

Individuation and Quantification: Do bare nouns in Mandarin Chinese individuate?

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Some have proposed that speakers of classifier languages such as Mandarin or Japanese, which lack count-mass syntax, have to rely on classifiers for acquiring individuated meanings of nouns (e.g., Borer 2005; Lucy 1992). This paper examines this view by looking at how Mandarin adults interpret bare nouns and use classifier knowledge to guide quantification in three experiments. Experiment 1 found that Mandarin-speaking adults quantify nouns that are equivalent to English count, mass, and mass-count flexible nouns just like English speakers from a previous study. Experiment 2 showed that adults quantified over broken objects using the noun criteria but not classifier knowledge. Our last experiment found that Mandarin adults would attend to classifier syntax when the units of quantification are vague, as in the case of mass-count flexible nouns such as apple or rock. Taken together, we argue that individuation can be specified lexically, and does not come from classifier syntax.

1. Introduction

Research on the meanings of words and on the concepts they express have focused mainly on categorization (Smith & Medin, 1981; Murphy, 2002). In philosophy and linguistics, some words and concepts provide criteria of individuation, which allows us to determine what constitute an individual (where one individual starts and another begins, and whether x is the same one as y), and to discriminate distinct individuals of the same category. For example, we cannot count the *red* in the room, but we can count the *dogs*. Concepts that provide criteria of individuation and numerical identity are thus called “sortals.” Sortal concepts guide quantification as well as classification, and quantification is among one of the important organizing systems of natural language semantics and syntax.

Languages differ markedly from one another in their quantificational resources, including how they express sortal concepts. The cross-linguistic differences in syntactic and semantic structures of quantification, as described below, have been posited to underlie differences in non-linguistic representations. These differences have also led researchers to wonder whether nouns and noun phrases in all languages really express the same conceptual content. For example, when an English speaker hears the word “table”, he or she knows that it refers to a kind of object (a kind of furniture whose members have

a flat surface to support objects) rather than arbitrary portions thereof (e.g., piles of rods and planks). But what mental representation would the Mandarin equivalent – “zhuozi” – generate in the mind of Mandarin speakers? This paper investigates this question by looking at the interpretation of bare nouns and the role of classifiers in Mandarin Chinese.

In English and other Indo-European languages, there exists a syntactic distinction (i.e., the mass-count distinction) that has been said to correspond to a conceptual distinction between individuals and non-individuals. Syntactically, nouns in count syntax can occur directly with numerals (e.g., one dog), singular-plural morphology (a dog, some dogs), and quasi-cardinal determiners (these dogs). In contrast, nouns in mass syntax cannot do any of the above. They cannot occur directly with numerals (e.g., *one sand), singular-plural morphology (*a sand, *some sands), or quasi-cardinal determiners (e.g., *these sands). The syntax-semantic correspondence, as suggested by researchers, is that count nouns refer to sortals, i.e., things that have “atomic structure” or atoms/individuals that can be counted. Mass nouns (e.g., water, wood, fun), on the other hand, refer to homogenous things (Quine 1960; Bloom 1994; Gordon 1988; Link 1983; Wisniewski, Imai and Casey 1996).

Classifier languages such as Mandarin Chinese and Japanese, however, lack such a mass-count distinction, and many have thus argued that all nouns are mass nouns (Allan 1980; Chierchia 1998). First, like English mass nouns, nouns in classifier languages such as Mandarin cannot co-occur directly with numerals (**san bi* ‘three pen’), and require classifiers (CLs) for counting (*san CL-zhi bi* ‘three pens’, is literally translated to ‘three CL-stick pen’). Classifiers are thus akin to English measure words (e.g., “piece” in “three pieces of toast”) that is added to nouns to provide information such as shape, animacy, functionality, and the unit of measure for the noun’s referent. Second, pluralization is often non-obligatory or non-existent in classifier languages. Third, whereas English has different sets of quantifiers for count and mass nouns (e.g., many pens/much water), classifier languages often do not (e.g., *henduo bi* ‘many pens’, *henduo shui* ‘much water’). These observations have led researchers to argue that nouns in classifier languages are syntactically mass, and that noun meanings differ between classifier and mass-count languages (e.g., Lucy 1992).

In particular, researchers reasoned that nouns in classifier languages, as mass nouns, do not provide criteria for individuation, and refer to unindividuated essence. As Lucy (1992) put it, in classifier languages such as Yucatec Mayan, all lexical nouns “are unspecified as to unit since they all require supplementary marking (i.e., numeral classifiers) in the context of numeral modification.” (p. 73). Under this account, classifiers do not merely reflect the meaning provided by the noun, but actually supply units of individuation and quantification, just as English mass nouns require unitizers like “piece” to specify the unit.

The view that only count nouns in mass-count languages specify a unit of individuation has received some experimental support. In particular, Lucy hypothesized that the difference between nouns in classifier and mass-count languages should cause its

speakers to classify entities differently as objects (individuals) or substances (unindividuated stuff). Because English count nouns are prevalent and the unit of individuation and quantification encoded by the noun is typically determined by shape, English speakers should pay more attention to shape information than Yucatec speakers. In contrast, because Yucatec nouns do not specify information about the unit of individuation, its speakers should pay more attention to the material composition than the shape relative to English speakers. In support, when participants were presented with an object (e.g., a cardboard box), and then asked to judge which of two alternatives was more similar, one matching the original in shape (a plastic box) and one matching in material (a piece of cardboard), English speakers preferred the shape-matched choice. Yucatec Mayans divided their choices between the two alternatives (see also Lucy & Gaskins, 2001; 2003). Similarly, Imai and Gentner (1997) found that relative to Japanese speakers, English speakers were more likely to extend novel words for novel referents on the basis of shape than material.

In addition to categorization studies from Lucy and others, recent studies from Huang and colleagues (Huang & Lee, 2009; Huang, 2009) have attempted to resolve the debate on noun semantics by directly exploring what the noun means to speakers. Using a picture verification task, they asked what range of things Mandarin nouns, whose English equivalents are count nouns, can reference. They found that, when shown pictures of whole objects or parts of an object (e.g., a whole chair or half of a chair), Mandarin-speaking adults would judge sentences containing a bare noun (*yizi* ‘chair’) as acceptable for describing pictures depicting either the whole object or just a piece of the object (*yizi* ‘chair’ was acceptable for a whole chair or half of a chair). However, when a classifier was added to the noun (*zhang yizi* ‘a chair’), adults rejected pictures depicting parts of an object, while children continued to accept them. Based on this finding, the researchers drew two conclusions. First, learning classifiers “initiates children into learning how individuals and non-individuals are encoded in the language” (Huang 2009: 150). Second, they argued that nouns do not have individuated meaning independent of the classifiers (see also Borer, 2005). The combination of the classifier and noun provides the criteria for individuation.

Unfortunately, at least half of the nouns Huang and Lee considered “count nouns” in English and that were included in their study were “flexible” nouns – i.e., nouns that could flexibly be count or mass in English (e.g., apple in “some apples” vs. “some apple”). For example, although it is true that “apple” denotes a kind of fruit for which it is clear what counts as an individual, English speakers use the same word to refer to the food stuff that one eat (“apple” also can refer to pieces of apple). Thus, the word “apple” in English can refer to both individual or nonindividuated stuff, depending on syntax. If we assume that noun meanings are the same cross-linguistically, Mandarin speakers might also be willing to accept whole and parts/pieces for the flexible nouns in a bare noun phrase, just as English speakers might be willing to accept either whole or parts/pieces depending on the syntax affixed to the flexible noun.

Moreover, there were also experimental concerns with the other nouns as well. Sometimes the part of an object depicted could still potentially function as a good individual of that kind. Huang (2009) mentioned anecdotes in which participants' explained that their judgments were mediated by potential functionality of the depicted object part – for example, they accepted a torn pair of pants as *kuzi* ('pants') because the torn half could still function as a pair of pants. This functionality factor played into participants' willingness to extend the noun to pieces and parts. Thus, had Huang and Lee chosen only count nouns and depictions of afunctional parts of the objects, participants might not have accepted parts of objects for the bare nouns. The current experiments will revisit the issue of noun choice and object parts to see if Huang and Lee's data hold.

In contrast to the position above, there are several recent studies that have argued that mass nouns and nouns in classifier languages can encode criteria of individuation. First, several researchers have argued that English mass nouns are not limited to denoting non-individuals (Barner & Snedeker, 2005; Chierchia, 1998; Gillon, 1999). Take, for example, the English mass noun "furniture." "A piece of furniture" cannot refer to just a leg of a chair, but must denote a whole individual (e.g., a chair, a table, a bookshelves, etc.). Only "a piece of a piece of furniture" can refer to the leg of a chair. This suggests that mass nouns like "furniture" do provide natural atomic units for counting, namely anything that counts as a "piece" (Doetjes, 2007). This intuition has been supported by experimental studies that probe how mass-count syntax affects quantity judgments. When asked to decide which of two sets contains "more furniture" or "more mail" participants based quantity judgments on number (e.g., judging that six tiny pieces of mail are more mail than two large pieces), despite basing judgments on volume for other mass nouns that denote substances (Barner & Snedeker, 2005, 2006). These findings show that mass nouns permit individuated denotations and that lexical concepts alone can determine individuation.

Second, given that mass nouns in languages like English can denote individuals, one might question the related proposal that all nouns in classifier languages denote unindividuated entities. Crucially, using Barner and Snedeker's quantity judgment task, recent studies have found evidence that many nouns in classifier languages also supply criteria for individuation (Barner, Inagaki & Li, 2009; Inagaki & Barner, 2009). In the absence of classifiers, Japanese speakers base quantity judgments on number to the same extent as English speakers for Japanese equivalents of English count nouns like "cup" and "plate" and for object-mass nouns like "furniture" and "mail", but based quantity judgment on volume for substance-mass terms like "ketchup" and "peanut butter". Barner and colleagues also tested flexible nouns that can be used as either mass or count nouns in English, such as "string" and "chocolate".¹ In this case, English speakers quantified by number when the nouns were presented in count syntax (more chocolates) and by volume

¹ An independent group of English speakers who did not participate in these quantity judgment tasks determined whether these nouns were count, mass, or flexible nouns (Barner et al 2009).

when in mass syntax (more chocolate). Because Japanese lacks mass-count syntax, their judgments for the flexible nouns were sometimes by number and sometimes by volume, in-between the count and mass groups of English speakers' judgments. This pattern of behavior is consistent with the hypothesis that both count and mass readings are available to Japanese and English speakers for flexible nouns, and that syntax selects from universally available lexical meanings. This finding is extremely relevant to Huang and Lee's study, because it suggests that the choice of nouns could indeed factor in how flexibly classifier language speakers are willing to accept amount of stuff or parts of objects as units of quantification for bare nouns.

Third, language differences on the classification of entities by shape (as objects) or by material (as substances) have not gone unchallenged. Contrary to Lucy (1992), these differences are much smaller than previously reported, present only when entities are ambiguous as to whether they have shape-based function, and can be made to disappear depending on testing context (see Li, Chen, Barner, & Carey, under review, for an English-Mayan replication). Importantly, these differences have been attributed to syntactic differences rather than to lexical semantics of nouns (Imai & Mazuka, 2003; Colunga & Smith, 2006; Li, Dunham, & Carey, 2009; Barner et al 2009; see Barner, Li, & Snedeker 2010 for a review). That is, the obligatory nature of having to assign count or mass status to noun phrases and the relatively high presence of high count syntax led English speakers to classify novel nouns as count nouns, and hence categorize on the basis of shape (i.e., object-kind match) rather than material (substance-kind match).

Lastly, although classifier languages lack a morpho-syntactic distinction between mass and count nouns, some have argued that the distinction is reflected at the classifier level (e.g., Cheng & Sybesma, 1998, 1998; Cheng, Doetjes & Sybesma 2008; Doetjes 1997), noting that there are two classes of classifiers (sortal and mensural classifiers) that appear in different syntactic contexts and that are associated with different types of nouns. Sortal classifiers belong to a closed class and are usually associated with particular nouns via rote memorization. In contrast, mensural classifiers can be used with any noun and belong to an open class. Practically any word that denote measures can be used productively as a mensural classifier (e.g., *wan* 'bowl' in *yi wan tang* 'one bowl soup'). Analogous to English mass-count syntax, the syntax-semantic correspondence is that sortal classifiers 'classify nouns that are cognitively singularizable, i.e., count nouns, such as pens, dogs, etc', but mensural classifiers are associated with nouns that are 'cognitively masses, such as water and sand, (plural) pens and dogs' (Cheng & Sybesma, 1998; p. 403). A growing body of experimental evidence has offered support for this analogy (e.g., Li, Barner, & Huang 2008).

In summary, our review indicates that there is a body of literature debating whether classifiers are necessary for individuation, with researchers providing evidence on each side. We believe, however, that the current state of affairs more strongly supports the position that noun semantics are not different cross-linguistically, and that some

nouns in classifier languages do provide criteria for individuation just like nouns in mass-count languages. The current study provides even stronger evidence for this position.

Experiment 1 replicated and extended Barner and colleagues' Japanese-English findings with speakers of another classifier language, Mandarin. Whereas prior studies tested count nouns, mass nouns, and flexible nouns, Experiment 1 further divided the flexible nouns into two kinds of flexible nouns on the basis of a conceptual distinction as judged by English speakers – nouns that name things for which it is clear what constitutes a whole object or “atom” of that kind (apple, pear) vs. nouns that do not (rock, string) have clear “atoms”. More specifically, an apple cut in half does not make two apples, while a rock cut in half makes two rocks. The flexible nouns Huang and Lee studied and labeled as count nouns were of the “apple” and “pear” kind, and the flexible nouns Barner and colleagues studied (Barner & Snedeker 2006; Inagaki & Barner 2009) were of the “rock” and “string” kind. Experiment 1 included both sets of nouns within one study as comparison. We reasoned that if Mandarin speakers are sensitive to the same conceptual distinction as English speakers, then their likelihood of quantifying by individuals and by volume should differ for these two classes of flexible nouns. We predicted that volume should be selected more often for “rock” type nouns than “apple” type nouns, since by picking the side with more volume one can potentially cut up individuals of the “rock” kind to make more of such individuals (i.e., more rocks), satisfying both volume and number.

Experiment 2, following Huang and Lee (2009), we explored Mandarin speakers' acceptance of parts and whole objects for nouns whose equivalents are English count nouns. If nouns in Mandarin do not provide criteria of individuation, then participants might accept broken parts as valid units of quantification for bare nouns. Experiments 2 and 3 also explored the role of classifiers in individuation by asking whether Mandarin speakers' quantification behavior would change with the addition of a sortal classifier to the noun.

2. Experiment 1: Quantity judgments involving Count, Mass, and Flexible Nouns

Following previous studies (e.g., Barner & Snedeker 2005, 2006; Gathercole 1985), we reasoned that quantification based on number is evidence for individuation. Thus, using the quantity judgment task, we tested the hypothesis that bare nouns in Mandarin do not individuate unless classifiers are present. All questions were presented without classifiers in Experiment 1. We predicted that, if bare nouns do not individuate because of a lack of classifier syntax, Mandarin speakers should quantify over volume rather than by number, or quantify randomly across different types of noun. On the other hand, if nouns can lexically specify individuation, even in absence of classifiers, Mandarin speakers should quantify by number for nouns denoting object kinds (e.g., chair), and by volume for nouns denoting substance kinds (e.g., mustard), and that quantificational behavior should fall in-between these two types of nouns for nouns that

can be used flexibly in either mass or count syntax in English (mass-count flexible nouns; e.g., chocolate, pear).

2.1. Participants

Fifty-six native Mandarin-speaking adults were recruited from six universities in Taiwan, and participated in a quantity judgment task with one of the following four noun types: count nouns, mass nouns, “apple” type flexible nouns, and “rock” type flexible nouns. Fourteen participants were assigned to each of the four noun groups.

2.2. Materials & Procedure

For each noun type, participants were shown photographs of two characters (Farmer Tom and Captain Peter) and asked to choose which of the two had more. The instructions were written in Chinese above the photographs: “Farmer Tom has some [NOUN]. Captain Peter has some [NOUN]. Who has more [NOUN]?” In each photograph, one character always had either two large objects or two large portions of a non-solid substance, while the other character had four small objects or four small portions of substances (e.g., two large forks vs. four small forks; two large portions of mustard vs. four small portions of mustard). The combined volume of the four small objects or portions was always less than the two large objects or portions. The dependent measure was whether participants chose the character with the greater number.

Four noun lists were created, one for each noun type. One list consisted of 16 nouns whose translations are equivalent to English count nouns (count noun condition). Eight of these 16 nouns are associated with the default “ge” classifier (bowl, bag, bottle, plate, clock, ball, cup, balloon), and eight with other sortal classifiers (car, table, shoe, sock, chair, key, shirt, fork). Another list consisted of eight nouns whose translations are equivalent to English mass nouns (mass noun condition; black pepper, mustard, ketchup, peanut butter, toothpaste, soy sauce, cream, sugar). The other two lists, consisting of eight nouns each, had nouns that can be used flexibly as mass or count noun in English. The two flexible noun lists differed in whether the nouns named things for which it was clear what constituted an atom of that kind (apple, egg, donut, pear, banana, fish, carrot, cucumber) or not (chocolate, diamond, hair, paper, rock, soap, sponge, string). We will henceforth refer to the first flexible list as “flexible A” and the second list as “flexible B.”

The nouns used in the current study were mostly chosen from MacArthur Communicative Development Inventory (Fenson 1994). A different group of 13 English-speaking adults provided ratings that corroborated our categorization of whether the noun was a count noun, mass noun, or mass-count flexible noun. Another group of 12 English-speaking adults verified the distinction between flexible A and flexible B nouns. They were asked to judge for each flexible noun whether number changes to two as a result of cutting (“Imagine one [noun]. Imagine that it is cut in half. Are there now two [noun]s?”).

2.3. Results

The percentages of trials on which participants quantified by number for each noun type are shown in Figure 1. Participants based their judgment on number for count nouns (99.1% of the trials by number, or 0.9% by volume), even in absence of classifiers. In contrast, participants in the mass noun condition never quantified by number (0%) and always by volume (100%). Replicating Barner et al. (2009)'s results with Japanese speakers, quantity judgments by number for mass-count flexible nouns were in-between count nouns and mass nouns (flexible A: 75.0%; flexible B: 62.5%)

With percentage of judgments by number as a dependent variable, an ANOVA comparing noun types (count, flexible A, flexible B, vs. mass) confirmed that the choice by number differed across noun types ($F(3, 56) = 24.88, p < .001, \eta_p^2 = 0.59$; $F(3, 40) = 1349.64, p < .001, \eta_p^2 = 0.99$). Pair-wise t-tests by subjects-analysis revealed count > flexible A = flexible B > mass (count noun vs. flexible A: $t(26) = 2.15, p < .05$; flexible A vs. flexible B: $t(26) = .74, n.s.$; flexible B vs. mass: $t(26) = 4.92, p < .001$) and t-tests by items-analysis revealed count > flexible A > flexible B > mass (count noun vs. flexible A: $t(22) = 13.13, p < .001$; flexible A vs. flexible B: $t(14) = 5.58, p < .001$; flexible B vs. mass: $t(14) = 53.46, p < .001$).²

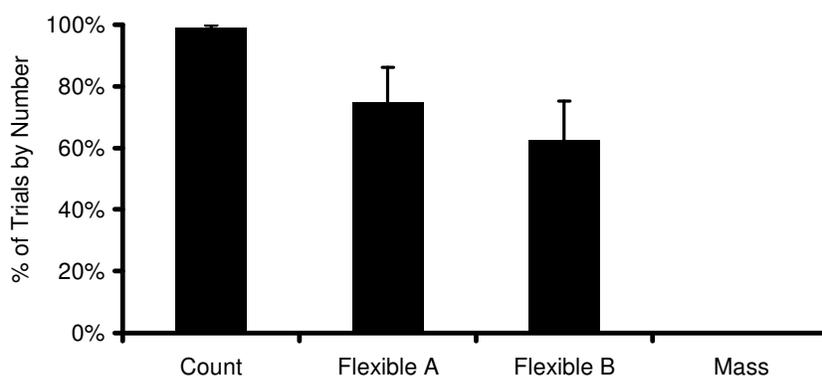


Figure 1. Percentage of quantity judgments based on number for Mandarin nouns that are equivalent to English count nouns, mass nouns, and mass-count flexible nouns. The error bars plot the standard error from subject-analysis.

2.4 Discussion

Mandarin speakers' quantity judgments differed significantly according to the type of nouns presented. They quantified on the basis of number for nouns whose equivalents in English are count nouns, and they quantified by volume for nouns whose

² Because participants were more likely to stick to one way of responding throughout the experiment, either always choosing by number or always choosing by volume, variance was high by subject-analysis. Item-analysis was therefore more sensitive at picking up the differences across noun type.

English equivalents are mass nouns. This finding argues against the claim that all nouns in classifier refer to “unindividuated essence” and do not provide criteria for individuation. For mass-count flexible nouns in English (e.g., apple, rock), judgments by number were in-between judgments for English count and mass nouns. This finding is parsimonious with the assumption that nouns in Mandarin have the same meanings as nouns in English. The referents of these flexible nouns can be easily conceived of as an object or as the stuff that make up the object. As such, English speakers could flexibly interpret the intended meaning when the quantity judgment question was asked in count or mass syntax. For Mandarin speakers, both construals were also available. However, because count or mass status was not explicitly marked, participants had to decide which construal was intended. As a result, some participants chose by number while others chose by volume. These findings on Mandarin nouns replicated Barner et al (2009)’s findings on Japanese nouns. Finally, we also found that the type of flexible noun mattered. Mandarin speakers were slightly more likely to quantify by number for flexible A (“apple”) nouns than flexible B (“rock”) nouns. Overall, this set of data suggests that noun meanings are the same cross-linguistically.

3. Experiment 2: Quantification of Broken Objects vs. Whole Objects

The fact that participants in Experiment 1 exclusively quantified by number for count nouns was taken to suggest that classifier syntax is unnecessary to give nouns individuated meanings. However, quantifying by number and not volume does not provide the strongest evidence that nouns do encode what constitutes an individual of that kind. Huang and Lee (2009) were on the right track in offering a more stringent test when they set out to see if Mandarin speakers were willing to accept bare nouns as referencing parts and pieces of objects (e.g., *yizi* ‘chair’ for half of a chair). Studies have shown that, prior to figuring out how units are identified by nouns, English-speaking preschoolers, unlike English-speaking adults, often accept parts of objects as valid units for quantification. They count a fork broken into three pieces as “three forks” and choose the three pieces as being “more forks” than two whole forks (Brooks, Pogue, & Barner 2010; Shipley & Shepperson, 1990). We may therefore wonder how Mandarin speakers would treat broken parts of objects - would they quantify by individual pieces or whole objects?

In Huang and Lee (2009)’s study, Mandarin-speaking adults were often willing to accept bare nouns as referencing pieces or parts of an object. For example, participants would often accept the expression “Zhuo-shang you pingguo” (Table-top have apple) as a valid description for a picture depicting half of an apple sitting on the table. In contrast, when a sortal classifier was added to the expression (i.e., “Zhuo-shang you (yi) ge pingguo” Table-top have (one) CL apple), participants rejected the expression as a valid description of the same picture. Thus, Huang and Lee interpreted their data as showing that all Mandarin nouns do not provide criteria for individuation and must rely on classifiers. However, as mentioned before, they did not restrict their test items to just

count nouns. They included flexible nouns, whose referents English speakers also sometimes construe as unindividuated.

Experiment 2 therefore tested Mandarin speakers to see if they would accept parts of objects as units of quantification when the nouns were restricted to those classified by English speakers as count nouns. The experiment also varied the syntactic context in which nouns appear to clarify the effects of classifiers on individuation. To do so, some participants were tested in the bare noun condition and some with classifiers added to the noun. For these tests, we again asked for quantity judgment, but contrasting an array of whole objects (e.g., two forks) with an array of an object broken into pieces (e.g., three pieces of one fork) where the side with pieces was greater by number than that of the side with whole objects. Brooks et al (2010; see also Shipley & Shepperson 1990) used this paradigm to test English-speaking adults and children. Importantly, they found English speaking adults, but not children, quantified by whole objects, choosing two whole forks as “more forks” than one fork cut into three pieces. If nouns in Mandarin do provide criteria of individuation, Mandarin speaking adults should quantify by whole objects regardless of whether a classifier is present. However, if nouns do not provide criteria of individuation, Mandarin speakers should only reliably choose the side with whole objects when the sortal classifier is present.

3.1. Participants

Thirty-one native Mandarin-speaking adults who had not participated in Experiment 1 were recruited from universities in Taiwan, and assigned randomly to one of three conditions.

3.2. Materials and Procedure

Two tasks were administered to each participant to assess their treatment of broken object parts in quantification. In the quantity judgment task, one of the two characters always had two whole objects while the other character had one object cut into three pieces. The objects tested were named by count nouns in English (shoe, fork, shirt, ball, cup, sock, plate), which were a subset of nouns from Experiment 1. In the counting task, participants saw either three or four objects, one of which was cut into three pieces. They were asked to count and to give a numerical response. The quantity judgment task was always run first, followed by the counting task.

Participants heard instructions containing either a bare noun phrase (bare noun condition) or a sortal classifier-noun phrase (classifier condition). Ten participants took part in the bare noun condition, and eleven took part in the classifier condition. In the quantity judgment task, participants were asked, “*Shui you bijiao duo* (CL) [noun]? (Who have more (CL) [noun]?). In the counting task, participants were asked, “*Zheli you duoshuo* (CL) [noun]? (Here have how-many (CL) [noun]?).

As in Brooke et al. (2010)’s quantity judgment task, all objects (whole or broken ones) were identical in size. The side with two whole objects was therefore twice as

voluminous as the side with one object broken into three pieces. Picking the side with two whole objects was hence confounded with picking the side with greater volume. Given the results of Experiment 1, where participants picked number over volume for the count nouns, a preference in the present experiment for the side with whole objects and greater volume would therefore unlikely be a preference for volume. Nonetheless, a control condition unconfounded volume and whole objects – i.e., the side with two whole objects had a smaller total volume than the side with one object broken into three pieces. Ten adults participated in this control condition and the instruction was administered in the bare noun phrase to again test whether participants would reliably choose the side with two whole objects over the side with one object broken into three. The counting task for this condition involved counting objects of different sizes that were either whole or broken into pieces.

3.3. Results

Figure 2 displays the results for the two tasks by plotting the average percentage of trials in which participants responded by kinds, i.e., by whole objects. In the quantity judgment task, a response by kind means that the participant chose two objects (e.g., two forks) as being ‘more’ than one object cut into three (e.g., three pieces of one fork). In the counting task, a kind-response means counting by whole objects. For example, for a display of two whole forks and one fork cut into three pieces, “two” or “three” were accepted as kind-responses – two for the intact forks and three for including the broken fork. An alternative to kind-responses might be counting by spatio-temporally discrete units as English-speaking children would typically do, by responding “five” as the total count of two whole forks plus three pieces of one fork.

As figure 2 indicates, participants overwhelmingly gave kind-responses for both tasks, regardless of whether the sortal classifier was present. For all conditions, their responses were near or at 100% ceiling for the quantity judgment task and at 100% for the counting task. Non-parametric Mann-Whitney U-test compared the three conditions of the quantity judgment task and found no significant difference (Bare Noun vs. Classifier, $U = 50$, $p = .34$, $r = .21$; Bare Noun vs. Control, $U = 40$, $p = .52$, $r = .32$; Classifier vs. Control, $U = 49.5$, $p = .52$, $r = .14$).

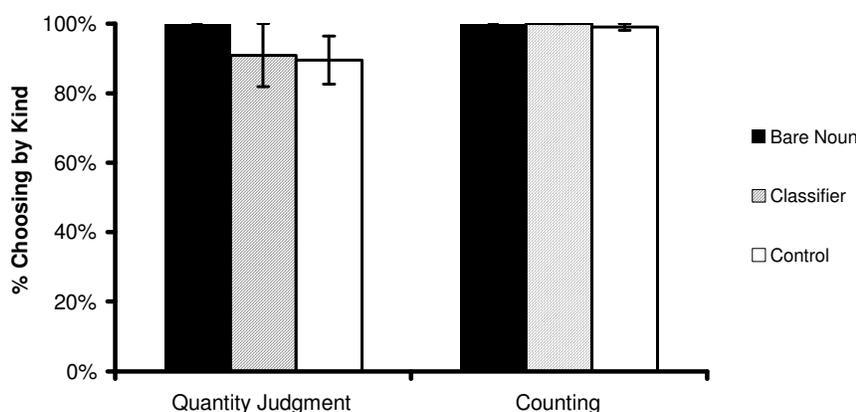


Figure 2. Percentage of kind-based responses for the quantity judgment and counting tasks, comparing the bare noun, classifier, and size control conditions. The error bars plot the standard error from subject-analysis.

3.4. Discussion

Experiment 2 provided further evidence that nouns in Mandarin do provide criteria of individuation, given that quantity judgments for broken objects did not differ between the bare noun and the classifier conditions. The finding that adults gave kind responses in the bare noun condition suggests that they were guided by the knowledge of how nouns pick out units of quantification. Sortal classifiers were therefore unnecessary to drive quantification by kind. If individuation can be specified lexically rather than through classifiers, the question then becomes: what is the role of sortal classifiers? In Experiment 3, we again manipulated the presence and absence of a classifier to see its effects on participants' interpretation of noun phrases.

4. Experiment 3A: Contribution of Classifiers

Our findings from the two previous experiments showed that classifiers were not necessary for providing criteria of individuation for nouns that reference clear individuals. However, just like the fact that English count syntax can disambiguate meanings for flexible nouns, we expect that sortal classifiers can do the same in Mandarin. Thus, Experiment 3 reran the flexible noun conditions in Experiment 1 and included a condition in which classifiers were added to the noun when querying who has more (*Zheli you duoshuo* (CL) [noun]? 'Here have how-many (CL) [noun]?'). With the addition of the sortal classifier, Mandarin speakers should now unambiguously quantify by number. Furthermore, if the effect of noun type is robust for the two different flexible noun types, participants should quantify by number more often for flexible A ("apple") nouns than for flexible B ("rock") nouns.

4.1. Participants

Sixty-four native Mandarin-speaking participants from Taiwan were recruited in the same manner as Experiment 1, and completed a quantity judgment task.

4.2. Materials and Procedure

Half of the participants were tested on the flexible A noun list, and half on flexible B; half of each group was assigned to the bare noun condition and half to the classifier condition. The two conditions differed in whether a sortal classifier was used in querying who had more (*Zheli you duoshuo* (CL) [noun]?; “Here have how-many(CL) [noun]?”). The rest of the experimental procedure was identical to Experiment 1.

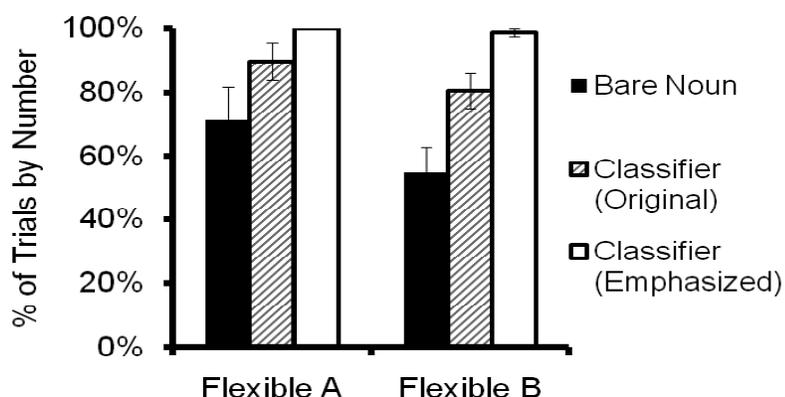


Figure 3. Percentage of quantity judgments by number for flexible A and flexible B nouns across the three conditions - the bare noun and original classifier conditions (from Experiment 3A), and the classifier emphasized condition (from Experiment 3B). The error bars plot the standard error from subject-analysis.

4.3. Results

Figure 3 plots the results of the bare noun and classifier conditions by noun type (the black bars and shaded bars, respectively). Noun Type (Flexible A vs. Flexible B) by Syntactic Frame (Bare vs. Classifier) ANOVA with percentage of trials by number found an effect of Syntactic Frame ($F(1,60) = 8.19, p < 0.01, \eta_p^2 = .120$; $F(1, 14) = 47.15, p < 0.001, \eta_p^2 = .771$). Participants quantified more by number in the classifier condition (85.2%) than in the bare noun condition (62.9%). For items-analysis, but not subjects-analysis, there was also a main effect of Noun Type, $F(1,14) = 12.62, p < 0.01, \eta_p^2 = 0.47$, indicating the percentage quantifying by number was slightly greater for Flexible A than Flexible B nouns (80.8% vs. 67.3%). However, rather surprisingly, the presence of a classifier did not entirely lead participants to choose by number 100% of the time, as one would expect if the classifier were the whole force for determining the unit of quantification.

4.4. Experiment 3B: Effects of Classifier Presentation

Given that participants were not at-ceiling in the classifier condition, we ran twenty additional participants in which we emphasized the classifier, to verify that the outcome would be as initially anticipated - i.e., participants heavily weigh the sortal classifier and quantify by number. The twenty participants were evenly assigned to the two flexible noun lists. To emphasize the sortal classifier, the word was underscored in the written instructions. All else was identical to Experiment 3A.

With the classifier emphasized, participants now quantified by number 100% of the time for both Noun Types (Flexible A: 100%; Flexible B: 99%; see Figure 3). A Noun Type (Flexible A vs. Flexible B) x Classifier Presentation (Original, Emphasized) ANOVA revealed a significant effect of Classifier Presentation ($F(1,48) = 7.70, p < 0.01, \eta_p^2 = .138$; $F(1,14) = 65.92, p < 0.001, \eta_p^2 = .825$). Participants quantified by number significantly more often when the sortal classifier was underscored (99.4%) than when it was not (85.2%). No other effects were found by subjects-analysis. Items-analysis again revealed an effect of Noun Type ($F(1, 14) = 12.62, p < .01, \eta_p^2 = .474$). Additionally, Noun Type x Classifier Presentation was significant ($F(1, 14) = 5.23, p < .05, \eta_p^2 = .272$), and was driven by the fact that Noun Type only mattered for the original presentation (Experiment 3A) but did not matter for the new presentation (Experiment 3B), since participants were already at-ceiling in quantifying by number.

4.5. Discussion

For both flexible A and B nouns, Mandarin-speaking adults showed more quantification by number in the two classifier conditions (original and emphasized) than in the bare noun condition. This shows that, just like count syntax, sortal classifiers may be useful for disambiguating between two competing interpretations for mass-count flexible nouns – i.e., individuated vs. non-individuated meanings. However, interestingly, judgments by number for both flexible A and B only reached 100% when we increased the saliency of classifiers by underscoring the classifier for emphasis. This finding is inconsistent with the account that it is the addition of the classifier to the noun that allows individuated meaning. If so, one would expect that whenever the classifier is present, it would be weighted heavily and would dictate quantificational decisions. Instead, our current finding is consistent with the account that sortal classifiers are present mainly for syntactic purposes. With the exception of flexible nouns, sortal classifiers often do not add much semantically in determining the unit of individuation. If so, we might expect people to pay relatively less attention to the presence of a sortal classifier in signaling individuation. Incidentally, consistent with the idea that sortal classifiers are often overlooked, a recent online sentence comprehension study showed that participants process and make use of mensural classifiers to resolve and determine the upcoming noun from referential context more so than sortal classifiers (Klein, Carlson, Li, & Tenenhaus, under review).

5. General Discussion

Three experiments investigated the view that bare nouns in Mandarin Chinese do not specify criteria of individuation, and that individuation is introduced by sortal classifiers. Using a quantity judgment task with nouns that are equivalent to English count nouns (e.g., car, shoe), mass nouns (e.g., peanut butter, sugar), and mass-count flexible nouns (e.g., rock, chocolate, paper), Experiment 1 found that Mandarin-speaking adults did not provide substance-like interpretations for bare nouns denoting object kinds. Even for mass-count flexible nouns such as apple or rock, Mandarin speakers used lexical semantics to determine the units for counting, as suggested by the percentages of their number judgments. Overall, the pattern of their judgments was highly similar to those of English and Japanese speakers reported in Barner et al. (2009).

Data from Experiment 2 further strengthened the position that nouns provide criteria of individuation. Previous studies (Brooke et al., 2010; Shipley & Shepperson, 1990) showed that, unlike adults, English-speaking preschoolers incorrectly identify units of quantification of count nouns, counting one fork cut into three as “three forks.” This behavior may be explained by a prelinguistic tendency to treat discrete physical objects as units prior to learning how units are identified by nouns. We asked whether Mandarin speakers, just like English-speaking preschoolers, would count and quantify over pieces of broken objects as individuals when tested on equivalents of English count nouns. Against this prediction, Mandarin-speaking adults behaved like English-speaking adults, choosing to count and quantify over whole objects regardless of whether the sortal classifier was present in the noun phrase.

Together, the findings in Experiments 1 and 2 suggest that Mandarin noun meanings are no different than English noun meanings - Mandarin nouns like *yizi* “chair” or *pingguo* “apple” denote individuals, just like English. If individuation needs not come from classifier syntax, what is the role of classifiers in noun phrases, given that a classifier and a noun are one tightly bound unit? Findings from Experiment 3 shed some light on the role of sortal classifiers by testing mass-count flexible nouns. Here, we found an effect of classifier syntax on quantity judgments; participants were more likely to provide number judgments when classifiers were added to flexible nouns. We argue that one important role of classifiers is therefore to provide information about how to quantify in cases where the noun is ambiguous between multiple meanings.

Moreover, one of the interesting findings from Experiment 3 was that adding the sortal classifier did not lead participants to always quantify by number (Experiment 3A). This finding is inconsistent with the account that the sortal classifier unequivocally functions to determine criteria of individuation. Given that judgments by number did not reach 100%, this suggests the presence of the sortal classifier was ignored or treated as irrelevant by some participants. Only when classifiers were emphasized did participants always reliably provide number judgments (Experiment 3B).

Why are sortal classifiers not so effective in indicating individuation? We speculate that sortal classifiers may be less relied upon as a cue to individuation because

nouns often already provide the criteria. Furthermore, children figure out the relation between classifiers and units of quantification relatively late, and certainly after four years of age (Li, Barner, & Huang, 2008; Li, Huang, & Hsiao, 2010). Therefore, there is a long period in which children could not and do not rely on classifiers as a cue. Possibly, as a result, they never subsequently develop a great reliance on sortal classifiers in processing whether a certain noun has individuated meaning (Klein et al., under review; Cheung, Barner, & Li, 2010).

In the current paper we do not address developmental issues, but a large debate in this literature pertains to the role of language learning in conceptual development. One position is that learning mass-count syntax or classifier systems lead children to learn about sortal concepts, which they would otherwise not have (e.g., Quine, 1960). Such a position would argue that adult participants quantified the way they did because they learned the classifier system and were perhaps implicitly adding the classifier they have come to associate with the noun when making quantity judgments. Although we cannot completely rule out this possibility, our finding that adults did not quantify by number 100% of the time even when classifiers were added (Experiment 3A) seem to speak against this idea. Importantly, the position that language learning gives rise to sortal concepts cannot easily account for the regularities that show up in both languages. According to this position, count nouns in English receive individuated denotations because of count syntax, but how does count syntax select count nouns in the first place? In other words, why do some nouns take count syntax, while some other nouns take mass syntax? Similarly, why do nouns denoting object kinds in Mandarin take sortal classifiers, but not those denoting substance kinds? Thus this position leaves unexplained the regularities we see across the two languages. Rather, we argue for the more parsimonious position, which is that speakers of classifier languages such as Mandarin and Japanese share a universal ontology with speakers of mass-count languages such as English.

In line with previous studies, our current data provide another piece of evidence that strongly suggests nouns have the same meanings cross-linguistically by virtue of a universal conceptual structure, which is closely related to the way the world is structured.

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