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Language, thought, and real nouns

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Abstract

We test the claim that acquiring a mass-count language, like English, causes speakers to think differently about entities in the world, relative to speakers of classifier languages like Japanese. We use three tasks to assess this claim: object-substance rating, quantity judgment, and word extension. Using the first two tasks, we present evidence that learning mass-count syntax has little effect on the interpretation of familiar nouns between Japanese and English, and that speakers of these languages do not divide up referents differently along an individuation continuum, as claimed in some previous reports (Gentner & Boroditsky, 2001). Instead, we argue that previous cross-linguistic differences (Imai & Gentner, 1997) are attributable to “lexical statistics” (Gleitman & Papafragou, 2005). Speakers of English are more likely to think that a novel ambiguous expression like “the blicket” refers to a kind of object (relative to speakers of Japanese) because speakers of English are likely to assume that “blicket” is a count noun rather than a mass noun, based on the relative frequency of each kind of word in English. This is confirmed by testing Mandarin-English bilinguals with a word extension task. We find that bilinguals tested in English with mass-count ambiguous syntax extend novel words like English monolinguals (and assume that a word like “blicket” refers to a kind of object). In contrast, bilinguals tested in Mandarin are significantly more likely to extend novel words by material. Thus, online lexical statistics, rather than non-linguistic thought, mediate cross-linguistic differences in word extension. We suggest that speakers of Mandarin, English, and Japanese draw on a universal set of lexical meanings, and that mass-count syntax allows speakers of English to select among these meanings.

What does syntax add to the meaning of words? In psychology and linguistics, this question has spawned investigations of compositionality in language – how the meanings of complex expressions, like noun phrases, are determined by the meanings of their parts and the rules that combine them (Fodor & Lepore, 2002; Frege, 1892; Partee, 1995). It has also led to cross-cultural investigations, which have asked whether cross-linguistic syntactic variation leads to differences in the content of nouns. For example, English, but not Japanese, makes a distinction between count syntax (e.g., *a string* / *some strings*) and mass syntax (*some string*), which corresponds to a referential distinction between a kind of individual and a kind of stuff. According to some, these syntactic differences lead not only to differences in noun content, but also to differences in non-linguistic thought and the perception of things in the world.

The mass-count distinction provides an ideal test of how language affects thought because it is subject to systematic cross-linguistic variation, making it easier to determine the effect of syntax on interpretation. In English and many other languages, names for countable individuals often appear in count syntax. Count nouns occur in singular and plural forms (e.g., *a cat* / *some cats*), with quasi-cardinal quantifiers and determiners (e.g., *these cats*, *those ideas*, *many blocks*), and can be directly modified by cardinal numbers (e.g., *one cat*, *two ideas*, *five blocks*). Mass nouns (e.g., *sand*, *dirt*) can occur in none of these contexts. For example, mass nouns cannot be used in singular or plural contexts (e.g., **some sands*, **two dirt*s). However, they can occur with quantifiers like *much* and *little* (e.g., *not much milk*). Most of the time, mass nouns do not denote kinds of individuals, though mass syntax does permit individuation (Barner & Snedeker, 2005, 2006; Barner, Wagner & Snedeker, 2008; Chierchia, 1998; Gillon, 1992, 1999).

Nouns in classifier languages, like Japanese and Chinese, lack count syntax, and behave syntactically like English mass nouns (see Allan, 1980; Chierchia, 1998). For example, Japanese

lacks obligatory singular-plural morphology, has few quasi-cardinal quantifiers, and does not permit nouns to be modified directly by numerals. Thus, to name a ball, a set of multiple balls, or even a portion of non-solid stuff like water, the same syntactic structure can be used in Japanese:

(1) Kenji-wa booru-o motteiru.

Kenji-Top ball-Acc have¹

“Kenji has a / some balls”

(2) Kenji-wa mizu-o motteiru.

Kenji-Top mizu-Acc have

“Kenji has water”

Further, nouns in Japanese require a measure word or classifier when counting, even when counting discrete physical objects:

(3) Kenji wa ni-ko-no booru-o motteiru.

Kenji-Top two-CL-Gen ball-Acc have

“Kenji has two balls”

Syntactically, classifiers resemble English measure words, which are required when counting portions that are named by mass nouns – e.g., two *cups* of water; one *piece* of chocolate; three *sheets* of paper (see Allan, 1980; Borer, 2004; Cheng & Sybesma, 1998; Chierchia, 1998; Li, Barner, & Huang, 2008; for discussion of how these structures are related cross-linguistically).

The lack of count syntax in classifier languages has led some researchers to argue that nouns in these languages are fundamentally different from nouns in English. Meanings encoded directly by nouns in English may be derived in classifier languages, via the combination of nouns, which denote properties or substances, and classifiers, which specify units. For example,

¹ “Top” = topic marker; “Acc” = accusative case marking; “CL” = classifier; “Gen” = genitive case marking; in example (4), below, “Nom” = nominative case marking.

Lucy (1992) argues that in classifier languages like Yucatec Mayan, nouns fail to encode individuation. Instead, “Yucatec nouns, lacking such a specification of unit, simply refer to the substance or material composition of an object” (p. 89). Thus, the Mayan word for *banana* (*ha’as*) does not denote a kind of individual by default, but is equally consistent with meanings like “banana-fruit”, “banana-leaf”, “banana-tree”, “banana-bunch”, and “banana-stuff”, among others. According to Lucy, speakers of Yucatec can distinguish these meanings via the use of classifiers: “all the lexical nouns of Yucatec are unspecified as to unit since they all require supplementary marking (i.e., numeral classifiers) in the context of numeral modification” (p. 73). Classifiers do not merely select from among multiple meanings provided by a particular noun, but actually supply units of individuation, just as English mass nouns require unitizers like *piece* and *bit* (see General Discussion, for details).

Lucy argues that this hypothesized compositional difference between Yucatec and English causes speakers of each language to think differently about objects and stuff in the world: “Use of the English lexical items routinely draws attention to the shape of a referent insofar as its form is the basis for incorporating it under some lexical label. Use of Yucatec lexical items, by contrast, routinely draws attention to the material composition of a referent insofar as its substance is the basis for incorporating it under some lexical label.” (p. 89) In support of this, he presents data from a similarity judgment task, in which Yucatec Mayan and English-speaking subjects were presented with an object, and then asked to judge which of two alternatives was most similar – one matching the original in shape, or one matching in substance. Lucy found that whereas English speakers preferred the shape-matched choice, Yucatec Mayans divided their choices between the two alternatives (see also Lucy & Gaskins, 2001; 2003). According to Lucy,

shape was a more salient dimension than material for speakers of English, a mass-count language, than for speakers of Yucatec Mayan, a classifier language.

The idea that learning mass-count syntax draws attention to stimulus properties like solidity and shape has also gained support from studies of other classifier languages, like Japanese (Imai & Gentner, 1997; Imai & Mazuka, 2003, 2007). Following up on a study by Soja, Carey, and Spelke (1991), Imai and Gentner (1997) tested English and Japanese-speaking 2-year-olds with a word extension task. Children were presented with novel labels for either a simple-shaped object, a complex-shaped object, or a portion of non-solid stuff. Novel labels were presented in mass-count ambiguous syntax for English children (e.g., *Look at the blicket*) to approximate the absence of mass-count syntax in Japanese. Results indicated that both groups of children were more likely to extend novel words by shape when they named solid objects than when they named portions of non-solid stuff (Imai, Gentner, & Uchida, 1994; Imai & Mazuka, 2007; Landau, Smith, & Jones, 1988, 1992, 1998, for more on the shape bias for solid objects). However, the two groups differed in the extent to which they extended words on the basis of shape. For simple objects and non-solid substances (but not complex objects), English 2-year-olds were more likely to extend words on the basis of shape than their Japanese peers.²

According to Imai and Gentner, this cross-linguistic difference was due to English-speaking children's acquisition of mass-count syntax, which emerges at around 24-months, when children begin using singular-plural morpho-syntax (Barner, Thalwitz, Wood, Yang, & Carey, 2007;

² Li, Dunham, and Carey (in press) find a similar result, but observe that the shape bias for non-solids disappears when the shapes of the portions do not resemble letter of the alphabet, as in Imai and Gentner's study, which used C and S shapes (see Imai & Mazuka, 2007, who also use C and S shapes). Also, they fail to replicate the exact age at which English and Japanese children differ. They find that English children exhibit a shape bias relative to both Japanese and Mandarin speaking children at around 4 years of age, rather than by 2.

Barner, Chow, & Yang, 2009; Brown, 1973; Cazden, 1968; Fenson et al., 1994; Li, Yang, Ogura, Barner, & Carey, in press; Kouider, Halberda, Wood, & Carey, 2006; Mervis & Johnson, 1991). Thus, they interpreted their results as evidence for a moderate form of the Whorfian hypothesis: “Japanese speakers and English speakers appeared to use different criteria in determining the class membership for a given instance, suggesting that they have a different representation for, or at least a different boundary between, individuals and non-individuals” (Imai & Gentner, 1997; p. 195). By this view, entities are situated along an “individuation continuum” which is divided up differently by different languages (Allan, 1980; Comrie 1981; Croft, 1990; Gentner & Boroditsky, 2001; Lucy 1992). Most “individuable” are humans and animals, which have multiple parts that move together (e.g., legs, arms, head, etc.). Next are inanimate solids. Among these, objects with complex shapes are classified as more individuable than simple shaped solids, by virtue of having more connecting geometric components that move together cohesively. Inanimate solids are in turn more individuable than non-cohesive non-solids (see Gentner & Boroditsky, 2001). According to this hypothesis, when children learn English, they learn to encode individuable things with count syntax, and thus become more sensitive to the status of things as individuals. This, in turn, leads them to include a broader class of entities as “individuated” relative to speakers of classifier languages like Japanese.

This Whorfian view has not gone unchallenged. First, efforts to replicate Lucy’s findings for Yucatec in other classifier languages, like Japanese, have found mixed results, raising the possibility that his results were not due to linguistic differences between speakers of Yucatec and English, but perhaps due to other cultural differences like education (Mazuka & Friedman, 2000). Second, recent studies have questioned the interpretation of results like those of Imai and Gentner (1997). Gleitman and Papafragou (2005) note that although cross-linguistic differences

in word extension are consistent with different sensitivities to individuation, they can also be explained by the greater frequency of count nouns in English. For example, Samuelson and Smith (1999) report that most nouns used in children's early speech are count nouns (as measured by adult ratings of words from the MacArthur-Bates Communicative Development Inventory). According to Gleitman and Papafragou (2005) "any English speaker equipped with even a rough subjective probability counter should take into account the massive preponderance of count nouns over mass nouns in English and conclude that a new word, *blicket*, used to refer to some indeterminate display, is probably a new count noun rather than a new mass noun. Count nouns, in turn, tend to denote individuals rather than stuff and so have shape predictivity." (p. 644)

In support of this "lexical statistics hypothesis", Li, Dunham, and Carey (in press) presented evidence that speakers of Japanese, English, and Mandarin Chinese do not perceive objects differently when tested with tasks that avoid linguistic labels. Li et al. found that although speakers of Japanese, English, and Mandarin exhibited differences like those reported by Imai and Gentner (1997) on word extension tasks, these differences disappeared when participants were asked to rate novel stimuli as objects or substances along a 7-point scale. Thus, cross-linguistic differences disappeared when participants were not required to interpret ambiguous nouns. Li et al. concluded that the previously reported effects of language on word extension reflect the relative frequency of count and mass nouns in mass-count languages, and not a fundamental difference in how objects are construed.³

³ A study by Imai and Mazuka (2007) attempted to address this debate using a no-label version of the word extension task, but unfortunately used a deictic pronoun "this" which is also subject to mass-count ambiguity – e.g., "*Which object is the same as this?*". Just as speakers must decide whether "this blicket" is mass or count, they also need to decide whether the "this" is mass or

To distinguish effects of lexical statistics from true Whorfian effects, the present study examined two additional predictions. First, an effect of language on thought should exist not only in early language acquisition, but should persist into adulthood as word meanings are mastered, and as syntactic structures become more deeply engrained. Therefore, cross-linguistic differences should exist not only for novel words, but also for real, known, words. In contrast, if lexical statistics explain word extension effects, then differences should only be found for novel words, when labeling is guided by inferences based on limited information. As word meanings are acquired, inferences based on correlations between shape, solidity, and syntax should be supplanted by taxonomic criteria, which should not differ cross-linguistically (see Imai, Gentner, & Uchida, 1994, for evidence that although 3-year-olds exhibit a shape bias when extending known words like *cake*, this bias disappears by 5 years of age when children extend words taxonomically and match cakes with other cakes rather than with same-shaped objects). Based on this logic, Experiment 1 used a word rating task (Samuelson & Smith, 1999; Colunga & Smith, 1999; Li et al., in press), and a quantity judgment task (Barner & Snedeker, 2005; Gathercole, 1985; McCawley, 1979), to test the interpretation of known nouns in English and Japanese.

Second, an effect of language on thought should affect non-linguistic construal of objects and should therefore be independent of online linguistic processing. As a result, individuals who speak multiple languages should construe objects similarly regardless of the language in which they are tested. In contrast, if the lexical statistics hypothesis is right, bilinguals should behave differently according to the language in which they are tested. Bilinguals should be more likely to extend novel words by shape when tested in English than when tested in Japanese or Mandarin, since only English requires a grammatical categorization of nouns as mass or count.

count, since it is used as the head noun in this expression. As a result, the study cannot address the question at hand.

To assess these predictions, we tested bilingual speakers of Mandarin and English using the word extension task, with mass-count ambiguous words, and compared them to English monolinguals.

Experiment 1

If the Whorfian hypothesis is the best account of previously reported effects of language on word extension, then known nouns, in addition to novel nouns, should show differences in individuation cross-linguistically. However, if lexical statistics best explain such results, then cross-linguistic effects should disappear when noun meanings are known (since inferences based on syntactic frame are relevant to discovering noun meanings, on this view, but not once meanings and syntactic features have been acquired). Therefore, no differences in individuation should exist cross-linguistically according to the lexical statistics view.

To test the effect of learning mass-count syntax on real noun interpretation, we tested both Japanese and English participants with two tasks. First, an object-substance rating task asked speakers of each language to judge whether common nouns denote objects, substances, or both. Second, we tested speakers of English and Japanese with a quantity judgment task. Participants were shown photos of two characters, each of whom had either a set of objects or a portion of non-solid stuff, and were asked to judge which character had *more* of the relevant stuff. Following the reasoning of Quine (1960, 1969) and previous studies of quantity judgment (Barner & Snedeker, 2005, 2006; Barner, Wagner, & Snedeker, 2008; Gathercole, 1985; Inagaki & Barner, in press), we reasoned that quantification based on number is evidence for individuation. The quantity judgment task was used to test three types of noun: (1) count nouns that denote solid things (e.g., *cup*), (2) mass nouns that denote non-solids substances (e.g., *mustard*), (3) mass-count flexible nouns (e.g., *string*). English participants were tested with explicit mass-count syntax, thereby providing the strongest possible test of the hypothesis that

mass-count syntax in English shifts interpretation relative to nouns in Japanese, which lack mass-count syntax. If mass-count syntax affects interpretation cross-linguistically, then judgments in the two languages should differ. However, if mass-count syntax does not shift the criteria of individuation for speakers, but merely selects among universally available meanings, then no difference should be found between English and Japanese speakers, except for mass-count flexible words, which should have multiple meanings both in English and in Japanese.

Method

Participants

A total of 122 native speakers of English were recruited from the University of Toronto's participant pool of freshman year psychology students. A total of 89 native Japanese speakers were recruited from Osaka Prefecture University in Osaka, Japan. Twenty-four of the English speakers and 24 of the Japanese speakers participated in an object-substance rating task. As part of the object-substance study, 24 additional English speakers performed a mass-count rating task, and 10 did a grammaticality judgment task. The remaining participants (64 English and 65 Japanese) completed the quantity judgment task. Japanese participants were either freshmen or sophomores, and majored in one of: Human Sciences, Language and Culture, Nursing, or Comprehensive Rehabilitation. Both groups received partial course credit for participation. The design was between subjects, such that each subject only participated in one of three tasks. Participants were tested either in the lab or in university classrooms.

Stimuli and Procedure

Words were selected from the Japanese Communicative Development Inventory (JCDI; Ogura & Watamaki, 1998), and were limited to three categories: household or miscellaneous goods, food and beverages, and toys. Each potential target word was translated into English by

the second author. Several word types were excluded: compounds, words with unrelated homonyms, inherent or irregular plurals (in English), and words with no clear translation. One hundred words were then randomly selected from the remaining list of words. These words were then rated in two additional tasks: the object-substance rating task and the mass-count rating task (see Appendix A for the full list of 100 words). Both tasks were “paper and pencil” tasks.

When we see something, we tend to think of it as either an object or a substance.

For example, when we see the entity in Picture A, we generally think of it as an object, a fan, regardless of what it’s made out of.

Picture A

But when we see the entity in Picture B, we generally think of it as a substance, ice cream, regardless of its form.

Picture B

You will make judgments about familiar nouns. Does the word X refer to a kind of object, kind of substance, both, or neither? If neither, what kind of entity does it refer to?

Figure 1. Instructions for the Object-Substance Rating Task.

Object-substance judgment. Twenty-four native English speakers and 24 native Japanese speakers rated the 100 words in Appendix A as “object”, “substance”, “both”, or “neither” using an adaptation of the object-substance judgment task of Li, Dunham, and Carey (in press). See Figure 1 for English instructions and Appendix B for Japanese instructions. If participants chose

“neither” they were asked to describe in writing what kind of entity the word denoted. Participants were evenly divided into one of two presentation orders.

Unlike previous rating studies, which tested correlations between shape, solidity, and syntax (e.g., Samuelson & Smith, 1999; Colunga & Smith, 2005), we specifically tested the object-substance distinction. Also, previous studies collected ratings for words used in the input of speakers’ respective languages, and therefore did not test the same nouns across languages. Here, participants were tested with the same set of words.

Mass-count judgment. Twenty-four additional native English speakers rated whether the 100 words used in the object-substance judgment task were mass nouns, count nouns, or mass-count flexible (see Appendix C for instructions). Words were presented in one of two orders.

Figure 2. A flexible noun presented in count syntax in the Quantity Judgment Task.

The top 16 words rated as mass nouns (range of ratings between 48-92% as mass), the top 16 words rated as count nouns (92-100% as count), and the 16 words most frequently rated as flexible (38-75% as flexible) were subjected to a grammaticality judgment task, which included 10 additional English participants. Each word was presented in either count or mass syntax (e.g., *a cat*, *some cat*) and participants rated each as ‘acceptable’ or ‘strange’. The top 10 most consistent words from each category were used for the quantity judgment task (i.e., the 10 words most consistently judged as acceptable in only count syntax, or only in mass syntax, or as flexible).

Quantity judgment. A total of 64 English and 63 Japanese monolinguals participated in this task (these participants did not take part in other tasks). Words were selected based on the results of the mass-count judgment task, and included 30 words in all. Count nouns were *balloon*, *bottle*, *towel*, *clock*, *doll*, *handkerchief*, *ball*, *pen*, *key*, and *bowl* (in Japanese: *fuusen*, *bin*, *taoru*, *tokee*, *ningyoo*, *hankati*, *tama*, *pen*, *kagi*, and *donburi*, respectively). It is noteworthy that these words all denote entities that would fall near the middle of the Gentner and Boroditsky (2001) individuation continuum (objects near the middle include things like “small mobile objects” and “complex structurally cohesive objects”). Mass nouns were *bread*, *sugar*, *butter*, *popcorn*, *salt*, *tofu*, *meat*, *margarine*, *gum*, and *ice* (in Japanese: *pan*, *satoo*, *bataa*, *poppukoon*, *sio*, *toofu*, *niku*, *maagarin*, *gamu*, and *koori*, respectively). Flexible nouns were *coffee*, *chocolate*, *soda*, *sauce*, *egg*, *cake*, *paper*, *candy*, *yoghurt*, and *pizza* (in Japanese: *koohii*, *tyokoreeto*, *soda*, *soosu*, *tamago*, *keeki*, *kami*, *ame*, *yooguruto*, and *piza*, respectively; see Figure 2 for an example of a flexible noun presented in count syntax).

English participants were divided equally into four quantity judgment conditions: mass nouns, count nouns, flexible mass nouns, and flexible count nouns. The same words were used in

both the flexible mass noun and the flexible count noun conditions except that they were presented in either mass or count syntax (e.g., *Who has more coffee?* vs. *Who has more coffees?*). Japanese participants were divided into one of three conditions: mass nouns, count nouns, or flexible nouns. Since there is no mass-count syntax in Japanese all participants were tested with the same syntactic frame, as in (4):

(4) dotira-no hito-ga X-o yori-ooku motteiru desyoo?

which-Gen person-Nom X-Acc more-many/much have

“Who has more X?”

Judgments were elicited using a paper and pencil task. Adults were shown photos of two characters and were asked to choose which of the two characters had more (e.g., *Who has more coffee?*). One character always had two large objects or portions of stuff while the other character had six small objects or portions. The six objects always had a smaller combined volume and surface area than the two large objects (1:2 ratio). Below each image, the size of each individual was noted in text. This allowed responses based on number to be distinguished from responses based on volume. Examples of each condition are displayed in Appendix D.

Results

Object-substance judgments

Japanese and English speakers showed remarkable agreement in their object-substance ratings for the 100 target words, despite the fact that Japanese lacks a mass-count distinction (see Figure 3). The average rating (where 1=object, 2=both, and 3=substance) was 1.72 for English and 1.73 for Japanese. The ratings for these 100 items were highly correlated ($r(100) = .941, p < .001$). Also, the distribution of ratings was such that Japanese speakers gave higher ratings than English speakers on 44 items, identical ratings on 10 items, and lower ratings on 46 items. A

Mann-Whitney test for each word compared English and Japanese ratings. Only one word – *clay* – differed significantly between groups (at $p < .05$). The mean rating for *clay* was 1.96 for Japanese speakers and 2.67 for English speakers, meaning that English speakers were more likely to call “clay” a substance than Japanese speakers.⁴

Figure 3. Japanese and English Object-Substance Ratings

The average number of words rated as “object” also did not differ between groups. Japanese

⁴ T-tests found similar results, with one additional word – *pudding* – significant at $p < .05$. As with *clay*, English speakers were more likely to call *pudding* a substance (E:2.83; J: 2.39).

speakers rated 58% of words as object words, on average, compared to 55% by English speakers ($t(46) = 1.18, p = .25$). The two groups also rated a similar number of words as “substance” (J: 32%; E: 31%; $t(46) = .43, p = .77$), and as “both” (J: 9%; E: 11%; $t(46) = .43, p = .67$). Thus, there was no evidence that Japanese speakers were less likely to construe referents of nouns as objects relative to speakers of English, even for individual items. These results fail to support the Whorfian claims of Lucy (1992) and Imai and Gentner (1997).

Mass-count judgments

The average mass-count rating was 1.68 (where 1= count, 2=flexible, and 3=mass). Fifty-five of the words had ratings below 1.5, and the remaining 45 words had ratings above 1.5. The mass-count judgments were highly correlated with both the English and Japanese object-substance judgments (English: $r(100) = .900, p < .001$; Japanese: $r(100) = .812, p < .001$).

Quantity judgments

Results for mass and count words are shown in Figure 4. Data⁵ were submitted to parallel subjects and items ANOVAs (labeled *F1* and *F2*) with two between-subjects variables: word type (mass vs. count) and language group (English vs. Japanese). The analysis revealed a significant effect of word type for both subjects and items ($F1(1,71) = 464.7, p < .001, \eta_p^2 = .87$; $F2(1,18) = 642.1, p < .001, \eta_p^2 = .97$). Overall, Japanese and English participants based quantity judgments on number 97.3% of the time for count items compared to only 13.6% of the time for mass items. Crucially, there was no main effect of language ($F1(1,71) = 1.47, p = .23, \eta_p^2 = .020$; $F2(1,18) = 2.03, p = .17, \eta_p^2 = .101$). Contrary to the Whorfian view, English speakers were not more likely to base quantity judgments on number than Japanese speakers (E: 53.1%; J: 57.8%).

⁵ All data reported in this paper were also analyzed after submitting them to an arcsine-square-root transform, and the subsequent analyses did not yield different significant results than non-transformed data (using a $p < .05$ cut-off).

There was, however, a weak but significant interaction between word type and language ($F(1,71) = 6.55, p = .01, \eta_p^2 = .08$; $F(1,18) = 9.0, p = .01, \eta_p^2 = .34$). For count nouns, English speakers were more likely to choose by number than Japanese speakers (English: 100% vs. Japanese: 94.8%; $t(20) = 2.59, p = .02$). The reverse was true for mass nouns (English: 6.3% vs. Japanese: 20.9%; $t(36) = 2.0, p = .053$). The presence of explicit mass-count syntax in English sharpened quantity judgments for English speakers, polarizing their responses relative to Japanese speakers.⁶ Overall, however, English nouns were not more likely to individuate than equivalent Japanese nouns.

Figure 4. Percentage of quantity judgments based on number for mass and count nouns between English- and Japanese-speaking adults

⁶ See Inagaki and Barner (in press) for a replication of the quantity judgment results reported in Experiment 1. They used a different sentence construction (*dotira-ga yori-ooku-no X-o motte-iru desyoo*), but found the same pattern of results for a different set of items (i.e., no effect of language or interaction between language and word type).

Figure 5. Results for the Quantity Judgment Task comparing the flexible count noun and flexible mass noun conditions for English to the flexible noun condition for Japanese.

Next, we analyzed quantity judgments for mass-count flexible words. Results are shown in Figure 5. English speakers based quantity judgments on number significantly more often for flexible words when they were presented in count syntax (72.5%) relative to when they were presented in mass syntax (1.9%; $t1(16) = 6.39, p < .001$; $t2(9) = 44.87, p < .001$). Japanese quantity judgments were based on number almost exactly 50% of the time (56.8%), and were significantly different from English mass judgments ($t1(26) = 9.49, p < .001$; $t2(9) = 6.96, p < .001$), and marginally different from English count judgments ($t1(23) = 1.29, p > .2$; $t2(9) = 2.00, p = .08$). These results indicate that Japanese judgments for nouns that are mass-count flexible in English fall between the mass and count judgments of English speakers, but that they differ most

from English mass judgments. This finding suggests that mass-count flexible words are ambiguous to Japanese speakers, and that both meanings encoded by English mass-count syntax are also available to Japanese speakers.⁷

Discussion

Two tasks revealed little difference between Japanese and English interpretations of common nouns. First, the object-substance rating task found almost identical ratings between the groups, and no greater tendency for English speakers to assign words “object” ratings, relative to Japanese speakers. This resembles the finding of Colunga and Smith (2003) and is consistent with Li et al.’s finding that English and Japanese subjects do not differ in their ratings for novel words. For a large set of familiar nouns ($n = 100$), English speakers are no more likely than Japanese speakers to construe the referents of words as objects.

For words that are used rigidly as mass or count in English, the quantity judgment task revealed no bias on the part of Japanese speakers to prefer unindividuated interpretations of nouns, though explicit mass-count syntax polarized English judgments relative to those of Japanese participants. Overall, there was no evidence of a Whorfian effect of language on thought for real, known, nouns. For words that are syntactically flexible in English, Japanese quantity judgments differed significantly from English mass usages, and marginally from English count usages. These results are consistent with the idea that mass-count syntax disambiguates between universally available meanings, and that semantic ambiguity in Japanese

⁷ It remains possible that testing subjects with different constructions would find different results. Although *ooku* – the Japanese quantifier used here – was grammatical with all words tested and permitted a full range of interpretations (from number-based to mass- or volume-based), it is possible that other words (e.g., *takusan*) would push Japanese speakers more towards number or more towards mass / volume. Crucially, for such words to test the hypothesis at hand, they would need to permit a full range of interpretations, like *ooku*, and not favor one form of interpretation over another. Future studies should investigate this possibility, and how particular quantifiers affect individuation.

is most likely for words that are syntactically flexible in English. These results are consistent with the idea that mass-count syntax does not shift a speaker's construal of objects per se, but instead that it selects from universally available lexical meanings, which are provided independent of syntax. Once real word meanings are acquired, cross-linguistic differences found in word learning studies disappear, as speakers rely on linguistic meaning, rather than statistical inference.

Experiment 2

Experiment 1 indicated that English speakers are no more likely than Japanese speakers to assign individuated interpretations to known nouns. These results support the hypothesis that previously reported differences between Japanese and English word extension are due to online inferences involving lexical statistics, rather than deeper effects of language on thought.

In order to show that cross-linguistic differences in word extension are due to lexical statistics, it is preferable to demonstrate this using the original methods of Imai and Gentner (1997). To do so, we tested bilingual speakers of English and Mandarin Chinese, a classifier language. As typically stated, the Whorfian hypothesis is a claim about how differences in one system – i.e., language – affect differences in a second, independent system – i.e., thought. If thought is indeed separable from language, then to the extent that the Whorfian hypothesis is true, the content of thought should be affected by differences from language to language. Following this, in bilinguals, the content of thought should amount to a compromise between the syntactic influences of each language spoken. Based on this assumption, we reasoned as follows. If language causes differences in word extension by changing a speaker's non-linguistic construal of objects then Mandarin-English bilinguals should perform identically whether tested in English or Mandarin. If, however, differences are caused by online lexical statistics, then

judgments should differ according to the testing language, even when no explicit syntactic cues are provided in English. Specifically, bilingual speakers should be more likely to extend novel words on shape when tested in English than when tested in Mandarin.

We tested advanced second language (L2) learners of English, whose first language was Mandarin (Mandarin-English bilinguals), and compared them to monolingual speakers of English. In one condition, we tested bilinguals in either English or Mandarin, and compared them to English monolinguals, using ambiguous syntax for all three groups. In a second condition, English monolinguals were tested with explicit mass-count syntax. This allowed us to test the prediction of the lexical statistics hypothesis that English judgments in ambiguous syntax should resemble judgments for words presented with explicit count syntax.

Method

Participants

Participants were 48 native English speakers, and 32 L2 learners of English whose first language was Mandarin Chinese. In Condition 1, 16 of the English speakers and 16 Mandarin-English bilinguals were tested in English with mass-count ambiguous syntax. The remaining 16 bilinguals were tested in Mandarin (with no mass-count cues). In Condition 2, 16 different English monolinguals were tested with count syntax and 16 were tested with mass syntax. All participants were recruited from the University of Toronto's Psychology subject pool, and were tested in the laboratory. Participants received partial course credit for their participation.

To verify each bilingual's level of English, we administered the Oxford University Press *Quick Placement Test*, a 30-minute English assessment test (Syndicate, U.C.L.E, 2001). There was no difference between the bilingual participants that were tested in English (average score of 81.7%; $sd = 10.5$) and those that were tested in Mandarin (also 81.7%; $sd = 12.4$; $t(30) = 0.0$, $p =$

1). Overall, the Oxford test found that the bilinguals were advanced learners of English.

Stimuli

Participants were tested with 12 kinds of novel objects (called standards), which varied in shape and material, in addition to 12 “shape alternatives” and 12 “substance alternatives”. The shape alternatives had the same shape as the standard objects with which they were paired, but differed in substance. The substance alternatives had the same material as the standards with which they were paired, but differed in shape. Sketches in Appendix E (created using a photo transformation tool in Photoshop from photos of the actual objects) depict the 12 standard objects, their novel labels, and their alternatives.

Since previous studies find cross-linguistic effects chiefly for “simple” objects, stimuli were restricted to simple objects selected from a larger pool of 24 objects, which varied in complexity. Twenty additional English-speaking participants verified the categorization of the stimuli as simple vs. complex by rating the complexity of all 24 objects presented as a single array on a scale from 1 (*low complexity*) to 7 (*high complexity*). Participants were given the following instructions (adapted from Li, Dunham, & Carey, in press):

You are to rate the complexity of the shape of the item displayed in front of you. Focus on the overall shape and outline of the three-dimensional item while ignoring the internal texture of the item. A complex-shaped item is one which has a complicated outline defined by multiple points and sides whereas a simple-shaped item has a relatively simple outline with few points and sides.

The 12 Simple Objects had ratings ranging from 1.33 to 3.75 ($M = 2.87$). The 12 Complex Objects had ratings ranging from 4.08 to 6.0 ($M = 4.96$), and were excluded from the study.

Procedure

Mandarin-English bilinguals were tested either in Mandarin or in English, between subjects, and English monolinguals were tested in English. In Condition 1, the “ambiguous syntax” condition, nouns were always presented in mass-count ambiguous sentences (to English-

speaking participants) or in Mandarin, which lacks the distinction. To begin each trial, the experimenter presented a standard object and said: “*Look; look at the blicket*” (Mandarin: *kan4, kan4 zhe4 fen2yan2*). Participants were then shown a shape alternative (that matched in shape but not substance) and a substance alternative (that matched in substance but not shape), and were asked which of the two objects the novel word named: “*Can you point at the blicket?*” (Mandarin: *qing2 ni3 zhi3 zhe fen2yan2*). The side of the shape alternative was counterbalanced across trials. An example trial is presented in Figure 6.

In Condition 2, the “syntactic cues” condition, English monolinguals were presented words in either mass or count syntax for all 12 items, between subjects – e.g., “*This is some/a wug. Have you ever seen any wug(s) before? This is some/a wug.*”⁸

Study Phase	Stimulus		English	Mandarin
Training			(Amb.) Look at the __.	噢, 看, 看這__
			Or	
			(Ct.) This is a __.	
			Or	
Word Extension			(Ms.) This is some __.	請你指著__
			(Amb.) Point to the __.	
			Or	
			(Ct.) Point to a __.	
			Or	
			(Ms.) Point to some __.	

Figure 6. An example trial set of the Word Extension Task, with ambiguous syntax, count syntax, and mass syntax for English, and neutral syntax for Mandarin.

⁸ Participants in both conditions also performed quantity judgments, not analyzed here. In Condition 2, the pattern of results for quantity judgments was identical to the pattern for word extension (see also Barner & Snedeker, 2006, for evidence that the two tasks produce similar results in English). For Condition 1, the quantity judgment trials did not include nouns (e.g., questions were “*Who has more?*”), such that the data could not speak to the question of NP interpretation. Neither task found evidence that English monolinguals are more likely to base judgments on number than bilinguals tested in English.

Results

Word extension with mass-count ambiguous syntax

Condition 1 data were submitted to an analysis of variance (ANOVA) with language group as a between subjects factor (monolingual English vs. bilingual Mandarin vs. bilingual English). Results are presented in Figure 7. There was a significant effect of language on word extension ($F(2, 45) = 8.9, p < .005; \eta_p^2 = .283; F(2, 10) = 78.4, p < .001, \eta_p^2 = .940$). English monolinguals extended words on the basis of shape significantly more than bilinguals tested in Mandarin (92% vs. 55%; $t(30) = 3.37, p < .005$). However, English monolinguals did not differ from bilinguals tested in English (92% vs. 88%; $t(30) = .7, p > .5$). Most crucially, there was a significant difference between bilinguals tested in English (88%) and bilinguals tested in Mandarin (55%; $t(30) = 2.99, p < .01$).

Figure 7. Results for the Word Extension Task comparing the three language groups: monolingual English, bilingual Mandarin and bilingual English

Although both groups of bilinguals had learned English to the same level, their judgments

differed significantly according to the language in which they were tested. These results are consistent with the hypothesis that cross-linguistic differences in word extension are driven by online lexical statistics, and not a deeper effect of language on thought.

Figure 8. Results for the Word Extension Task across three syntactic frames: English mass, English ambiguous, and English count.

Word extension with mass-count syntax

An ANOVA testing the effect of syntax (count, mass, and ambiguous) on English monolinguals' word extension revealed a significant effect of syntax ($F(2,45) = 18.97, p < .0001, \eta_p^2 = .46$; $F(2, 22) = 270.79, \eta_p^2 = .95, p < .0001$). Consistent with the lexical statistics hypothesis, word extension did not differ between English monolinguals tested with ambiguous syntax (92% by shape) and count syntax (98% by shape; $t(30) = 1.42, p > .17$). Also, judgments

for mass syntax (46% by shape) differed from both ambiguous syntax ($t(30) = 4.08, p < .0001$), and count syntax ($t(30) = 4.96, p < .0001$).⁹

These data, similar to those reported by Imai and Mazuka (2003) and Gathercole and Whitfield (2001) are consistent with the hypothesis that English speakers assume that ambiguous nouns are count nouns, when the novel words name solid objects. Thus, speakers processing English do not merely exhibit a subtle shift in their criteria for individuation, but behave exactly as though they think novel words are count nouns.

Discussion

Word extension judgments of Mandarin-English bilinguals differed significantly according to the language in which speakers were tested, even when explicit mass-count cues were absent. Also, in English monolinguals, judgments for ambiguous syntax did not differ significantly from those involving explicit count syntax. This result is consistent with the idea that English speakers assume that ambiguous words are count nouns. Together, these results support the hypothesis that lexical statistics cause cross-linguistic differences in word extension. They are not consistent, however, with the idea that learning mass-count syntax causes non-linguistic differences in how speakers perceive objects and stuff in the world.

Typically, proponents of the Whorfian hypothesis assume that online effects, such as those reported here, do not count as instances of language affecting thought. Instead, it is assumed that thought is a language-independent system, and that there are not multiple systems of thought for each language spoken. For example, in their study of how Indonesian speakers encode action events, Boroditsky, Ham, and Ramscar (2002) distinguish between effects that are mediated by online linguistic processing, like the effects reported here, from effects that are attributable to changes in thought processes that are language independent. It remains possible, of course, that

⁹ Judgments of bilinguals tested with ambiguous syntax in English differed from both English monolingual mass ($t(30) = 3.70, p < .0001$) and count judgments ($t(30) = 2.31, p = .03, eta = .15$). Although lexical statistics mediated their judgments, it did not do so as strongly as in English L1 speakers (presumably because L2 knowledge of syntax was not as entrenched).

language and thought are not separable – that thought is, for example, just a component of language (e.g., its semantics). Following this, one might claim that speakers of multiple languages have multiple systems of thought, and that language does affect thought after all. This modified theory would account for the data of Experiment 2, but in doing so greatly limit the Whorfian hypothesis to a view that is much narrower in scope – i.e., that language-independent processes are not affected by linguistic variation. Such a view, besides being narrow in scope, would still not account for the findings of Experiment 1. If linguistic variation affects object perception, this should be true for both novel and known nouns. On the other hand, if the lexical statistics hypothesis is right, linguistic variation in the presence of count syntax should affect inferences about novel word meanings, but should not affect the interpretation of known nouns.

GENERAL DISCUSSION

A study of how mass-count syntax affects individuation failed to find evidence of Whorfian effects for real or novel nouns. Instead, results favor the hypothesis that cross-linguistic differences in word extension are attributable to online lexical statistics. According to this hypothesis, languages share a universal ontology of individuals. However, when speakers of English hear a novel ambiguous noun, they assume it is a count noun and therefore infer that the word must individuate. Speakers of Japanese and Mandarin, however, do not acquire obligatory mass-count syntax, and therefore do not make syntactically mediated inferences about individuation.

Using the quantity judgment task, Experiment 1 tested the lexical statistics hypothesis by comparing speakers of Japanese and English. Overall, we found no evidence that speakers of English favor individuated meanings relative to speakers of Japanese, even though English participants were tested with explicit mass-count syntax. Similarly, an object-substance rating task found no evidence that nouns are more likely to individuate in English. Japanese speakers were as likely as English speakers to judge that a common noun denoted a discrete physical

object, and did not show a material bias as predicted by the Whorfian view. Overall, the results support the conclusion that speakers of English and Japanese access a universal ontology of individuals. Once speakers have acquired the meanings of real nouns, online statistical cues that provide cues to meaning become irrelevant. Although syntactic inferences based on lexical statistics make English speakers more likely to extend novel words by shape, these inferences are not at play for real words, and thus no difference between languages is found.

Experiment 2 tested the lexical statistics hypothesis using a word extension task, and found that the judgments of Mandarin-English bilinguals differed according to the language in which they were tested. When tested in English, bilinguals extended novel words primarily by shape. These judgments did not differ from those of monolingual English speakers tested with ambiguous syntax. In contrast, bilinguals who were tested in Mandarin extended words significantly less by shape, and also differed from English participants tested with ambiguous syntax. These results fail to support the idea that learning mass-count syntax causes non-linguistic differences in how speakers perceive objects and stuff in the world. Instead, they support the idea that cross-linguistic differences are mediated by online lexical statistics.

These results challenge the Whorfian idea that learning count syntax shifts the perceptual boundary of what speakers consider to be discrete individuals. What, then, is the alternative to this hypothesis? The simple answer to this is the null hypothesis – i.e., that the status of things as individuals is unaffected by linguistic variation. Cross-linguistic effects are the product of differences in how speakers process sentences online, with English speakers categorizing ambiguous words as count nouns according to statistical frequency, and Japanese or Mandarin speakers basing their semantic assessments on lexical semantics. When word meanings are known, or when language is not involved in judgment tasks, as in the study of Li, Dunham, and Carey (in press), cross-linguistic effects disappear.

Still, while this simple response provides an explanation of effects like those presented by Imai and Gentner (1997), it hardly amounts to a theory of language, or even a theory of how syntax and semantics interact when interpreting nouns. To move the debate beyond the question of whether particular effects are Whorfian or non-Whorfian, a theory of how noun phrases relate to individuation must describe more broadly how lexical and syntactic representations interact.

One such proposal comes from a recent study of noun learning in Japanese (Yoshida & Smith, 2005). In this study, Japanese 2-year-olds were taught names for solid objects and non-solid portions. Half of the children heard names for solids used with a classifier *hitotsu* (used when counting discrete inanimate things) and non-solids used with *sukoshi* (used when describing portions of stuff or things). The other half of children did not hear these cues. At test, children who had heard *hitotsu* and *sukoshi* in training were more likely to extend new names for solids by shape and new names for non-solids by substance, whether or not the linguistic cues were used explicitly on test trials.

To explain their results, Yoshida and Smith (2005) suggest that, “by teaching associations between words and perceptual properties, one will change not only what is known about the words, but also what is known about the correlations among the perceptual properties” (p. 94). Thus, learning that solidity and shape are correlated may be facilitated by learning a redundant correlation between property and linguistic cues (i.e., *hitotsu* vs. *sukoshi*). This is intriguing, they suggest, “because languages offer many kinds of devices that redundantly correlate with regularities in the world, and in these ways may broadly influence what is learned about those regularities” (p. 94). Although this account is consistent with their findings, our results indicate that a different interpretation is needed. Specifically, Yoshida and Smith’s hypothesis cannot explain why nouns in adult English vocabularies are no more likely to individuate than Japanese

nouns, despite the fact that only English has redundant correlated cues to meaning (i.e., mass-count syntax). If such correlations were relevant to the final form of linguistic representations, then differences would be expected. However, they are not.

Our suggestion is that although *correlations* between percepts, category structure, and syntax may change with word learning experience, these changes do not affect perception and categorization *per se*, nor do they affect how real word meanings are eventually acquired; changes in correlations between domains do not necessarily equal changes in the domains themselves. Such correlations may inform hypotheses about word meaning when meanings are still unknown (consistent with the lexical statistics hypothesis), leading speakers of Japanese and English to arrive at different judgments in word learning tasks (since English speakers use syntactic inferences to disambiguate words). However, once the real meanings of nouns are acquired, differences between correlations should cease to affect interpretation.

Rather than syntax restructuring lexical concepts (or the perception of referents), lexical concepts may determine when mass and count syntax can be used. Our hypothesis is that the ontology of individuals is identical cross-linguistically. In all languages, some words denote things that can only be construed as kinds of things, and some words have denotations that can only be construed as unindividuated stuff. In between these two poles are a host of words that provide multiple construals, each word differing in the extent to which one construal is favored over the other. Languages, we assert, do not alter preferences between construals, but rather differ in whether they provide obligatory syntactic mechanisms for selecting between them. Some languages provide syntax for selecting among construals (like mass-count syntax in English), and some languages do not make such an obligatory distinction (like Japanese and Mandarin). Thus, languages vary in their capacity to tease apart lexical construals on the fly.

Consider, for example, the words in (5), which can be used to refer to either kinds of individuals or unindividuated “stuff”, depending on their use in mass or count syntax.

(5) *hamburger, water, orange, banana, chicken, deer, fish, duck, steak, difference, coffee, tea, meaning, hope, paper, chicken, rabbit, fish, authority, television, chocolate, stone, string, coffee, error, wine, cheese, bread, pasta, paint, romance, comedy, tragedy*

English provides obligatory marking that distinguishes the multiple construals associated with each word, whereas Japanese does not. Still, as shown in the experiments above, whenever nouns are mass-count flexible in English, Japanese speakers exhibit corresponding flexibility in their interpretation of equivalent Japanese nouns (though the extent of this flexibility, whether syntactic or conceptual, may vary from item to item). For example, for words like *chocolate*, *egg*, and *pizza* Japanese participants based quantity judgments on number around half of the time, whereas English participants based judgments on number when the words were used in count syntax and on mass or volume when they were used in mass syntax. This pattern is also found cross-linguistically. If a particular noun can be used as mass in one language (and quantifies by mass or volume), and also appears as a count noun in another language, then in classifier languages the noun is likely to be semantically ambiguous (see Bale & Barner, in press, for a formal semantic model that accounts for this). For example, Inagaki and Barner (in press) report that whereas French speakers base judgments on number for count nouns like *épinards* (i.e., “spinaches”) English speakers base judgments on mass or volume for equivalent mass nouns in English, like *spinach* (other examples include *toast*, *hair*, and *pasta*). Such data suggest that Japanese speakers, like speakers of mass-count languages, have access to multiple construals for words that exhibit syntactic flexibility, despite the fact that they lack multiple syntactic structures for disambiguating between them. Words that are used rigidly as either mass or count

are also subject to rigid interpretations in Japanese, whereas words that are syntactically flexible are relatively ambiguous when mass-count syntax is not available.

Our main argument is that nouns in Japanese, Mandarin, and English share a universal ontology of individuals, and that within this ontology, there are nouns that permit multiple interpretations. By this view, count syntax and classifiers do not add meaning to nouns, but merely select between the multiple interpretations that nouns permit. When nouns are novel, speakers bring prior syntactic knowledge to bear, and make inferences about their meanings based on statistics relations between syntax and semantics. Once words are known, lexical knowledge replaces inference in interpretation, and cross-linguistic differences disappear.

In one respect, this hypothesis may be too strong, since new meanings can sometimes be generated on the fly. Not all nouns that can appear in count syntax are created equal – some nouns specify particular units for counting, whereas other nouns require units to be specified contextually. The word *cat*, for example, restricts counting to whole cats, and does not support counting of arbitrary cat parts. However, *tea*, when used in count syntax (e.g., *Can I have a tea, please?*) signals only that some unit of tea is being referred to, without saying anything about its shape or size. If there are two *teas* on a table, there may be two cups of tea, two tea bags of different kinds, two types of leaf intermixed, or two pots of tea. In this case, count syntax does little more than to tell the listener that some countable unit or another is being referred to. Instead of selecting a pre-existing meaning, it directs attention to a novel one, by signaling the presence of units where none would typically be assumed to exist.

Similarly, classifiers can sometimes be used to specify units of individuation when nouns fail to do so. In addition to what some have called “sortal” classifiers, which are used with sortals like *cat* and *cup*, languages like Mandarin have “mensural classifiers” or measure words (see

Cheng & Sybesma, 1998; Grinevald, 2004; Li, Barner, & Huang, 2008; Lyons, 1977). Sortal classifiers (or what Cheng and Sybesma call “count” classifiers) are a closed class, and each classifier is restricted to use with a certain set of nouns. In Mandarin, classifiers are matched to nouns according to agreement in properties like shape (e.g., rod-shape; flat-sheet-shape). Since these memorized associations between sortal classifiers and nouns are relatively rigid, there is little reason to stipulate a compositional relation between them. It is this kind of classifier that we suspect has little effect on individuation, beyond licensing the use of numerals.¹⁰

Measure words, on the other hand, clearly change the unit of counting when used, and even allow unitization of non-solid portions like *water* and *mud*. In Mandarin, like in English, measure words are an open class and can be generated from nouns. For example, in English we can talk about *piles*, *buckets*, *cups*, or *boatloads* of water. These words can also refer to portions of things denoted by count nouns – e.g., *a bucket of marbles*. Clearly, measure words create units of counting that are not specified by the noun alone.

Some authors have claimed that classifiers in Chinese always add content to nouns, regardless of their sub-variety, and that nouns in isolation have “mass” denotations. This view is expressed, for example, by Borer (2005):

“[T]he need for a classifier projection to license counting vs. the absence of classifiers in the context of mass interpretation confirms the claim that in the absence of classifiers, [noun] predicates in Chinese are interpreted as mass. Thus, at least in Chinese there is direct evidence that count interpretation must be structurally licensed, but mass interpretation need not be.” (Borer, 2005, p. 108)

¹⁰ The use of classifiers with specific words likely also leads to classifiers licensing inferences about the meanings of novel words with which they are used. If a given classifier is always used with nouns that denote rod-shaped objects, then the speaker may infer that a novel noun used with this classifier also denotes a rod-shaped object. This, however, is different from adding meaning to the noun compositionally. In Mandarin, it is impossible, for example, to use the classifier for rod-shaped objects to refer to a person who is tall, or to use the animate classifier with a noun like *statue* to communicate that the statue is animate. Classifiers agree with the content of NPs rather than contributing to it.

A similar view is found in Greenberg (1972) :

“...nouns in their isolated form, that is when not accompanied by a classifier or a plural marker, are like collectives in their semantic non-specification of number and in their avoidance of a direct number construction.” (p. 26)

Although we agree that Japanese and Chinese do not mark the mass-count distinction *syntactically* at the level of the noun, we disagree that nouns in these languages must therefore have “mass” denotations, since individuation can be specified lexically (like English object-mass nouns, such as *furniture* and *jewelry*; Barner & Snedeker, 2005; Bale & Barner, in press). Yucatec Mayan, however, may differ from Japanese and Chinese, since in Yucatec classifiers that serve a sortal function are not bound in one-to-one relation with nouns. As noted in the Introduction, a noun like *banana* can, according to Lucy, occur with a variety of classifiers, each yielding a different interpretation (e.g., banana-stuff; banana-object; banana-tree; banana-leaf, etc.). If this is right, such uses do appear to be truly compositional, since different combinations of words result in different interpretations. Thus, it is possible that classifiers in Yucatec Mayan are not simply selecting pre-existing meanings that are supplied by nouns, and that like measure words in other languages, they do add content to lexical nouns. The current study cannot answer the question of whether the structure of lexical items differs across different kinds of classifier languages.

Here, we have argued that speakers of Japanese, English, and Chinese do not draw different boundaries between individuals and non-individuals. Instead, we have suggested that the salience of individuation is equal cross-linguistically. Languages differ in their capacity to express the different construals of entities. In languages that use syntax to select between different construals (like English), inferences about the meaning of unknown words is mediated by lexical statistics as speakers generate sentences online.

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Appendix A

Words used in Noun Judgment and Object-Substance and Mass-Count Rating Tasks for

Experiment 1

apple	clay	knife	radish
bag	clock	margarine	salt
ball	coffee	meat	sandwich
balloon	comb	medicine	sauce
banana	corn	microphone	scotch tape
bat	crayon	milk	seaweed
battery	cucumber	noodle	slipper
bean	curry	pancake	soap
blanket	doll	paper	soda
block	doughnut	peach	spinach
book	drum	peanut	spoon
bottle	dustcloth	pear	sugar
bowl	egg	pen	sushi
bread	eggplant	pencil	tangerine
broom	fork	pickle	tofu
bucket	futon	picture	tomato
butter	glue	pillow	toothbrush
cake	gum	pizza	towel
camera	hamburger	plate	toy
can	handkerchief	popcorn	tray
candy	ice	potato	tuna
carrot	jam	present	vegetable
chalk	jelly	pudding	wallet
cheese	juice	pumpkin	water
chocolate	key	puzzle	yogurt

Appendix B

Instructions for Object-Substance Task in Japanese for Experiment 1

われわれはものを見ると、そのものが物体か、物質かで捕らえる傾向があります。

例えば、写真Aに示されたものは、それが何の材料でできていようとも、扇風機という物体とみなすのが普通です。

写真A

逆に、写真Bにあるものを見ると、形がどうであれ、アイスクリームという物質として捕らえるのが普通です。

写真B

本調査では、よく使われる名詞に関して判断をしていただきます。それぞれの語が指すものは、物体でしょうか、物質でしょうか、それとも両方でしょうか、あるいはどちらでもないでしょうか？もしどちらでもない場合は、他のどんなものを指すでしょうか？

Appendix C

Instructions for Noun Judgment Task for Experiment 1

In many languages there is a distinction made between words that can be pluralized and words that cannot be. For example, in English we can pluralize the word “cat” to form “cats” and the word “table” to form “tables”. However, words like “smoke” cannot be pluralized. The ability to be pluralized depends on what grammatical category the word belongs to.

Count nouns can be pluralized, used with number words, and follow words like “a”, “these”, “those”, “several”, etc.:

Count nouns: a cat; two tables; several ideas; many days; several dogs, etc.

Mass nouns are words that cannot be pluralized, that cannot occur with words like “a”, etc., and that can follow words like “much”:

Mass nouns: some smoke; much mud; some hope; much sand, etc.

Some words can be used either way (as either mass nouns or as count nouns). In English we can talk about “some string” (mass noun) to mean a bunch of string, or “some strings” (count noun) to mean a certain number of pieces. Other flexible words are *stone, rope, chicken, lamb*.

Below, please indicate whether you think each word can be used as a count noun, mass noun or as both, by circling either “mass” or “count” or “both”.

Remember the following tests

- (1) if the word can appear in either singular or plural, as in “a table” and “some tables”, then it is a count noun
- (2) if it can appear with “not much”, as in “not much mud”, then it is a mass noun
- (3) if it can be used in both ways, then it is flexible, and is both a mass noun and a count noun.

Appendix D
Examples of mass nouns, count nouns, flexible mass nouns, and flexible count nouns in the
Quantity Judgment Task

<p style="text-align: center;">Farmer Brown Captain Blue</p> <div style="display: flex; justify-content: space-around;"> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>12 kg each</p> <p>2 kg each</p> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>⏟</p> <p>⏟</p> </div> <p>Question: Overall, who has more sugar?</p> <p style="text-align: center;">Farmer Brown Captain Blue</p> <p style="text-align: center;">Flexible Mass Noun</p>	<p style="text-align: center;">Farmer Brown Captain Blue</p> <div style="display: flex; justify-content: space-around;"> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>3 g each</p> <p>0.5 g each</p> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>⏟</p> <p>⏟</p> </div> <p>Question: Overall, who has more keys?</p> <p style="text-align: center;">Farmer Brown Captain Blue</p> <p style="text-align: center;">Flexible Count Noun</p>
<p style="text-align: center;">Farmer Brown Captain Blue</p> <div style="display: flex; justify-content: space-around;"> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>0.5 g each</p> <p>3 g each</p> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>⏟</p> <p>⏟</p> </div> <p>Question: Overall, who has more egg?</p> <p style="text-align: center;">Farmer Brown Captain Blue</p> <p style="text-align: center;">Flexible Mass Noun</p>	<p style="text-align: center;">Farmer Brown Captain Blue</p> <div style="display: flex; justify-content: space-around;"> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>0.5 g each</p> <p>3 g each</p> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <p>⏟</p> <p>⏟</p> </div> <p>Question: Overall, who has more eggs?</p> <p style="text-align: center;">Farmer Brown Captain Blue</p> <p style="text-align: center;">Flexible Count Noun</p>

Appendix E

Sketches of Experiment 2 stimuli showing 12 objects, their novel labels and alternatives

Object name (English/ Mandarin)	Standard Objects		Alternative Objects	
	Shape	Substance	Shape	Substance
Blicket / 槓邢 (gang4xing2)		Red Sculpy		Turquoise Foil
Pimwit / 墳嚴 (fen2yan2)		Purple Floam		Beige Wax
Speff / 同惹 (tong2re3)		Gold		Red Textured Paint
Tupa / 搭赧 (da1nan3)		Sand		Black Paint
Fem / 波鄂 (bo1e4)		Pearl		Silver Sparkles
Wug / 蠻撇 (man2pie3)		White Sculpy		Silver
Dax / 卡離 (ka2li2)		Blue Crayola Magic		Spikey White Paint
Tannin / 精 (jing2)		Terracotta		Pink Incandescent Glass Paint
Tulver / 櫃 (gui2)		Blue Stone		Metallic Pink Paint
Toma / 扁 (jiong4)		Blue Granite Sculpy		White Clay
Fendle / 尖懷 (jian1hauai2)		Green Suede		Beige Paint
Rapple / 擴 (kuo2)		Green Fabric Paint		Grey Sculpy