic differences highlight perceptual distinctions.

Consider the first claim. Yoshida and Smith motivated their hypothesis by noting a potential parallel between the animate/inanimate boundary and the object/substance boundary investigated by Imai and Gentner (1997). Since English marks the count/mass distinction at the object/substance boundary, American adults and children extended names for simple objects based on shape whereas Japanese adults and children did not. Similarly, Japanese marks the animate/inanimate distinction, and the current study found that Japanese children extended names for ambiguous stimuli based on multiple similarities, suggesting that they construed them as animate where American children did not do so. According to the proposal, ontological categories such as animates, complex objects and substances are universal, but cross-linguistic differences may shift the boundaries between them, depending on where the language draws the distinction. However, a peculiarity in Imai and Gentner (1997) muddies the water: the American adults in their study did not generalize substances based on material; they were ambivalent between generalizing based on shape or material. That is, even unambiguous substances were sometimes construed as individuals by American adults. In other words, the Japanese and American participants differed on both simple objects (which, by hypothesis, lie at the category boundary) and substances (which do not lie at the category boundary). Perhaps the analogy between the two cases is not as clear-cut as one would like. It is not just the case that stimuli that lie at the category boundary tend to be assimilated to the individualized side by virtue of being marked in the language; American adults tend to construe everything as individuals (Bloom, 2000).

Perhaps the second claim made by Yoshida and Smith is a better characterization of how cross-linguistic differences might impact on conceptual development. Some have suggested that the salience of perceptual distinctions may be influenced by whether a particular language marks it obligatorily (e.g. Lucy, 1992; Slobin, 1996). What is new in this paper is the proposal that these changes in salience may speed up development – Japanese-speaking children are earlier in picking up animacy cues than English-speaking children – but the differences may be transient – eventually, both English and Japanese speakers are able to use all the animacy cues (Yoshida & Smith, 2001). What is unknown is whether adults would behave differently. Suppose both American and Japanese adults are equal in how likely they construe the ambiguous stimuli as animate, then Yoshida and Smith's proposal adds to Sera, Bales and del Castillo Pintado's (1997) finding that Spanish-speaking children acquire the appearance/reality distinction faster because it is aided by a marked linguistic distinction. Of course, eventually English-speaking children also acquire the same conceptual distinction even though English does not mark the distinction linguistically.

These findings further our understanding of how language acquisition may influence the course of conceptual development. The proposal is a modest one: cross-linguistic differences may facilitate conceptual development. If a particular language marks a conceptual distinction linguistically, it is likely that children learning that language would be faster in acquiring that conceptual distinction. That is, the linguistic markers 'invite' the child to look for relevant conceptual distinctions (when they exist, since not all syntactically marked

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distinctions have straightforward semantic/conceptual underpinnings).

I believe this proposal is consistent with the view that words may serve as invitations to form categories (Waxman & Markow, 1995; Waxman, 1999) and that words may serve as pointers to kinds (Xu, in press; Xu, 2002). The former suggests that the presence of a word may facilitate categorization in infants as young as 9 months by 'inviting' them to look for commonalities across exemplars; the latter suggests that the presence of two distinct labels may allow infants to establish two object kinds (therefore two object tokens) in an object individuation task.

Perhaps one way to unite these different proposals is that words or other aspects of language may serve as 'conceptual placeholders'. Language, by itself, cannot give children, or anyone else, concepts (of course language conveys new information, but that is not the sense we are interested in, see Bloom & Keil, 2001, for a review). However, language can serve as placeholders in two senses. First, in the present case and in Sera *et al.* (1997), certain linguistically marked distinctions may lead the child to look for the relevant conceptual distinctions. Second, given an expectation such as (count) nouns refer to categories/kinds, a child can use language, in this case words, to 'set up' categories/kinds, e.g. *dog*, *cup*, etc. Once such kinds are set up, the child can proceed to figure out exactly how the kind *dog* is fundamentally different from the kind *cup*.

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Language and thought: methodological issues in cross-linguistic research on ontological categories

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This is a timely and important paper. In recent years, a growing body of research has provided evidence for the influence of language on thought (e.g. Lucy, 1992; Slobin, 1996; Choi, McDonough, Bowerman & Mandler, 1999). To this literature, Yoshida and Smith add important evidence for the early influence of linguistic categorization on children's conceptual development, using data from English and Japanese. In this commentary I discuss some issues that need further investigation.

The study concerns an area of inquiry that has been intensively investigated during the past decade following Soja, Carey and Spelke's (1991) seminal study, which argued that children are pre-linguistically equipped with the distinction between objects and substances. Many

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studies have been conducted to test this claim, and the debate continues. This line of research has since been closely identified with Lucy's influential proposal of an ontological trichotomy of animates, objects and substances (see also Bowerman, 1985, p. 1299). Soja *et al.* and related studies focus on the object–substance distinction of this trichotomy, whereas Yoshida and Smith focus on the animate–object distinction.

Lucy's framework and studies along this line are not without problems. First, it is not that children (or adults) pay attention only to shape and material in determining category membership (e.g. children also pay attention to function; Nelson, Russell, Duke & Jones, 2000). Many studies used object classification tasks to test how children attend to shape and material, by asking them to choose an entity that belongs to the same class as the model entity. Within a single study, the researcher may be able to effectively control extraneous variables, but across different studies this is not easy because experimental procedures and instruments differ slightly from study to study. Children may pay more attention to particular aspects of an item other than shape or material, and this cannot be controlled if different stimuli are used. Also there are the factors of children's age and language development. For adults, there are confounds of educational background, etc. For example, Mazuka and Friedman (2000) replicated Lucy's (1992) experiment using native speakers of English and Japanese, a classifier language without a mass–count distinction, similar to Yucatec Maya studied by Lucy. They controlled for the educational backgrounds of the participants, which was not controlled in Lucy's study. It turned out that American and Japanese college students behaved very similarly, thus casting doubt on Lucy's linguistic relativity argument.

Second, there is the difficulty of holding variables constant in cross-linguistic experiments. Building on Imai and Gentner's (1997) finding that American children showed stronger shape bias than Japanese children in sorting ambiguous objects, Yoshida and Smith hypothesized that Japanese children tend to treat ambiguous entities more frequently as animates than American children because the Japanese language encodes an animate–inanimate distinction. This hypothesis was supported by their Experiment 2. However, Imai and Gentner's results, which suggest greater shape bias among English-speaking 2-year-olds, appear to have been influenced by a stimulus that biases children to construe objects as count nouns. The experimenter said to children, 'Look at this dax' and then asked them to 'point to the tray that also has the dax on it'. The definite article in the second sentence is not entirely neutral in terms of the count/mass distinction (Mazuka & Friedman, 2000, p. 372; Whitman & Shirai, 2000, p. 320). In fact, when Imai and Mazuka (1997) replicated the study with more neutral stimuli, American children's shape bias dramatically decreased, to a level similar to that of Japanese children (Mazuka & Friedman, 2000, p. 372).

Yoshida and Smith's crucial Experiment 2 needs to be examined in this light. Strictly speaking, their Japanese and English stimuli were not equivalent because in Japanese, the stimulus (*Kore wa _____ kana?*) was truly neutral concerning count vs. mass, whereas in English it was not, since the question was asked in a count noun context (*Is this a ____?*). This may not be relevant to their research question because the experiment only concerns the animate–object distinction of the trichotomy, and since both animates and objects are count nouns, the count/mass distinction is irrelevant. Even so, it would be useful to use stimuli without count noun syntax (e.g. *Give me the same one*). This is because some of the objects shown to the children did look like substances (see their Figure 2). This means that the Japanese stimulus may have required children to deal with a larger problem space (animate, object and substance) compared to the English stimulus (animate and object only). This difference might have had a subtle influence on the results. Since Yoshida and Smith's boundary shift hypothesis crucially depends on the claim by Imai and Gentner, as well as on the validity of their Experiment 2, further empirical testing is in order.

Finally, the issue of animacy needs to be commented on. Although Yoshida and Smith claimed that animacy is more important in Japanese than in English, no independent evidence was provided (see Yamamoto, 1999 for a detailed discussion of animacy encoded in English and Japanese). Not mentioned in Yoshida and Smith, but highly relevant to their argument are the competition model studies (Bates & MacWhinney, 1989), which have established empirically that animacy is a more important cue in the interpretation of sentences in Japanese than in English. A number of competition model experiments have also shown that some languages have animacy as the strongest cue for children (e.g. Italian, Serbo-Croatian, Warlpiri, Hungarian). Since the attention to animacy can stem from any source, replication of the present study with children of these languages will be useful to test whether animacy is the key to the results of Experiment 2. A comparison with Dutch would be especially revealing since animacy is a weak cue for Dutch children.

Although this commentary takes a cautious stance, it should not be taken as discounting the importance of the cross-linguistic work in this area undertaken by Imai and Gentner and by Yoshida and Smith. These studies are truly important in that they correct the existing English-language bias in this area (see also Gathercole & Min, 1997). More cross-linguistic research in this area needs to be conducted to advance our knowledge of the important question of language and thought in development.

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Are there language-specific individuation boundaries?

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Yoshida and Smith have successfully shown that children interpret novel nouns differently depending on the structure of the language they are learning. With no explicit syntactic cues, Japanese-speaking children generalized names for simple, solid objects with some subtle animal feature by multiple similarities as if they interpreted the objects as animate objects. English-speaking children, on the other hand, generalized names for the very same objects by shape as if they interpreted them as inanimate objects. With an explicit syntactic cue (the verb *iru* or *aru*), however, Japanese-speaking children interpreted the same, ambiguous object either as an animate object or as an inanimate object depending on the syntactic cue given. Yoshida and Smith interpret this finding together with Imai and Gentner's (1997) cross-linguistic findings on the count–mass distinction as providing evidence in support of their boundary-shift hypothesis that the linguistic boundary between individuals and nonindividuals shifts the perceptual boundaries between ontological kinds. Yoshida and Smith propose that 'entities that straddle the individuation boundary of a language are assimilated toward the individuated side' and that this asymmetry of the boundary-shift effect is a universal phenomenon. Yoshida and Smith's hypothesis appears to account for Imai and Gentner's and their own cross-linguistic findings on the ambiguous, simple objects.

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However, it fails to account for Imai and Gentner's findings on substances as noted by Yoshida and Smith. In this commentary, I discuss some problems with their proposal on the language-specific individuation boundaries and suggest a new analysis of individuations in English and Japanese.

Yoshida and Smith claim that there is a linguistic boundary which distinguishes individuals from nonindividuals. The individuation boundary in Japanese is between animates and inanimates, whereas in English it is between objects and substances. But are there such language-specific individuation boundaries? Let us consider English first. English makes the count/mass distinction as well as the singular/plural distinction. Count nouns are used to refer to individuals and mass nouns are used to refer to nonindividuals. Although objects are canonical individuals and substances are canonical nonindividuals in English, this does not necessarily mean that English provides an individuation boundary between objects and substances. This is because in English count nouns refer to countable kinds or entities whether they are bounded objects or not. Children learning English must learn that things which do not refer to bounded objects such as puddle, dream and sound are all quantifiable individuals and could be referred to by count nouns when they are construed as individuals. In the case of Japanese, children must learn that individuated entities and nonindividuated entities are syntactically treated the same, because Japanese provides no explicit syntactic device to mark the count/mass distinction nor the singular/plural distinction. As Yoshida and Smith noted, 'inu ga ita' could mean either 'there was a dog' or 'there were dogs'. Thus, individuations cannot be done in Japanese, unless a numerical classifier is used. But numerical classifiers are not obligatory; they are used only when some kind of quantification is required.

Furthermore, contrary to Yoshida and Smith's claim, the Japanese classifier system does not seem to privilege animates over inanimate entities, because there are no general classifiers which could be applied to all animate objects. In contrast, there are two general classifiers, *ko* and *tsu*, which can be applied to any inanimate bounded objects. In fact, children acquire the general classifiers *ko* and *tsu* long before they acquire specific classifiers including those for animates (Uchida & Imai, 1999; Naka, 1999), suggesting that the Japanese classifier system highlights inanimate bounded objects over animates and substances. There is a plural suffix, -*tachi*, which is used with nouns referring to animate objects, as pointed out by Yoshida and Smith. However, this plural suffix is very different from English plural markers. First, it cannot be applied to all nouns referring to humans and young animals. It is applied to definite references as opposed to indefinite references. For instance, we can say, 'ano hitotachi' (that-determiner person-plural) but we cannot say 'hitotachi' without a determiner or a modifier specifying the referents. Second, it does not necessarily function like an English plural suffix. For instance, 'anetachi' (sister-plural) does not necessarily mean 'sisters'; it could mean 'a sister and someone else'. We can use -*tachi* with a proper name as in 'Yamada-kun-tachi' (Yamada-Mr-plural) meaning 'Mr Yamada and someone else'.

Taking all these facts into account, there seems to be no individuation boundary between animates and inanimates in Japanese. I suggest that a language simply provides syntactic devices which distinguish individuals from nonindividuals rather than providing a constant individuation boundary. Individuals are construed based solely on quantifiability in English, whereas both the quantifiability and the ontological classes (animates, inanimate bounded objects and substances) are bases for the construal of individuals in Japanese. In fact, Imai and Gentner's cross-linguistic findings on substances, which Yoshida and Smith's hypothesis has trouble with, can be accounted for by this new analysis without problems. English-speaking children in Imai and Gentner's study showed random responses for substances because the substances were configured into a shape; English-speaking children could not decide whether they should treat them as nonindividuals by focusing on the materials or whether they should treat them as individuals by focusing on the shape. On the other hand, Japanese-speaking children showed consistent material responses for substances because they must have habitually attended to the type of materials, not to the shape, in order to determine appropriate classifiers in quantifying the substances in everyday life. This interpretation is consistent with Lucy's (1992) claim that 'when a language signals a semantic distinction more obligatorily, then speakers of that language should "habitually attend" more to that semantic distinction'.

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