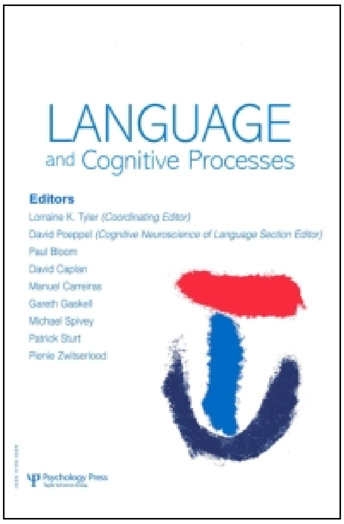

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Does the grammatical count/mass distinction affect semantic representations? Evidence from experiments in English and Japanese

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Does the grammatical count/mass distinction affect semantic representations? Evidence from experiments in English and Japanese

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We investigate linguistic relativity effects by examining whether the grammatical count/mass distinction in English affects English speakers' semantic representations of noun referents, as compared with those of Japanese speakers, whose language does not grammatically distinguish nouns for countability. We used two tasks which are sensitive to semantic similarity, error induction in picture naming and similarity judgements, upon nouns referring to food items (English words and their translation equivalents in Japanese), and contrasted English speakers' performance to that of Japanese speakers. Results reveal that speakers of both languages are highly sensitive to semantic correlates of the English count/mass distinction, suggesting that the grammatical count/mass distinction in English does not affect English speakers' semantic representations in a language-specific manner, contrary to predictions of linguistic relativity theories, in which this grammatical property should exert language-specific effects on English speakers' semantic representations while they are engaged in language tasks.

Keywords: Count/mass nouns; Linguistic relativity; Semantic similarity; Speech errors.

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INTRODUCTION

Languages differ in properties that are required to be overtly marked on a regular basis. In some languages grammatical gender, whether conceptually based or arbitrarily determined, requires distinctive marking on nouns, determiners, verbs, and adjectives. Some languages require marking of plurality, often in addition to gender marking (Corbett, 1991). English requires count nouns to be marked for the plural-singular distinction. While the referents of count nouns are perceived as possessing the properties that allow them to be counted, referents of the other nouns, mass nouns, are considered as not being easily countable. For example, *apples* and *biscuits* are usually considered as being countable, but *wine* and *soup* are not.

Not only do languages differ in whether morphological marking of the plural-singular distinction is obligatory, but they also vary in whether certain entities are regarded as countable or not. For example, *peas* and *beans* are count nouns in English but their Russian equivalents are (arguably) considered to be mass nouns according to Wierzbicka (1983). Words referring to vegetables such as *corn* are mass nouns in English, as seen in the ungrammaticality of the plural form in (1a) and the acceptability of the forms in (1b and 1c), while words referring to vegetables such as *carrots* are count nouns (2a is grammatical while 2b and 2c are not). Neither of the equivalent nouns in Japanese, however, can be pluralised.[1] Instead, if necessary, any entity can be counted with classifiers; this is true regardless of whether translation equivalent terms in English are count or mass. The classifier *–hon* is a classifier for long, thin inanimate objects, and can be used for either nouns that in English are mass such as *toomorokosi* 'corn' or that are count nouns such as *ninzin* 'carrot' as in examples (3a and 3b).

1. a. *I bought two corns.
   b. I bought some corn.
   c. I bought two ears of corn.

2. a. I bought two carrots.
   b. *I bought some carrot.
   c. *I bought two stems/roots/stalks of carrot.

[1] Japanese does have certain plural markers (*–tachi* and *–ra*) but these can only be used for humans.

3. a. Toomorokosi-o ni-hon kat-ta.[2]
corn-accusative two-classifier buy-past
'I bought two [classifier] corns'
b. Ninzin-o ni-hon kat-ta.
carrot-accusative two-classifier buy-past
'I bought two [classifier] carrots'

Although some numeral classifiers in Japanese may be typically associated with either 'countable' or 'uncountable' entities, there are fundamental differences between the English count/mass distinction and Japanese classifier preference (see also Imai and Mazuka, 2003). First, in Japanese, unless a speaker desires to specify the quantity/number of referents, bare nouns without classifiers that are neutral with respect to countability/plurality are used. Thus, Japanese speakers do not need to pay attention to countability regularly when speaking while English speakers must in most circumstances, especially if they are talking about indefinite referents (e.g., to choose appropriate determiners *a* or *some*). Second, *any* noun in Japanese can be counted with the use of classifiers. Classifiers individuate nouns into entities, and specific classifiers are selected based on the ways in which nouns' referents stand in the real world (e.g., the way they are presented, clustered, served, etc.; see also Matsumoto, 1988, 1993) and on various conceptual properties such as shape (e.g., *–mai* for flat thin objects, *–hon* for long objects) and functions (e.g., *–dai* for machines, *–ken* for buildings), or type of portion (e.g., *–hai* 'a bowl/glass of liquid or granular objects', *–kire* 'slice of something'). Any noun has the potential of being counted by a number of different classifiers. Hence, when a Japanese speaker decides to specify the quantity or number of referents, what they need to pay attention to is not whether a noun referent is countable, rather, it is *how* it can be counted. In other words, while English speakers need to focus on whether a referent is countable when speaking, Japanese speakers consider various conceptual properties of referents, and they do so only when they wish to specify the referent's number.

Although English count/mass can therefore be considered to be language-specific, it is conceptually motivated because there is correspondence between the grammatical property (count vs. mass) and conceptual properties (e.g., individuation of discrete bounded entities vs. non-individuation). More strongly, some authors argue that because most count nouns can be used in mass sentence contexts, and most mass nouns can be used in count sentence contexts given a suitable conceptual context (e.g., Allan, 1980; Conrad & Schousboe, 1992; Mufwene, 1984), grammatical count/mass status

[2] The romanisation adopted here is Kunrei method in principle, except for romanisation of long vowels and loanwords.

is fully conceptually derived (e.g., Middleton, Wisniewski, Trindel, & Imai, 2004; Wierzbicka, 1983, 1988; Wisniewski, Lamb, & Middleton, 2003). If this were to be the case, then even speakers of a language which does not possess this distinction should still be sensitive to similarities among count nouns (nouns that are usually used as count nouns) and to those among mass nouns (nouns that are usually used as mass nouns). However, even if this were to be the case, the question remains whether they are sensitive to the countablity of the referents in the same way and to the same extent.

On the other hand, there are several reasons to believe that the English count/mass distinction is grammaticalised to the extent that the boundary of countability is arbitrary and that speakers of other languages cannot accurately make judgements of countability of nouns. First, flexibility of nouns to be used either in count or mass contexts is not the norm, as numerous nouns exhibit very strong preferences for count or mass status: for example, *car*, *boat*, *closet*, *table* are preferentially countable (and nearly always appear in count contexts), whereas *lightning*, *mankind*, *evidence*, *furniture* are preferentially mass. Second, some linguists have argued that the distinction is arbitrary because of the existence of numerous synonyms or closely semantically related words that differ in count/mass status such as *gravel* vs. *pebbles*, *coins* vs. *change*, and *noodles* vs. *spaghetti* (e.g., Gleason, 1961; McCawley, 1975; Quirk, Greenbaum, Leech, & Svartvik, 1972). Further evidence for a language-specific, non-conceptual basis of English count/mass comes from studies of second language acquisition of English, where it has been found that learners find it difficult to decide whether referents are countable (Butler, 2002; Master, 1987). A major obstacle for Japanese speakers in correctly choosing articles in English is misdetection of referents' countability (Butler, 2002). Such difficulty would not be expected if count/mass is transparently related to individuation/non-individuation or other conceptual distinctions.

Moreover, there are a number of studies showing that English count/mass is dissociable from semantic/conceptual dimensions. For example, Garrard et al. (2004) found that an English-speaking patient with semantic dementia preserved the syntactic distinction between count and mass while being insensitive to a semantic dimension of food to which unimpaired participants were highly sensitive (i.e., prepared vs. natural). Steinhauer, Pancheva, Newman, Gennari, and Ullman (2001) examined event-related potentials of English speakers listening to sentences containing count (vs. mass) nouns, and found that count (vs. mass) elicits a frontal negativity, resembling anterior negativities related to grammatical processing, rather than the N400 marker typical of conceptual-semantic processing. Moreover, in a study on tip-of-the-tongue (TOT) phenomena in English, Vigliocco, Vinson, Martin, and Garrett (1999) found that count/mass status was not always retrieved in cases where participants were unable to retrieve a word's form but had full access to its semantics, which should not have been the case if count/mass status derives completely from conceptual knowledge. Importantly, count/mass status was more often correctly guessed in positive TOT states (where participants were thinking of the word intended by the experimenter, given its definition) than in negative TOT states (participants were thinking of some other word). If count/mass status were strictly based on conceptual dimensions, count/mass should have been guessed at the same rate in both cases, because of the conceptual information provided by the word's definition. These findings indicate that the count/mass distinction in English is unlikely to be fully conceptually determined. Thus, from the literature reviewed above, we can argue that English count/mass is a language-specific property that, although clearly conceptually motivated, is also arbitrary to some extent. As we have also discussed, English count/mass is interestingly different from the classifier system of a language such as Japanese.

Hence, although count vs. mass is a matter of degree, and is conceptually motivated to a certain extent, in many cases, the preference for using a given noun in a count *or* mass context is strong. This latter fact has behavioural consequences, as shown in ERP and TOT studies. Crucially, it is undeniable that there is cross-linguistic variability in whether, and the extent to which, conceptual individuation/countability is expressed in a language.

The main question we address here is whether English speakers, who mark count/mass in their language, and Japanese speakers, who do not mark count/mass, show similar or different sensitivity to this dimension. In English, count nouns may be construed as more similar to one another, and mass nouns as more similar to one another, by virtue of being marked in the language as count or mass. To assess this possibility, we compare the performance of English speakers to the performance of Japanese speakers on translation-equivalent words. Because of the differences between English and Japanese outlined above, we would expect that for Japanese speakers, words whose translation equivalents in English share count/mass status are not as semantically similar to each other as for English speakers.

Finding that English and Japanese speakers are differentially sensitive to this dimension would indicate a linguistic relativity effect; finding that they are equally *highly* sensitive to this dimension would make the novel and interesting point that conceptual individuation, as expressed in the English count/mass distinction, is a conceptual property whose salience is not affected by whether the language expresses it or not. Importantly, the current study could provide evidence to support a limited version of linguistic relativity – influence of language in cases in which speakers are engaged in verbalisation tasks (i.e., tasks that require speakers to use their language). Such limited linguistic relativity, which has been marshalled by Slobin (1996, 2000) under the label of 'thinking for speaking', is a prerequisite to arguing any language-specific effect on cognition more broadly (Sapir, 1921; Whorf, 1956). Previous research often attempted to assess the effect of language in non-verbal/non-linguistic tasks, but it is extremely difficult to entirely prevent the possibility that language representations are accessed or used strategically in even experimental tasks that do not directly involve language. Instead, we directly examine the effect of language in verbal tasks: Finding effects in our tasks is a prerequisite to finding effects more broadly in non-verbal tasks. If a language-specific property such as count/mass were to be found not to affect the semantic representation used in 'thinking for speaking' there would be little point in attempting to establish whether it can affect non-verbal tasks (the same logic was used in our previous work concerning grammatical gender: Kousta, Vinson, & Vigliocco, 2008; Vigliocco, Vinson, Paganelli, & Dworzynski, 2005).

A number of studies have investigated the effect of numbering system (count/mass distinction) on English speakers' cognition through behavioural experimentation, beginning with Lucy and colleagues (e.g., Lucy, 1992; Lucy & Gaskins, 2001) who studied the relationship between the number marking system and speakers' classifications of objects vs. substance. They argue that English speakers associate the unit of individuation with count nouns and as a result classify entities based on their shapes, which are the best indicators of individuated entities, while speakers of Yucatec Maya (an indigenous classifier language spoken in southeastern Mexico) pay habitual attention to the material composition of the entities rather than shapes. Lucy and colleagues argue that this latter pattern would arise because all nouns in Yucatec Maya are equivalent to English mass nouns, for which material composition, rather than shape, is a likely basis for classification. The language of Yucatec Maya utilises numeral classifiers for counting objects, which typically carry information as to the shapes or material properties of the objects (e.g., '*un-tz'íit kib*' [one long thin candle], '*kå'a-tz'íit kib*' [two long thin candles]). In his original study, Lucy used several exploratory experiments among which was a forced choice triadic task, in which English speakers and Yucatec Maya speakers were shown triads of objects with which both groups were familiar. The subjects' task was to observe an original pivot object and to decide which of two alternative objects (one had the same shape as the pivot object, the other had the same material composition as the pivot object) was more like the pivot. He found that while Yucatec speakers preferred the material alternative, English speakers preferred the shape alternative. Based on this study and subsequent extensions, Lucy and Gaskins concluded that this property of language affects speakers' cognition, supporting a strong version of linguistic relativity.

However, using a comparable non-linguistic forced choice triadic task as the ones used by Lucy (1992), Mazuka and Friedman (2000) provide some evidence contrary to Lucy's conclusions. They compared English speakers with speakers of Japanese who, like their English speakers, were college students, and they found no differences between English and Japanese speakers (both preferred shape alternatives), suggesting that the difference between speakers of English and Yucatec Maya villagers may have been due to their differential non-linguistic experiences such as educational and cultural backgrounds.

Yet, both Imai and Gentner (1997) and Imai and Mazuka (2007), who also contrasted English with Japanese, provided partial support for Lucy's claim, using a similar forced choice triadic task. While Imai and Gentner (1997) used linguistic labels (novel words), the task used by Imai and Mazuka (2007) did not provide any linguistic labels. They used three kinds of entities as pivot objects: simple-shaped objects (e.g., pyramid-shaped cork), complex-shaped objects (e.g., porcelain lemon juicer), and substance (e.g., lumpy hand cream shaped like a reverse C). For simple-shaped objects, they found cross-linguistic differences similar to Lucy (1992) in that English speakers were biased toward shape classification, while Japanese speakers were biased toward material classification. In addition, only Japanese speakers showed material bias for substance trials. However, there was also similarity between the two groups; for complex-shaped objects, adult participants tended to choose the alternative with the same shape, regardless of their language.[3] In addressing the somewhat conflicting results of the previous studies, Imai and Mazuka (2003, 2007) argue that both English and Japanese speakers have language-independent concepts of individuation and thus classify objects with good indicators of individuation (e.g., complex shape), but that two languages influence the speakers' construal when entities' characteristics are ambiguous in terms of their class membership, providing partial support for the strong version of linguistic relativity advocated by Lucy (1992).

There are confounding factors in the above studies, however. The objects used by Lucy (1992) may have had labels shared by pivot objects and material alternatives only in the Yucatec Mayan language. This possibility led Bloom and Keil (2001) to suggest that Yucatec Mayan participants' response pattern in the study by Lucy (1992) may have arisen from covert naming. For example, in the language of Yucatec Mayan, the same word is used for a candle and wax (the two are only distinguished by classifiers), and

[3] While children (2- or 4-year-olds) displayed behaviour similar to adults in the tasks using linguistic labels (Imai & Gentner, 1997), 4-year-old children's classification behaviour in non-linguistic tasks diverged from adults' behaviour (Imai & Mazuka, 2007). English-speaking children did not show clear preference for shape or material choice for all three entity types, and Imai and Mazuka suggest that the presence of labels fosters adult-like, principled classification behaviour in young children. Japanese-speaking children's behaviour did not show a clear dissociation across the linguistic and non-linguistic tasks, and Imai and Mazuka suggest that Japanese children may have classified entities on the basis of salient perceptual properties of the target entities in non-linguistic tasks.

this is the case for many objects composed of the same materials. Bloom and Keil (2001) thus concluded that Lucy's subjects may have selected material alternatives because the pivot object and the material alternative shared the lexical label even if the task did not require use of the labels.

Such criticism does not apply to the studies of Imai and Gentner (1997) and Mazuka and Friedman (2000), as most of the objects used in those experiments had labels referring to the shape and to the material in both languages (e.g., 'cork' and 'pyramid' from Imai & Gentner; 'cardboard' and 'box' from Mazuka & Friedman). Nonetheless, Papafragou (2005) has argued that English speakers' shape/object preference may arise because there are more count nouns than mass nouns in English, leading English speakers to label a novel entity as a count noun. Moreover, she suggested that even non-linguistic tasks like those employed by Lucy (1992) and Imai and Mazuka (2007) are likely to be mediated by participants' language, thus reproducing the results of linguistic tasks rather than truly reflecting effects of a grammatical property on non-linguistic thought. This latter is a particularly difficult argument to dismiss. Thus overall the existing evidence does not provide clear support for strong versions of linguistic relativity, which argues that language affects speakers' cognition even in non-linguistic tasks.

By assessing whether English and Japanese speakers' semantic similarity among words differ by virtue of between count and mass nouns, we take a new perspective on the question of whether language-specific properties may affect cognition: as already mentioned, finding any language-specific effect in linguistic tasks is a prerequisite to the possibility of observing effects in other cognitive domains. Importantly, our methodologies avoid an important possible confounding factor, namely, participants' use of strategies in the experimental tasks. As discussed by Vigliocco et al. (2005), tasks that give salience to a specific conceptual dimension associated with the linguistic dimension of contrast may easily trigger task-specific strategies; hence results may have more to do with problem-solving processes than reflect automatic access to semantic/conceptual knowledge. In order to prevent participants from using task-specific strategies, we assess whether the count/mass distinction has consequences on semantic representation in that words that share count or mass status should be more semantically similar than words that do not share count/mass status. These semantic differences should be reflected in any task that is sensitive to fine-grained semantic similarity (Vigliocco et al., 2005).

We employ two complementary tasks that have been shown to uncover cross-linguistic differences in previous studies of grammatical gender: induction of semantic errors and semantic similarity judgements (e.g., Kousta et al., 2008; Vigliocco et al., 2005). Crucially, both of these tasks have characteristics that prevent participants from using strategies based on grammatical categories. This is because they do not require identification of specific semantic properties (such as shape or material) that are presumed to be affected by language differences but instead test effects of language differences indirectly via their consequences on semantic representations. This allows the crucial experimental manipulation (in this case, shared count/mass status in English) to be disguised by other properties of the experimental items used.

EXPERIMENT 1

We begin by investigating substitution errors induced in the laboratory to reveal semantic similarity between words using an online task (following Kousta et al., 2008; Vigliocco et al., 2005). Semantically related lexical substitution errors (e.g., *beer* substituted by *wine*) are quite common among spontaneously occurring slips of the tongue, due to co-activation of semantically related lexical candidates during a conceptually driven retrieval process (e.g., Garrett, 1984, 1992; Levelt, Roelofs, & Meyer, 1999). Syntactic properties such as grammatical classes also appear to play a role in errors of this type (Fromkin, 1973; Garrett, 1992). A substantial advantage of this task is that it is not subject to strategic effects of the type discussed above. If English speakers' semantic representations are affected by the count/mass distinction, then their substitution errors are expected to include more cases in which target and error words share count/mass status, compared with the errors made by Japanese speakers. Vigliocco et al. (2005) employed this methodology to explore language-specific effects of grammatical gender of Italian nouns. In their experiment they compared semantically related substitution errors made by Italian speakers and those made by English speakers. The hypothesis was that errors made by Italian speakers should preserve the grammatical gender of the nouns. English, a language that does not have grammatical gender, was used as a baseline. Errors produced by Italian speakers were more likely to share grammatical gender of the target, compared with naming errors made to the same pictures by English speakers, even when phonological correlates of gender were taken into account (see also Kousta et al., 2008).

In the present study, we focus on words referring to foods for the following reasons. First, the food domain offers important within-category variability when it comes to count/mass status (especially when it comes to picturable items). Second, in this field there are both solid and non-solid entities, and within solid items there are differing degrees of ease of individuation (e.g., 'apple' might be more easily individuated than 'celery') that can overlap with count/mass status. Finally, Bloom (1990, 1994) found that English-speaking children tend to make errors involving count/mass status in the semantic field of foods (e.g., 'eating a bacon', 'I drop a celery'), suggesting that this is a domain where the link between conceptual and grammatical properties may be more arbitrary than in other domains.

If English count/mass status has come to affect English speakers' semantic knowledge as a consequence of the relationship between the conceptual properties (object vs. substance, or individual vs. portion) and the grammatical properties (count vs. mass), we should observe language-specific effects on semantic substitution errors, such that errors sharing count/mass status with the target picture name are more common for English speakers than for Japanese speakers for whom this distinction is not grammatically marked.

As discussed above, numerical classifiers (which Japanese speakers need to employ when specifying quantities of referents) are somewhat correlated with count/mass status of English nouns. In this experiment we reduce the potential confounding effect of Japanese classifiers and English count/mass by selecting items for which specific Japanese classifiers were preferred across both English count and mass nouns (a classifier *–hon* is preferred not only for count nouns such as carrot and cucumber but also for mass nouns such as corn and celery).

In the experiment participants were presented with food pictures at a rapid pace and were asked to name them aloud. While naming the pictures, from time to time participants spontaneously made lexical substitution errors, saying, for example, 'carrot' when presented with a picture of a cucumber. For each substitution error we assessed whether the erroneously produced word maintained the (English) count/mass status of the correct target word. If the grammaticalised count/mass distinction has language-specific consequences, English speakers' errors should exhibit a greater tendency to share count/mass status than the errors made by Japanese speakers.

Method

Participants. Twenty-four native English speakers (16 women, 8 men, average age 20.8) and 21 native Japanese speakers[4] residing in London (17 women, 4 men, average age 29.5) participated in the experiment (one Japanese participant's data were excluded, as he spoke too quietly to be understood). For Japanese speakers, the length of stay in English-speaking countries ranged from 6 months to 6 years (average 2.3 years).

Materials. Sixty-eight food pictures (photographs) scanned from two food encyclopaedias (Murdoch Books, 2001; Willan, 1989) and some pictures

[4] Because the English speakers provide a baseline measure of the effects of count/mass on errors in a language where this property is grammaticalised, we aimed for a greater number of errors in this population. Randomly excluding some English-speaking participants to match the number of errors in the two languages more closely does not change the pattern of results reported.

available on the internet were first presented to 12 Japanese and 12 English speakers. Speakers of both languages were asked to name the pictures in their respective native language. Japanese speakers were asked to name each picture using a single word, and English speakers were asked to name the pictures using either a count phrase ('a____') or a mass phrase ('some____'), which also provides an indication of preferred count/mass status. Based on their responses, 42 pictures with better than 80% name agreement in both languages (82–100%, mean 96%) and for which English speakers agreed on count/mass preference at least 80% of the time (80–100%, mean 98%) were selected, although two items (i.e., crab and lobster) were subsequently excluded from the analysis because they were highly confusable in the experimental task. The remaining 40 food pictures consist of 25 pictures with count noun labels and 15 pictures with mass noun labels.[5] The list of English names and Japanese names are given in Appendix A. It should be noted that some Japanese food items have loanword labels and others native Japanese labels. This is because loanwords from English are ubiquitous and are nativised to the Japanese language; both Japanese native words and loanwords are used for many food items in Japan (Kay, 1995; Stanlaw, 2005).[6]

Because Japanese classifier preference depends upon the actual referents rather than the words in isolation, we also conducted a norming study in which we asked 10 native Japanese speakers to list their first and second preferred classifiers to describe each of the 40 food pictures. Appendix A lists the preferred classifier for each picture (classifiers chosen by 6 or more of the 10 speakers, left blank when participants' responses were more variable). Only a single item, a photographed image of salad, was strongly associated with a mass-classifier (*–sara*, 'a plate of'). Most other items were associated with count-classifiers: *–hon* (4 count, 3 mass), *–mai* (2 count, 2 mass), *–tu* or *–ko*[7] (17 count, 4 mass). Because *–tu*/*-ko* was dominant for English count

[5] There were more count nouns in the final set than mass nouns, primarily related to the relatively limited number of clearly picturable foods with high name agreement in both languages and for which English speakers strongly preferred mass noun contexts.

[6] For example, the same ingredient, say garlic, may be called *nin-niku* or *gaarikku* depending on what it is used for, or on the speaker's personal preferences. According to a lexical database based on occurrences of printed words in a Japanese newspaper (Amano & Kondo, 2003), for some food items, the loanword is more frequent (e.g., *chikin* 'chicken' with 92 occurrences is more frequent than *toriniku* with 63 occurrences: 2 in hiragana, 61 in kanji). The native Japanese and loanword alternatives used by the participants in the current experiment were also rated as familiar-sounding in the same lexical database. In these familiarity ratings (7 being the most familiar), ratings of *zyagaimo* 'potato' and *poteto* were 6.31 and 6.25 respectively, and other pairs were also comparable: *nin-niku* 'garlic' 6.19 and *gaarikku* 5.88; *syooga* 'ginger' 5.6 and *zinzuaa* 5.3; *kabu* 'turnip' and *radisshu* 5.0; *toogarasi* 'chili pepper' 6.1 and *chiri* 5.7.

[7] Matsumoto (1993) characterised *–tu* as a classifier for inanimate entities in general and *–ko* as a classifier for concrete objects in general.

nouns over mass nouns, we also considered this factor in the analyses. The fact that almost all the pictures are associated with count-classifiers may be due to the fact that picturable items which are easy to identify also tend to be easier to count. The fact that 15 out of 40 of these are mass nouns in English highlights the arbitrariness of the distinction in English between count and mass nouns.

Because visual similarity may be correlated to shared count/mass status and may also affect the errors produced in speeded picture naming, we also collected visual similarity ratings between all possible pairs of pictures used in the experiment in order to consider this factor in the analysis. We asked a separate group of participants ($n = 23$) to rate the similarity in appearance between pairs of pictures using a 1–7 scale (1 = least similar in appearance, 7 = most similar). Each participant saw 260 of the 780 possible picture pairs, and each pair was rated by between 6–8 participants. Overall, considering all possible target-error pairs, those sharing count/mass status (average visual similarity 2.40) did tend to be slightly more visually similar than those not sharing count/mass status (average visual similarity 2.24); $t(778) = 2.026$, $p < .01$.

Each picture was presented in colour within a 240×240 pixel space. Blocks of 14 pictures were constructed by randomly selecting pictures, subject to the constraint that each picture could occur no more than once within a block, and could not occur as the last item in one block and the first item in the next. Finally, each picture was to appear 28 times in the course of the experiment (a total of 84 experimental blocks). The order of blocks was randomised for each participant.

Procedure. The procedure followed Vigliocco, Vinson, Indefrey, Levelt, and Hellwig (2004a), Vigliocco, Vinson, Lewis, and Garrett, (2004b), and Vigliocco et al. (2005). The experiment took place in a sound-proof booth; stimulus presentation was carried out on IBM-compatible computers using E-Prime (Schneider, Eschman, & Zuccolotto, 2002).

The participants were told that they were taking part in research that studies speech patterns under time pressure, and that they were asked to name aloud food pictures using single words (or a name such as ‘green bean’) in their respective native language as they appeared on the computer screen. It was emphasised that participants should attempt to keep up with the rate of presentation: i.e., they should skip items if necessary to recover from difficulty and name the pictures as they appeared rather than naming previously presented pictures by retaining them in memory. All participants gave consent to have their responses recorded; all spoken responses were tape-recorded and later transcribed and scored.

The experiment began with a name agreement phase. In this phase, participants were asked to name each experimental picture without time pressure. The experimenters noted any variation from the intended names, and also provided prompts if the participants were unable to produce a label for the picture. After this, participants performed a set of practice trials (in which each target picture appeared once). In the practice trials, 14 pictures in a row were presented in one of four possible locations on the screen, and the participant was instructed to name each aloud. After each block of 14 pictures, the experimenter altered the rate of presentation to accommodate each speaker's speech rate, adjusting the presentation rate by 100 milliseconds in either direction if necessary. Presentation rate was speeded up if a participant successfully named all pictures without errors, and slowed down if a participant was unable to keep up with the presentation. In the practice session, there was a total of 12 blocks. Initial presentation parameters were 700 milliseconds display time for each picture, with a blank interval (ISI) of 200 milliseconds before the next picture appeared in a block. This rate was altered by the experimenter during the practice session in order to make the task difficult but manageable for each speaker; final presentation rates ranged from 600 ms to 1100 ms display time ($M = 795$ ms) for Japanese speakers, and 600 to 1000 ms display time ($M = 767$ ms) for English speakers, always with a 100 ms ISI. English presentation rates were overall slightly faster than Japanese, perhaps because the Japanese words tended to be longer and thus required more time between picture presentation to permit comparable levels of performance.[8]

Once the practice session was completed, the experimental blocks were presented. Participants verbally signalled their readiness, and the experimenter pressed a key to begin each trial. Then the sequence of 14 pictures appeared at randomly selected positions on the screen, with time parameters as determined in the practice session. After each block, the participant was given the opportunity to take a break if necessary. Each picture was presented 28 times for naming in the course of the experiment, which lasted between 30 and 50 minutes.

Data analysis. Participants' responses were transcribed and scored in the following categories. *Correct responses*: participant uttered the correct target word completely. *Omissions*: participant did not attempt to produce the

[8] Presentation speed did not affect participants' performance related to English count/mass status: our results show the same pattern of performance in the two groups with regard to English count/mass, despite the (small) differences in timing. We also reanalysed the data, and found that when the English participants with the fastest presentation rate are compared with the English participants with the slowest presentation rates (splitting at the median), there is no difference in the magnitude of count/mass effects. The same is true if Japanese participants are split according to presentation rate.

target word. *Different label*: participant used a different word than our intended target, but did so consistently. This was identified in either of two ways: the participant used the different label in the initial naming phase, or the participant used the different label twice or more in the experiment itself without self-correcting. These items were treated as correct in the analyses. *Lexical errors*: participant produced a word that differed from the target and that did not qualify as a 'different label'. *Corrections*: participant started producing an incorrect word, but changed their response to the correct target before it was complete. *Miscellanea*: other responses not included above, such as dysfluencies and unintelligible responses.

All the analyses reported below concern lexical errors (i.e., cases in which the word produced for a target was another word), which were the most common type of error. Japanese errors and English errors were analysed by subjects and by items. In each case the crucial dependent variable was the proportion of errors that preserved the English count/mass status of the target label, the independent variable was the language (English, Japanese), a between-subjects variable but within items (English and the translation-equivalents). For the subjects analysis the number of lexical errors sharing (English) count/mass status was divided by the total number of lexical errors by that participant (excluding any participant who produced no such errors); for items analysis a similar measure was assessed for each target picture. Non-parametric tests were used to assess whether the count/mass preservation rate differed across languages (by subjects, Mann–Whitney U test; by items, Wilcoxon matched-pairs test). Count/mass preservation rates were also assessed using sign tests, to reveal whether English count/mass status affected performance overall. We also analysed visual similarity among target and error pictures to see whether visual similarity among pictures in the experiment could account for the count/mass effects we observed.

Results

Most of the lexical errors were labels of other pictures in the experiment although there were a small number of lexical errors from outside the set (< 5%). English speakers produced a total of 470 lexical errors (1.7% of all responses), and Japanese a total of 427 lexical errors (excluding two errors whose count/mass status is not clear) (1.8% of all responses). Count/mass status of the target words of these errors in Japanese were 289 count nouns and 138 mass nouns, and in English, 301 count nouns and 169 mass nouns. Targets and intruders in 379 (80.6%) errors in English and 339 (79.4%) errors in Japanese shared count/mass status (significantly above

TABLE 1
Number of errors made by English and Japanese speaking participants in Experiment 1, broken down by (English) count-mass status of target and error words

	English speakers		*Japanese speakers*	
	Count targets	*Mass targets*	*Count targets*	*Mass targets*
Count errors	244	34	234	33
Mass errors	57	135	55	105

chance rate;[9] separate sign tests against chance for each language yielded $p < .0001$). This effect did not differ between languages; by subjects $Z = 0.15$ (one-tailed $p = .44$); by items $Z = 0.29$ (one-tailed $p = .39$). See Table 1 for a breakdown of errors according to count/mass status of the target.

Although it is not possible that Japanese speakers' errors are sensitive to English count/mass status because of correlations between count-classifiers and mass-classifiers in Japanese (because only one item was associated with a mass-classifier in the norming phase), it may be possible that Japanese speakers' preference for *specific* classifiers can explain the error patterns rather than the English count/mass distinction. For example, the most frequently used classifier among the experimental items (*-tu*/*-ko*) was preserved in 136 errors. Of these, 126 (92.6%) also shared English count/mass status. This pattern of results suggests that the apparent effects of English count/mass status on Japanese picture naming may have instead arisen from one specific aspect of Japanese classifier preference (the dominance of *-tu*/*-ko* and its correspondence with English count status in these items). If this is the case, we should not observe effects of English count/mass status on Japanese errors once we exclude those cases in which the target and error share the same preferred classifier in Japanese. We tested this possibility by considering only those Japanese errors for which the target and intruding word had different preferred classifiers, removing all errors which shared a preferred classifier with the target, those errors from outside the response set for which preferred classifier could not be determined, and also those cases for which participants were not in agreement on the preferred classifier (for either target or error). This left 178 errors, of which 151 (84.8%) shared English count/mass status. This level is well above what might be expected by chance (sign test $p < .0001$, again, assuming that errors

[9] We estimated the chance level by assuming all items in the experiment were equally likely to be produced as an error for a given target, and taking into account the fact that there were unequal numbers of count and mass targets. Under this assumption, the probability that a given error would preserve count/mass status was 61.5% for count nouns, and 35.9% for mass nouns. Averaged across all count and mass noun targets, chance rate was determined to be 51.9%.

are equally likely to be count or mass regardless of the count/mass status of the target), and demonstrates that the effect of English count/mass status on Japanese errors is not simply a consequence of Japanese classifier preference.

Finally, we assessed visual similarity between the target pictures and the errors produced by the Japanese speakers. One may argue, in fact, that because visual similarity is correlated with count/mass status among the set of all possible target-error pairs in the experiment as described in the Materials section, the apparent effects of English count/mass status have simply arisen due to visual similarity among items. However, Japanese target-error pairs that shared count/mass status in English actually had lower visual similarity ratings ($M = 3.01$) than those that did not share count/mass status, $M = 3.27$, $t(407) = 2.206$, $p < .05$. Thus, although visual similarity does predict errors to some extent: mean visual similarity among actual target-error pairs (above 3.10) is significantly greater than visual similarity among all possible target-error pairs: (average similarity below 2.4), the effect of English count/mass status cannot be explained by the visual similarity.

Discussion

The main finding of this experiment is that when a speaker produces speech errors involving food names, those errors tend to reflect the (English) count/mass status of the target words even in Japanese, a language that does not possess the count/mass contrast. The results of Experiment 1 also suggest that the effects of English count/mass status are dissociable from Japanese classifier preference. Thus, taken together, these results are contrary to a linguistic relativity account, which would predict increased effects of count/mass status in English speakers' errors. Rather, the extent to which also Japanese errors share count/mass status suggest that this distinction reflects underlying conceptual dimensions that may or may not be explicitly realised in languages. The high extent of count/mass preservation among Japanese errors further supports the claim that Japanese speakers possess concepts of individuation, independent of the language they speak (e.g., Imai & Mazuka, 2007).

However, there is a possibility that the Japanese speakers' experience with English may have eliminated any language-specific effect. After all, the Japanese speakers who participated in this experiment were recruited from populations studying or working in London, and had spent an average of two years living in English-speaking countries. Their experience with English, particularly learning the count/mass distinction, may have rendered them more sensitive to the conceptual consequences of English count/mass status, thus eliminating the language-specific effects in English speakers.

Pertinent to this concern are studies by Athanasopoulos (2006) and Cook, Bassetti, Kasai, Sasaki, and Takahashi (2006). Athanasopoulos (2006) adopted a picture selection task similar to Lucy (1992), and found that advanced Japanese speakers of L2 English responded more like English speakers than like monolingual Japanese speakers, a difference that was statistically significant. However, this experiment confounded the degree of English knowledge with the language used in the experimental instructions: only monolingual Japanese speakers were given instructions in Japanese. This difference may have affected participants' performance, especially if this task invites linguistically based strategies. Cook et al. (2006) tested Japanese speakers who were proficient in English using the same methods as Imai and Gentner (1997). Though they found that long-stay bilinguals increasingly preferred shape alternatives for simple-shaped objects (like English speakers), the responses of their long-stay group (3–8 years) and short-stay group (6 months to 2 years and 11 months) were like those of monolingual Japanese speakers. Although Cook and colleagues found that the long-stay group's response patterns became more similar to those of English speakers than did those of the short-stay group, no significant differences were reported *between* the groups of Japanese speakers. It is therefore difficult to conclude from this evidence that even long-stay bilinguals were different from monolingual Japanese speakers. A more tightly controlled study carried out by Kousta et al. (2008) tested whether advanced bilinguals' (L1 Italian, L2 English) semantic representations were affected by grammatical gender, using the same error-induction task as employed in Experiment 1. Crucially, each participant was tested in two sessions, once in their L1 (conducted entirely in Italian) and once in their L2 (conducted entirely in English). This allows investigation of linguistic relativity effects within individuals. Kousta et al. found monolingual-like effects in speech errors made by bilingual speakers in both their Italian (L1) and English (L2). When naming in Italian, bilingual speakers were affected by gender to the same extent as monolingual Italians, but when naming in English, the same speakers' responses were comparable to those of English speakers. Thus, their performances in their first language, Italian, were not affected by their knowledge and experience with English when they were using Italian.

In the task we employed in Experiment 1, Japanese speakers were using Japanese, and thus, following Kousta et al., it is unlikely that their knowledge of English would affect their performance. Nonetheless, to test whether exposure to English abroad influenced participants' performance on the present task, we divided the 20 Japanese participants' data (excluding one who did not report the length of stay) into two groups,[10] on the basis of

[10] We did not assess the participants' English proficiency, but unlike the participants in Cook's study who were all university students or English language school students, our participants were a mix of students and those who were tourists or visitors on working holiday, and thus likely to be a mixture of English speakers of various proficiency.

the speakers' length of stay abroad: 10 participants who spent less than a year and a half abroad (average of 10.7 months) and 10 participants who spent more than a year and a half (average of 4.3 years), and we compared errors produced by these two groups. In the less-exposure group, count/mass was preserved 80% of the time, while in the more-exposure group, count/mass was preserved less than 75% of the time. This pattern of results is in the opposite direction that would be predicted if degree of exposure to English was responsible for the pattern of errors made by Japanese speakers (in which case the more-exposure group should have shown a greater effect of English count/mass).

To further assess the generality of these results, in Experiment 2 we turn to another task involving verbal materials: similarity judgements on words, using translation-equivalent words in English and Japanese. Here we recruited Japanese speakers residing in Okinawa (participants who had much less exposure to English than the Japanese participants in Experiment 1), to further rule out the possibility that results could be explained in terms of exposure to English.

EXPERIMENT 2

In this experiment, Japanese and English speakers were asked to make semantic judgements on triads of words referring to foods (translation-equivalent in the two languages). Their task was to spot the odd one out, by crossing out the word less similar to the other two in terms of meaning (along the lines of the tasks conducted by, for example, Fisher, Gleitman, & Gleitman, 1991; Garrard et al., 2004; Romney, Moore, & Rusch, 1997). This task has been successfully employed to investigate the language-specific consequences of grammatical gender (Vigliocco et al., 2005), where language-specific effects were found only in the verbal domain, not when pictorial materials were used. Moreover, just as in the error induction experiments reported by Vigliocco et al., effects were limited to the domain of animals and were not observed for artifacts.

If count/mass status affects English speakers' semantic representations, English speakers should show a greater tendency to select words sharing count/mass, compared with judgements by Japanese speakers for whom the count/mass distinction is linguistically irrelevant. However, if grammatical count/mass status is based on conceptual distinctions which are salient regardless of the language spoken, then both English and Japanese speakers should choose words sharing (English) count/mass status as similar above chance level; in other words, grammatical count/mass status should affect performance, not as a direct consequence of the grammatical property itself, but only due to the underlying conceptual properties correlated with grammatical status. Of course these possibilities are not mutually exclusive; speakers of both languages could be sensitive to English count/mass status (based on the largely transparent link between conceptual and grammatical properties), but English speakers would be more sensitive to it than Japanese speakers.

In the experiment, the count/mass dimension was orthogonally combined with a semantic manipulation (natural vs. prepared). The reasons for introducing this semantic manipulation, in addition to the count vs. mass manipulation are: first, the semantic manipulation provides us with a check that participants are indeed carrying out the task on the basis of meaning similarity as instructed, regardless of their language. Second, using the same task and the same manipulations, Garrard et al. (2004) have reported a dissociation (in English) between semantic and syntactic dimensions in the performance of patient Oscar suffering from semantic dementia. He showed normal sensitivity to the count vs. mass manipulation but no sensitivity to the semantic manipulation. Just as with the normal controls in the study by Garrard et al., here we expect our English participants to show both effects; the Japanese speakers, however, may show the semantic but not the count vs. mass effect (the opposite pattern from patient Oscar in Garrard et al.'s study).

Method

Participants. Twenty-four monolingual English speakers residing in London (mean age 20.3; 14 women and 10 men) and 24 monolingual Japanese speakers residing in Okinawa (mean age 21.5; 12 women and 12 men) participated. Although these Japanese speakers have studied English since the age of 12, they had a minimal amount of exposure to English. Only six of them had ever been abroad, and only for a maximum of 5 weeks. After completing the experiment, all of the Japanese participants were asked to rate the goodness of sentences containing each of the English food names in both mass and count noun contexts as in sentences shown in (6), on a seven-point scale (1 = totally unacceptable, 7 = totally acceptable).

6. a. Pass me an apple.
   b. *Pass me some apple.
   c. *Pass me a bread.
   d. Pass me some bread.

The correlation between each Japanese participant's responses and the average of the English speakers' responses (discussed in the Materials section) was computed, in order to ensure that the Japanese speakers were relatively unaware of the English count/mass status of these items. Pearson correlation coefficients ranged from -0.13 to 0.7 (average 0.24), and only three participants had correlations above 0.5. This provides evidence that these Japanese speakers largely lack appropriate knowledge of the grammatical consequences of the English count/mass distinction.[11]

Materials. Twenty-four food names were selected. Twelve referred to natural foods such as *spinach* and *egg* that are not processed or cooked, and the other twelve referred to prepared foods that are processed or cooked such as *sausage* and *soup*. We selected prepared food items with which both Japanese and English speakers are very familiar; Japanese speakers are typically familiar with many foods prepared in Western ways, while the reverse is much less so (at least among our participant pool). Though two-thirds of these items have loanword labels in Japanese, they are commonly used in Japanese, and importantly they are never used with plural (English) morphology. In each semantic class, six words were count nouns and six were mass nouns. The list of all the food names is reported in Appendix B. Because it was crucial to select items that were known to both groups, we did so at the expense of controlling various lexical variables. We did, however, analyse whether uncontrolled lexical variables affected performance (see Results section).

Thirteen English speakers who did not participate in any of the experiments reported here were asked to judge the grammaticality of sentences containing these words (as in (6a–d) above), in order to verify the count/mass status of each word. With the exception of 'ice cream' which was equally acceptable as count (6.54) or mass (6.69), all other words were separated by at least two points on the scale. Those items selected as count nouns were rated as extremely highly acceptable in count contexts (average rating = 6.96), and much less so in mass contexts (average rating = 3.87), while the reverse was true for mass nouns (excluding ice cream; average rating for count contexts = 2.71, average for mass contexts = 6.81).

A total of 2024 triads that constitute all possible triadic combinations derived from the 24 food names were created, and the order of the three words in each triad was randomised. The triads were subdivided into six experimental lists (4 lists of 337 triads and 2 lists of 338 triads), and their order was randomised. This was because a list of all 2024 triads is too lengthy for a single participant to complete. Each participant was asked to

[11] While we cannot altogether exclude the possibility that learning English at school might have had some effect on participants' performance, it is not possible to find a Japanese participant pool without any exposure to English. This is because most adults in modern Japan learn English as a compulsory subject starting at age 12 (and often in evening or weekend private schools, as well as widely available learning materials including TV and radio broadcasts).

complete one experimental list, and four different participants from each language group completed each list.

Procedure. Each participant responded to triads from one list (337 or 338 triads). They were instructed to cross out one of the three words based on the similarity of meaning (as opposed to orthographic or phonological similarities among the words). Participants completed the task using paper and pencil, and each session lasted approximately 50 minutes. Response sheets were scored and analysed by subjects and by items.

Results

As mentioned in the Materials section, English speakers' responses to sentence judgements revealed that the word *ice cream* is acceptable as both mass and count (i.e., they felt that sequences 'an ice cream' and 'some ice cream' were equally good and natural); thus, this item was excluded from the analysis. We then classified the word pairs selected by each participant into those falling into the same (English) count/mass class, vs. those falling into different count/mass classes. The dependent variable was the proportion of 'same class' word pairs selected as similar, considering only those triads which offered the opportunity for selecting 'different class' pairs (i.e., those triads containing two words of count status in English and one word with mass status; and those triads containing two mass words and one count word. These amounted to 1584 of the 2024 unique triads.). For English speakers the selection proportion was 0.378 ($SD = .041$); for Japanese speakers it was 0.361 ($SD = .037$). See Appendix C for item-specific tables which depict the proportion of selection for each possible word pair in English and in Japanese.

We first assessed whether there were language-specific differences in selection of words sharing count/mass status, as predicted if the grammatical status of count/mass in English is affecting semantic representations. An independent samples t-test (treating subjects as a random factor) revealed no significant difference between the language groups, $t(46) = 1.192$, $p = .239$, converging with the results of Experiment 1 in which comparable effects of count/mass status were observed in both languages.

Next we tested whether participants were actually sensitive to count/mass status of the nouns in this task. If count/mass status has no effect on participants' responses, a rate of 1/3 would be expected (as there are two possible pairs of different count/mass status in a qualifying triad, vs. only one possible pair of words sharing count/mass status. Speakers of both languages selected words with the same count/mass status significantly more often than 1/3 of the time; one-sample t-tests conducted separately upon each language group (vs. chance value of 1/3) revealed that both were significantly greater: English, $t(23) = 4.897$; $p < .001$; Japanese, $t(23) = 3.576$; $p = .002$.

However, there was also a strong (purely) semantic distinction among the items: natural vs. prepared, which must be taken into account.[12] Considering the same subset of items as above (those 1584 triads which offered the opportunity to pick items of same or different count/mass status), we contrasted those cases in which participants chose words of the same semantic status (natural/prepared) vs. those in which they did not. When participants chose words of the same semantic status (more than 55% of the time in both language groups, vs. a chance rate of 1/3 as described above), this distinction was strong enough to override any preference on the basis of count/mass; neither English speakers nor Japanese speakers chose words sharing count/mass status at a rate above 1/3 (English speakers' selection proportion was 0.348; Japanese speakers' was 0.337, neither of which was significantly different from 1/3). However, when participants chose two words that did not share semantic status, those two words were significantly likely to share count/mass status above a 1/3 rate: selection proportion was 0.420 in English, one-sample $t(23) = 7.479$; $p < .001$; selection proportion was 0.407 in Japanese, one-sample $t(23) = 4.992$, $p < .001$; and again this tendency did not differ between languages: independent samples $t(46) = 0.495$; $p = .495$.

Finally, we considered only those triads which offered not only the opportunity to select same or different count/mass status, but also the opportunity to select same or different semantic class (excluding all triads which had three words of the same count/mass status, and also all trials which had three words from the same semantic class: 1224 triads in total). See Table 2 for the relative proportions of selection on the basis of count/mass status and the natural/prepared distinction within these triads.

Among these triads, participants showed a strong tendency to make their judgements on the basis of semantic class (English selection proportion = 0.550, Japanese selection proportion = 0.563, difference not significant), but also a significant tendency to reflect count/mass status (English selection proportion = 0.374, Japanese selection proportion = 0.363, again both greater than 1/3 and not significantly different from each other).

[12] The item set included two mass nouns which refer to liquids (soup and wine). In order to ensure that speakers' sensitivity to count/mass status was not simply due to the distinction between these items and the others in the set, we conducted another analysis in which all triads containing 'soup' or 'wine' were excluded. The pattern of results was the same: no effect of count/mass status when participants chose two items from the same semantic class (.327 in Japanese, .341 in English, neither significantly greater than 1/3), and reliable effects of count/mass status when they did not (.415 in Japanese, .412 in English, both significantly greater than 1/3, $p < .001$), and no differences between the rates at which English and Japanese speakers chose words of the same count/mass status.

TABLE 2
Proportion of item selection among triads offering the opportunity to select same/different semantic class (natural/prepared) and same/different English count/mass status ('CM'). If speakers' judgements are not sensitive to a distinction, the ratio between 'same' and 'different' should be 1:2

	Different CM	*Same CM*	*Overall*
English-speaking participants			
Different semantic	0.258	0.191	0.449
Same semantic	0.368	0.183	0.551
Overall	0.626	0.374	
Japanese-speaking participants			
Different semantic	0.257	0.179	0.436
Same semantic	0.379	0.185	0.564
Overall	0.636	0.364	

Although these results are consistent with Experiment 1, it is possible that speakers from the two groups have substantially different semantic representations about the food items used in this experiment. In order to rule this out, we investigated the degree of convergence between the English and Japanese similarity ratings at a fine-grained level. We did this by assessing the overall extent to which speakers in the two language groups agreed in judgements on an item-by-item basis (see Appendix C for item-level similarity ratings in both languages). We first calculated the selection probability of each possible pair of words in a given language, and assessed the correlation across item pairs between the two language samples. Pearson's $r = +0.832$ ($p < .0001$), suggesting a high degree of correspondence.[13]

Discussion

The robust effect of the semantic class (natural/prepared) indicates that the subjects were performing the task based on semantic similarity as they

[13] To provide some context for this degree of correlation, we conducted a follow-up analysis of the English results, randomly dividing English participants into two groups, and calculating the correlation coefficient between those two groups. For this analysis, Pearson's $r = +0.881$, which was significantly higher than the English–Japanese correlation (estimated $Z = 2.169$; $p = .032$). This difference may be related to cultural differences in the way different foods are typically served (for example, Japanese speakers rated 'tart' as most similar to 'pancake', while English speakers rated it as most similar to 'biscuit'); nonetheless, the cross-linguistic correlation was of similar magnitude to the within-English correlation.

were instructed to do, rather than on the basis of other factors such as orthographic or phonological similarity of the words.[14] Most importantly, we observed consistent effects of English count/mass status in conjunction with the overall tendency for participants to judge along the natural/prepared dimension, which did not differ for English and Japanese speakers despite the lack of grammaticalised count/mass status in Japanese, in parallel to the results of Experiment 1.

GENERAL DISCUSSION

The results of the two experiments converge on the same picture: in Experiment 1, participants' semantic substitution errors reflected English count/mass status, regardless of whether the speakers' language marks for count/mass (English) or not (Japanese); Experiment 2 showed similar results: both English and Japanese speakers exhibited comparable significant sensitivity to the English count/mass distinction.

In our study, we used convergent methods which have been demonstrated to be sensitive to semantic similarity: induction of lexical substitution errors, a language production task in which the semantic effects arise automatically, and similarity judgements, an offline comprehension task. Each of these tasks complements the other, together minimising the disadvantages of either of them considered alone: similarity judgements reflect quite direct access to semantic representations, but are performed offline and thus potentially subject to strategic responses; lexical substitution error induction is an online task and thus reflects automatic access to semantic representations, but it also reflects other processes involved in lexicalisation (such as retrieval of phonological information). An important advantage of both tasks is that the linguistic and associated conceptual distinctions of interest are not overtly engaged by the task; participants are unaware of the manipulation of count/mass status (no participant in any of the studies reported being aware of the varying count/mass status of the items, nor of any correlated conceptual property such as individuation) which minimises the possibility that these results are due to strategic attention to these dimensions. The error induction task employed in Experiment 1 is particularly effective in this regard. In this task, semantic similarity leads to a decrement in accurate performance (the likelihood of substitution errors increases with greater semantic similarity),

[14] We also performed regression analyses to test whether the apparent effect of count/mass status could be instead explained by other characteristics of the items such as length; shared letters, characters, phonemes; word frequency, etc., and considering whether the partial effect of count/mass status remained significant once these factors were taken into account. None of these factors contributed significantly to the likelihood of selecting a particular word pair, and the count/mass effect remained significant when these variables were partialled out.

so any strategy based on the grammatical distinction between count and mass nouns would be counterproductive. Further, Japanese speakers who do not have this grammatical distinction also showed the same type of effects as English speakers. Crucially, these tasks have been demonstrated to be sensitive to cross-linguistic differences in the domain of grammatical gender (Vigliocco et al., 2005); hence the lack of a difference between our Japanese and English speakers cannot simply be attributed to lack of sensitivity of our experiments.

Moreover, although one must always be cautious in interpreting null results (here, the lack of differences between English and Japanese speakers), in both experiments this null difference is found in the context of a reliable positive effect: Japanese speakers' substitution errors and similarity judgements reflect the English count/mass distinction at levels well above chance. Finally, while previous research has centred around solid objects that are often artifacts, we extended the semantic domains of entities under investigation to food, which is an important basic semantic domain consisting of both solid and non-solid items, and containing many exemplars which are highly semantically similar to each other, but crossing the border between count and mass (e.g., carrot/celery).

Taken together, these results argue against language-specific effects of count/mass status on semantic representations in English speakers, suggesting, instead, that the conceptual foundation on which the English count/mass distinction is based must be shared by English and Japanese speakers given that both English and Japanese speakers appear to be both clearly sensitive to those conceptual distinctions underlying English count/mass at least as far as food names are concerned. In other words, not only were Japanese speakers found to possess the conceptual distinction related to English count/mass, this distinction was also salient for them despite the fact that Japanese does not require speakers to pay attention to countablity and individuation when speaking. This is a novel result that has important implications concerning our characterisation of English count/mass status and individuation at the conceptual level.

Our results indicate that at least in the domain of foods, the conceptual countability and individuation of entities are salient conceptual properties regardless of whether the language draws more or less attention to them by marking them. Thus, our results converge with previous work by Mazuka and Friedman (2000) who observed no linguistic relativity effects related to differential number marking systems in English and Japanese. The important aspect of these results lies in the fact that whereas we found no differences between English and Japanese, we observed clear semantic differences in both languages for entities that can be more easily individuated (and hence are marked as count in the English grammar) and entities that are harder to individuate (and hence are marked as mass in the English grammar).

These results clearly suggest that, although indeed there is arbitrariness in the mapping between countability and individuation and the count/mass status of English nouns, this linguistic feature builds upon cognitively salient conceptual properties whose salience is not enhanced by the marking in the grammar, at least for adult language users. This does not necessarily imply that the presence of syntactic-semantic mappings does not play a role in development. Bloom (1994) argued that children utilise bidirectional mappings between syntax and semantics in which count nouns are mapped to kinds of individuals and mass nouns to kinds of portions, and simultaneously kinds of individuals are mapped to count nouns and kinds of portions to mass nouns. According to him, these mappings are used along with cognitive biases to encode discrete physical objects as individuals and substances or collections of particles as portions. More generally, arguments along these lines have been made by proponents of the *syntactic bootstrapping* hypothesis (Fisher, 1994; Fisher & Gleitman, 2002; Landau & Gleitman, 1985) according to which similarity in syntactic context provides important cues to word meaning (and hence meaning similarity). Our results clearly indicate that for adults, regardless of whether syntactic similarity helps bootstrapping aspects of meaning during language acquisition, it does not have processing consequences for the count/mass dimension in a domain of concrete knowledge such as that of foods.

The extent to which the conceptual dimensions of countability and individuation, underlying the count/mass distinction of English nouns are cognitively salient may also critically depend upon the conceptual domain being investigated; hence we may observe language-specific effects in some domains and not in others. In particular, the perceptual affordances of food items may be similar to complex-shaped solid entities used in Imai and Gentner's (1997) study and artifacts typically found in our lives such as the stimuli used in Mazuka and Freidman's (2000) study. However, going beyond semantic domains like food and other solid entities, perceptual affordances may be less relevant; nonetheless, English nouns still divide into count and mass nouns. Revealing examples come from abstract domains such as those related to information and knowledge which include both count and mass nouns (e.g., *knowledge*, *fact*, *wisdom*, *idea*, *thought*). A Japanese-speaking participant in Butler's (2002: 469) study, for example, contends:

> I don't know whether or not you can count something that you cannot see, such as *feelings* and *time*. I don't think they can be counted, but I sometimes see them used with *a*. So I don't know what to do.

Whether grammatical count/mass distinction in such domains influences English speakers' construal of abstract concepts may further elucidate the effect of grammatical count/mass on semantic representations.

Thus, it is a plausible possibility that, when it comes to abstract knowledge, language-specific effects might be found, reflecting a process of bootstrapping. Gleitman, Cassidy, Nappa, Parafragou, and Trueswell (2005) have hypothesised a developmental trajectory in which first the conceptual distinctions are learned, followed by learning the abstract syntactic properties that correspond (or largely correspond) to those distinctions (semantic bootstrapping, e.g., Grimshaw, 1981; Pinker, 1984). In the case of grammaticalised count/mass status, this developmental trajectory would correspond to learning count/mass status for concrete objects and substances ('easy words'; Gleitman et al., 2005). Knowledge of the syntactic properties of count/mass status would then provide clues to the meanings of abstract words ('hard words'; Gleitman et al., 2005) through the different linguistic contexts associated with count vs. mass. Such an account would suggest a dissociation between concrete and abstract words; the importance of linguistic context in learning the latter would suggest that language-specific effects of grammaticalised count/mass status can be observed, but only in abstract domains.

Getting back to concrete domains of knowledge, our finding that English count/mass builds upon cognitively salient conceptual properties whose salience is not enhanced by the marking in the grammar, at least for adult language users, leads prima facie to the prediction that because of the conceptual support, the English count/mass distinction should be easy to learn for Japanese speakers, which is in sharp contrast with the available data (as well as with the personal experience of the two authors of this paper who are L2 speakers of English – NI and GV). However, learning mappings between conceptual dimensions and linguistic forms may not be sufficient to ensure being able to produce well-formed syntactic frames as additional constraints apply to language processing. Along these lines, we have found that in an unpublished follow-up study, when English speakers are asked to produce noun phrases, rather than bare nouns, in the same kind of error induction task we have used in Experiment 1, the rate of preservation of count/mass status between the target and the error significantly increases (85.2% count/mass preservation, compared with 80.6% in Experiment 1 where participants produced the same nouns as single words). This fact indicates that sentence production is imposing additional constraints on which lexical elements can be inserted in a given frame and it is the use of these additional constraints that is harder for adult second language learners.

To conclude, our work has assessed whether the presence (in English) or absence (in Japanese) of marking of count/mass in the grammar of the language has implications for the semantic representation of the corresponding words. We have found no support for language specific effects, and hence for linguistic relativity in this domain. Instead, we found that English count/mass (at least in the domain of foods) has a clear conceptual basis: in contrast to many linguistic accounts that view count/mass as arbitrary to some important extent across domains of knowledge (e.g., Gleason, 1961; McCawley, 1975; Quirk et al., 1972). The important lesson learned from this study with regard to investigation of linguistic relativity is that effect of a language-specific property may depend on semantic domain, as demonstrated by Vigliocco et al. (2005) (who found language-specific effects of grammatical gender only for the semantic domain of animals, but not for tools). We found no language-specific effect of grammatical count/mass on the construal of food items, but this does not preclude the possibility that an effect may be found in other semantic domains. Thus researchers investigating linguistic relativity need to be cautious in considering whether their findings hold across semantic domains. Finally, our results also indicate that despite the grammatical character of count/mass in English, its largely conceptual basis is reflected in performance of Japanese speakers whose language does not have this distinction.

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APPENDIX A

Names of food pictures used in the error induction experiments (Experiments 1) and their English count/mass status and preferred Japanese classifiers

English names	*Japanese names*	*Count/mass*	*Classifiers*
cucumber	kyuuri	count	*hon*
carrot	ninzin	count	*hon*
green bean	ingen(mame)	count	*hon*
sausage	sooseezi	count	*hon*
pancake	hottokeeki/pankeeki	count	*mai*
pizza	piza	count	*mai*
mushroom	massyuruumu	count	*tu/ko*
tart	taruto	count	*tu/ko*
pepper	piiman	count	*tu/ko*
onion	tamanegi	count	*tu/ko*
waffle	waffuru	count	*tu/ko*
croissant	kurowassan	count	*tu/ko*
pie	pai	count	*tu/ko*
potato	zyagaimo/poteto	count	*tu/ko*
donut	doonatu	count	*tu/ko*
egg	tamago	count	*tu/ko*
hamburger	hanbaagaa	count	*tu/ko*
hotdog	hottodoggu	count	*tu/ko*
aubergine	nasu	count	*tu/ko*
radish	radissyu/(aka)kabu	count	*tu/ko*
tomato	tomato	count	*tu/ko*
sandwich	sandoicchi	count	*tu/ko*
sushi	susi	count	*tu/ko*
chicken	tori/chikin	count	
chili	toogarasi/chiri	count	
asparagus	asuparagasu	mass	*hon*
corn	toomorokosi	mass	*hon*
celery	serori	mass	*hon*
ham	hamu	mass	*mai*
bacon	beekon	mass	*mai*
toast	toosuto	mass	*mai*
salad	sarada	mass	*sara*
broccoli	burokkori	mass	*tu/ko*
garlic	nin-niku/gaarikku	mass	*tu/ko*
lettuce	retasu	mass	*tu/ko*
jelly	zerii	mass	*tu/ko*
cheese	chiizu	mass	
ginger	syooga/zinzyaa	mass	
soup	suupu	mass	
rice	kome	mass	

APPENDIX B
Food names in English and Japanese used in Experiment 2
(similarity judgements on words)

Semantic	*Count/mass*	*English*	*Japanese*
natural	count	apple	ringo
natural	count	banana	banana
natural	count	carrot	ninzin
natural	count	egg	tamago
natural	count	nut	nattsu
natural	count	tomato	tomato
natural	mass	beef	gyuu-niku
natural	mass	celery	serori
natural	mass	corn	toomorokosi
natural	mass	garlic	nin-niku
natural	mass	rice	kome
natural	mass	spinach	hoorensoo
prepared	count	biscuit	bisuketto
prepared	count	omelette	omuretu
prepared	count	pancake	hottokeeki
prepared	count	sandwich	sandoicchi
prepared	count	sausage	sooseezi
prepared	count	tart	pai
prepared	mass	bread	pan
prepared	mass	cereal	koonhureeku
prepared	mass	ice-cream	aisukuriimu
prepared	mass	soup	suupu
prepared	mass	spaghetti	supageti
prepared	mass	wine	wain

APPENDIX C

Item similarity matrices for Experiment 2. Values reflect the proportion of times a pair of words was chosen as ‘similar’ among all the triads in which those two words appeared. For example, English speakers chose ‘apple’ and ‘banana’ together on 93% of all triads, and they never chose ‘tart’ and ‘wine’ together. Matrix is symmetrical for ease of reference

Japanese monolinguals

	apple	banana	beef	biscuit	bread	carrot	celery	cereal	corn	egg	garlic	nut	omelette	pancake	rice	sandwich	sausage	soup	spaghetti	spinach	tart	tomato	wine
apple		0.93	0.24	0.19	0.18	0.73	0.66	0.20	0.38	0.42	0.53	0.43	0.05	0.19	0.34	0.14	0.15	0.08	0.06	0.70	0.39	0.83	0.15
banana	0.93		0.18	0.27	0.08	0.73	0.59	0.31	0.34	0.34	0.40	0.42	0.16	0.26	0.26	0.08	0.25	0.08	0.14	0.53	0.25	0.73	0.05
beef	0.24	0.18		0.11	0.17	0.33	0.24	0.11	0.34	0.48	0.25	0.18	0.28	0.13	0.34	0.27	0.93	0.24	0.42	0.32	0.09	0.28	0.14
biscuit	0.19	0.27	0.11		0.66	0.06	0.15	0.64	0.32	0.15	0.07	0.40	0.36	0.77	0.42	0.56	0.14	0.22	0.32	0.09	0.78	0.10	0.13
bread	0.18	0.08	0.17	0.66		0.23	0.26	0.66	0.56	0.32	0.30	0.34	0.59	0.59	0.66	0.82	0.38	0.45	0.59	0.20	0.43	0.28	0.22
carrot	0.73	0.73	0.33	0.06	0.23		0.89	0.31	0.49	0.24	0.68	0.57	0.15	0.10	0.40	0.18	0.33	0.23	0.22	0.78	0.14	0.82	0.01
celery	0.66	0.59	0.24	0.15	0.26	0.89		0.32	0.47	0.40	0.57	0.50	0.14	0.06	0.30	0.17	0.15	0.28	0.23	0.82	0.09	0.77	0.09
cereal	0.20	0.31	0.11	0.64	0.66	0.31	0.32		0.72	0.27	0.14	0.63	0.44	0.51	0.68	0.44	0.16	0.30	0.53	0.22	0.36	0.24	0.10
corn	0.38	0.34	0.34	0.32	0.56	0.49	0.47	0.72		0.35	0.40	0.72	0.33	0.26	0.75	0.30	0.22	0.27	0.36	0.58	0.11	0.45	0.05
egg	0.42	0.34	0.48	0.15	0.32	0.24	0.40	0.27	0.35		0.36	0.35	0.68	0.41	0.38	0.22	0.49	0.26	0.39	0.41	0.20	0.49	0.08
garlic	0.53	0.40	0.25	0.07	0.30	0.68	0.57	0.14	0.40	0.36		0.61	0.11	0.09	0.35	0.15	0.22	0.30	0.33	0.73	0.11	0.72	0.20
nut	0.43	0.42	0.18	0.40	0.34	0.57	0.50	0.63	0.72	0.35	0.61		0.10	0.20	0.49	0.09	0.16	0.08	0.20	0.39	0.27	0.44	0.13
omelette	0.05	0.16	0.28	0.36	0.59	0.15	0.14	0.44	0.33	0.68	0.11	0.10		0.74	0.30	0.72	0.50	0.51	0.61	0.24	0.39	0.18	0.11
pancake	0.19	0.26	0.13	0.77	0.59	0.10	0.06	0.51	0.26	0.41	0.09	0.20	0.74		0.33	0.50	0.25	0.27	0.42	0.14	0.76	0.13	0.11
rice	0.34	0.26	0.34	0.42	0.66	0.40	0.30	0.68	0.75	0.38	0.35	0.49	0.30	0.33		0.38	0.25	0.31	0.76	0.38	0.20	0.41	0.16
sandwich	0.14	0.08	0.27	0.56	0.82	0.18	0.17	0.44	0.30	0.22	0.15	0.09	0.72	0.50	0.38		0.40	0.45	0.57	0.20	0.47	0.16	0.11
sausage	0.15	0.25	0.93	0.14	0.38	0.33	0.15	0.16	0.22	0.49	0.22	0.16	0.50	0.25	0.25	0.40		0.27	0.42	0.23	0.30	0.28	0.08
soup	0.08	0.08	0.24	0.22	0.45	0.23	0.28	0.30	0.27	0.26	0.30	0.08	0.51	0.27	0.31	0.45	0.27		0.56	0.25	0.31	0.25	0.50
spaghetti	0.06	0.14	0.42	0.32	0.59	0.22	0.23	0.53	0.36	0.39	0.33	0.20	0.61	0.42	0.76	0.57	0.42	0.56		0.40	0.27	0.34	0.23
spinach	0.70	0.53	0.32	0.09	0.20	0.78	0.82	0.22	0.58	0.41	0.73	0.39	0.24	0.14	0.38	0.20	0.23	0.25	0.40		0.10	0.78	0.15
tart	0.39	0.25	0.09	0.78	0.43	0.14	0.09	0.36	0.11	0.20	0.11	0.27	0.39	0.76	0.20	0.47	0.30	0.31	0.27	0.10		0.10	0.00
tomato	0.83	0.73	0.28	0.10	0.28	0.82	0.77	0.24	0.45	0.49	0.72	0.44	0.18	0.13	0.41	0.16	0.28	0.25	0.34	0.78	0.10		0.20
wine	0.15	0.05	0.14	0.13	0.22	0.01	0.09	0.10	0.05	0.08	0.20	0.13	0.11	0.11	0.16	0.11	0.08	0.50	0.23	0.15	0.00	0.20	

APPENDIX C (*Continued*)

Japanese monolinguals

	apple	banana	beef	biscuit	bread	carrot	celery	cereal	corn	egg	garlic	nut	omelette	pancake	rice	sandwich	sausage	soup	spaghetti	spinach	tart	tomato	wine
apple		0.78	0.20	0.25	0.13	0.57	0.48	0.23	0.52	0.50	0.45	0.42	0.13	0.27	0.19	0.09	0.15	0.06	0.13	0.51	0.41	0.52	0.09
banana	0.78		0.26	0.47	0.20	0.40	0.42	0.36	0.44	0.23	0.26	0.50	0.15	0.49	0.13	0.17	0.22	0.10	0.18	0.33	0.39	0.52	0.19
beef	0.20	0.26		0.09	0.23	0.38	0.32	0.10	0.30	0.42	0.44	0.22	0.33	0.13	0.48	0.19	0.73	0.24	0.31	0.40	0.11	0.24	0.30
biscuit	0.25	0.47	0.09		0.60	0.08	0.13	0.81	0.17	0.18	0.09	0.59	0.33	0.72	0.19	0.55	0.34	0.17	0.24	0.09	0.72	0.15	0.26
bread	0.13	0.20	0.23	0.60		0.13	0.24	0.64	0.30	0.34	0.16	0.33	0.58	0.80	0.64	0.70	0.52	0.43	0.68	0.17	0.65	0.27	0.30
carrot	0.57	0.40	0.38	0.08	0.13		0.65	0.14	0.70	0.41	0.70	0.27	0.20	0.08	0.32	0.20	0.25	0.11	0.10	0.83	0.09	0.75	0.08
celery	0.48	0.42	0.32	0.13	0.24	0.65		0.19	0.55	0.38	0.56	0.45	0.22	0.10	0.23	0.19	0.22	0.22	0.17	0.73	0.14	0.82	0.15
cereal	0.23	0.36	0.10	0.81	0.64	0.14	0.19		0.45	0.17	0.16	0.51	0.28	0.63	0.45	0.53	0.34	0.34	0.47	0.15	0.56	0.17	0.16
corn	0.52	0.44	0.30	0.17	0.30	0.70	0.55	0.45		0.57	0.58	0.44	0.28	0.15	0.50	0.27	0.31	0.22	0.15	0.66	0.10	0.52	0.08
egg	0.50	0.23	0.42	0.18	0.34	0.41	0.38	0.17	0.57		0.52	0.33	0.55	0.32	0.35	0.36	0.31	0.26	0.19	0.61	0.28	0.42	0.08
garlic	0.45	0.26	0.44	0.09	0.16	0.70	0.56	0.16	0.58	0.52		0.28	0.19	0.02	0.31	0.16	0.28	0.17	0.22	0.74	0.11	0.61	0.11
nut	0.42	0.50	0.22	0.59	0.33	0.27	0.45	0.51	0.44	0.33	0.28		0.28	0.28	0.32	0.24	0.27	0.10	0.26	0.23	0.36	0.41	0.27
omelette	0.13	0.15	0.33	0.33	0.58	0.20	0.22	0.28	0.28	0.55	0.19	0.28		0.57	0.42	0.64	0.65	0.50	0.82	0.17	0.43	0.26	0.19
pancake	0.27	0.49	0.13	0.72	0.80	0.08	0.10	0.63	0.15	0.32	0.02	0.28	0.57		0.25	0.70	0.36	0.28	0.50	0.13	0.76	0.13	0.16
rice	0.19	0.13	0.48	0.19	0.64	0.32	0.23	0.45	0.50	0.35	0.31	0.32	0.42	0.25		0.45	0.26	0.23	0.47	0.28	0.25	0.22	0.09
sandwich	0.09	0.17	0.19	0.55	0.70	0.20	0.19	0.53	0.27	0.36	0.16	0.24	0.64	0.70	0.45		0.45	0.36	0.76	0.15	0.60	0.30	0.17
sausage	0.15	0.22	0.73	0.34	0.52	0.25	0.22	0.34	0.31	0.31	0.28	0.27	0.65	0.36	0.26	0.45		0.33	0.58	0.39	0.34	0.24	0.25
soup	0.06	0.10	0.24	0.17	0.43	0.11	0.22	0.34	0.22	0.26	0.17	0.10	0.50	0.28	0.23	0.36	0.33		0.63	0.17	0.30	0.25	0.66
spaghetti	0.13	0.18	0.31	0.24	0.68	0.10	0.17	0.47	0.15	0.19	0.22	0.26	0.82	0.50	0.47	0.76	0.58	0.63		0.22	0.42	0.39	0.27
spinach	0.51	0.33	0.40	0.09	0.17	0.83	0.73	0.15	0.66	0.61	0.74	0.23	0.17	0.13	0.28	0.15	0.39	0.17	0.22		0.08	0.69	0.07
tart	0.41	0.39	0.11	0.72	0.65	0.09	0.14	0.56	0.10	0.28	0.11	0.36	0.43	0.76	0.25	0.60	0.34	0.30	0.42	0.08		0.18	0.23
tomato	0.52	0.52	0.24	0.15	0.27	0.75	0.82	0.17	0.52	0.42	0.61	0.41	0.26	0.13	0.22	0.30	0.24	0.25	0.39	0.69	0.18		0.17
wine	0.09	0.19	0.30	0.26	0.30	0.08	0.15	0.16	0.08	0.08	0.11	0.27	0.19	0.16	0.09	0.17	0.25	0.66	0.27	0.07	0.23	0.17	