

## RESEARCH

# Nouns are both mass and count: Evidence from unclassified nouns in adult and child Mandarin Chinese

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This paper examines the interpretation of unclassified nouns in Mandarin Chinese from the perspective of three theoretical approaches to the mass-count distinction in Mandarin: a lexico-syntactic approach (Doetjes 1997; Cheng & Sybesma 1998), a syntax-driven approach (Borer 2005), and a hybrid approach (Pelletier 2012). Employing a Quantity Judgment Task (Barner & Snedeker 2005), we examined the interpretation of unclassified nouns of different ontological types (*count*, *mass*, *flexible*, *object-mass*) in both adult and child Mandarin. In order to explain possible interpretational preferences, we also analysed the distributions of the tested nouns in the Chinese Internet Corpus (Sharoff 2006). The results of 27 adults and 55 children (2;11–5;09), together with the corpus data provide strong support for Pelletier. We therefore conclude that Mandarin nouns are semantically both count and mass, and receive a number-based or a volume-based interpretation according to the type of classifier they appear with. However, we argue for one exception in this respect: following Bale & Barner (2009) we assume that nouns of the *object-mass* type (e.g., *furniture*) are marked for individualization in the lexicon. Finally, the emergence of adultlike preferences for number-based or volume-based interpretations in child Mandarin is argued to be linked to the acquisition of the classifier system.

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**Keywords:** child language acquisition; classifier languages; Mandarin Chinese; mass-count distinction; syntax-semantics interface; unclassified nouns

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## 1 Introduction

In the world surrounding us, entities are divided into different categories depending on whether they are countable. *Countable* entities such as BIRD or BALL refer to individual objects, which have clear boundaries, whereas *uncountable* entities such as DOUGH or WATER refer to substances, which do not seem to have a clear boundary (see Quine 1960; Jackendoff 1993). This ontological distinction between countable and uncountable entities (i.e., bounded vs. unbounded, and individual vs. substance-referring) is not only present in our worldview but also seems to be reflected in the language we speak (see Strawson 1959), roughly as *count* and *mass* nouns, respectively. In this paper, we use the mass-count distinction to refer to the linguistic distinction between mass and count nouns. Number-marking languages such as English, mark the mass-count distinction as follows. Count nouns can be accompanied by an indefinite article, or a plural marker, and can also be directly modified by numerals; whereas mass nouns do not allow these possibilities. This is exemplified in (1) and (2).

- (1) a. I saw a dog yesterday.  
 b. I saw dog-s yesterday.  
 c. I saw three dog-s yesterday.
- (2) a. I drank (\*a) water just now.  
 b. I drank water(\*-s) just now.  
 c. I drank (\*three) water(\*-s) just now.

Yet, languages differ in how they encode (un)countability in the syntax. Classifier languages such as Mandarin Chinese, for instance, do not display the same mass-count syntax as illustrated above for number-marking languages. Mandarin does not have an article system; nor does it have plural morphology (e.g., Li & Thompson 1981).<sup>1</sup> Thus, the use of an indefinite article or plural morphology cannot be a syntactic cue to distinguish count from mass nouns. Although Mandarin does use numerals for quantification, they cannot serve as a linguistic cue for the distinction between mass and count nouns, either: neither count nor mass nouns can be directly modified by numerals. Furthermore, unlike English, Mandarin Chinese does not distinguish between quantifiers for mass or count nouns. For instance, English *many* and *much* are used to quantify count and mass nouns, respectively: *many/\*much dogs* vs. *\*many/much water*. Mandarin lacks such a distinction: *xuduo gou* ‘many dogs’ vs. *xuduo shui* ‘much water’. All these differences illustrate that Mandarin syntactically marks the mass-count distinction in a much less discrete way than English. Given this, some researchers have argued that unlike English, which distinguishes mass from count nouns at the level of syntax, the mass-count distinction is not syntactically relevant in Mandarin (Allan 1980; Chierchia 1994; 1998; Krifka 1995; see also Grimm 2012 for a recent discussion).

However, other scholars have argued against the view that the mass-count distinction is absent in Mandarin Chinese syntax, and claim that Mandarin does syntactically realize the mass-count distinction, namely at the level of *classifiers* (Doetjes 1997; 2012; Cheng & Sybesma 1998; 1999; 2012; Cheng 2012). Nevertheless, the use of classifiers in Mandarin is only obligatory when nouns are modified by numerals. In fact, the appearance of classifiers gives rise to ungrammaticality in the absence of numerals (see Li & Thompson 1981). Thus, in classifier languages such as Mandarin, nouns may freely occur without classifiers (see Chierchia 1998). An empirical question that now arises is how Mandarin speakers interpret unclassified nouns, i.e., nouns appearing without any classifiers, with respect to their number-based or volume-based denotations.

The current study explores this question from three different theoretical points of view, by empirically investigating a group of Mandarin-speaking adults and children on their interpretation of unclassified nouns. As our results will show, participants have different interpretational preferences for unclassified nouns of different ontological types. Our study also explores how such preferences can be accounted for by analysing the syntactic distribution of different types of nouns in a corpus of Mandarin.

The paper is organized as follows. Section 2 provides the relevant background in Mandarin Chinese, including the classifier system, different theoretical approaches to the mass-count distinction and what they predict regarding the interpretation of unclassified nouns. Section 2 also presents a summary of previous empirical findings. Section 3 introduces the current study, consisting of a Quantity Judgment Task and a study of the Chinese Internet Corpus. The results of both the experiment and the corpus study are presented in Section 4, which are further discussed in Section 5. Section 6 concludes the paper.

<sup>1</sup> Human-denoting nouns in Mandarin Chinese allow optional plural marking (Li & Thompson 1981).

## 2 Background

### 2.1 Classifiers in Mandarin Chinese

As mentioned in Section 1, classifiers are crucial to the mass-count distinction in Mandarin Chinese. Mandarin Chinese is a classifier language, in which numerals are not allowed to directly modify count nouns, as opposed to number-marking languages such as English. Instead, the presence of a numeral requires the obligatory use of classifiers (see Li & Thompson 1981), which are words that classify the noun depending on the type of its referent.

In the Chinese literature, two general types of classifiers are distinguished: *sortal classifiers* and *mensural classifiers* (Allan 1977; Tai 1992; 1994; Tai & Wang 1990; among many others). Sortal classifiers are also referred to as *count classifiers*. They classify nouns such as *shu* ‘book’ or *ma* ‘horse’, which name things with naturally existing quantificational units, or boundaries, illustrated in (3). Mensural classifiers, which are also known as *measure words* or *mass classifiers* on the other hand, do not seem to have a rigid association with sortal nouns. As mass classifiers do not denote naturally existing quantificational units, they can co-occur with both nouns such as *shu* ‘book’ and nouns such as *shui* ‘water’, as exemplified in (4).

- |     |    |   |    |   |
|-----|----|---|----|---|
| (3) | a. | wu-ben-shu<br>five-CL-book<br>‘five books’                              | b. | san-pi-ma<br>three-CL-horse<br>‘three horses’                           |
| (4) | a. | shi-gongjin-shu<br>ten-CL <sup>kilo</sup> -book<br>‘ten kilos of books’ | b. | wu-wan-shui<br>three-CL <sup>bowl</sup> -water<br>‘five bowls of water’ |

To better understand the classifier system in Mandarin, we illustrate a number of differences between the two types of classifiers on the basis of (3) and (4) (following Li & Thompson 1981; Tai 1992; 1994; Cheng & Sybesma 1998; Cheng 2012). First, count classifiers belong to a closed class whereas mass classifiers are members of open categories. Count classifiers do not convey concrete lexical meanings but fulfil a grammatical function in the language. Mass classifiers, on the other hand, do have lexical meanings and can therefore – in addition to their classifier function – also appear on their own as lexical items (Tai 1994; Cheng & Sybesma 1998). For instance, when not used as a mass classifier, *wan* ‘bowl’ (see (4a)) has a denotation similar to its English counterpart *bowl*.

A second difference between the two classifier types concerns their relation to the noun they classify. Count classifiers, due to their function of indicating naturally existing counting units of sortal nouns, display a fixed and rigid association with the noun they classify (Tai & Wang 1990; Tai 1992; Ahrens 1994). As illustrated in (3), different nouns require different count classifiers. Although semantic properties of sortal nouns, such as animacy, solidity, and function may be cues for language speakers to use one count classifier but not another, the knowledge of count classifiers is argued to be rote-learned (e.g., Li et al. 2010). On the contrary, the relation between mass classifiers and the noun they classify is considered contingent and temporal (Tai 1992; 1994; Ahrens 1994). Nouns do not seem to require a specific mass classifier. The same noun can be compatible with different mass classifiers as long as an appropriate discourse context is provided.

Finally, as count classifiers behave more like grammatical elements than like lexical items, there is a default, namely *ge* (Cheng & Sybesma 1998). As the default, or the general count classifier, *ge* is not specified for any shape information, nor does it seem to provide any information about animacy or function. Thus, the examples of sortal nouns

we gave in (3) are both compatible with the default *ge*, although the use of *ge* may sound informal or less literate.

Employing two diagnostics, Cheng & Sybesma (1998; 1999; 2005; see also Cheng 2012) argue that count and mass classifiers display different syntactic behaviours, which they consider evidence for a syntactic mass-count distinction in Mandarin Chinese. We start with the (im)possibility of co-occurrence with *de*, a modification marker according to the traditional view (Li & Thompson 1981). Cheng & Sybesma demonstrate that in Mandarin, only mass classifiers, which are also referred to as *massifiers* in their work, can co-occur with the modification marker *de* (see (5)), whereas the co-occurrence of count classifiers with *de* gives rise to ungrammaticality (see (6)).

- |     |    |  |    |   |
|-----|----|--|----|---|
| (5) | a. | shi-gongjin-de-shu<br>ten-CL <sup>kilo</sup> -DE-book<br>'ten kilos books' | b. | wu-guan-de-shui<br>five-CL <sup>jar</sup> -DE-water<br>'five jars of water' |
| (6) | a. | wu-ben-(*de)-shu<br>five-CL-DE-book<br>Intended: 'five books'              | b. | san-pi-(*de)-ma<br>three-CL-DE-horse<br>Intended: 'three horses'            |

Secondly, count and mass classifiers behave syntactically differently with respect to the insertion of BIG/SMALL adjectives in classified noun phrases (henceforth CNPs). As is illustrated in (7), CNPs with massifiers allow the insertion of adjectives like *xiao* 'small' or *da* 'big'; whereas the insertion of such adjectives leads to ungrammaticality in CNPs with count classifiers, as illustrated in (8).

- |     |    |   |    |   |
|-----|----|---|----|---|
| (7) | a. | wu-xiao/da-guan-shui<br>five-small/big-CL <sup>jar</sup> -water<br>'five small/big jars of water' | b. | san-xiao/da-kuai-rou<br>three-small/big-CL <sup>piece</sup> -meat<br>'three small/big pieces of meat' |
| (8) | a. | wu-(*xiao/*da)-ben-shu<br>five-small/big-CL-book<br>Intended: 'five small/big books'              | b. | san-(*xiao/*da)-pi-ma<br>three-small/big-CL-horse<br>Intended: 'three small/big horses'               |

As observed in Doetjes (1997), among others, classifiers in Mandarin Chinese are only obligatory when nouns are modified by numerals. In the absence of numerals, nouns can appear without classifiers. Some examples of such unclassified nouns are provided in (9) and (10).

- (9) Wo zuotian qu shudian mai-le shu.  
I yesterday go book store buy-PERF book  
'I went to a book store yesterday and have bought (a) book(s).'
- (10) Wo yijing he-guo niunai le.  
I already drink-PERF milk PAR  
'I have already drank (some) milk.'

Thus, even though the mass-count distinction in Mandarin Chinese is reflected in the syntax, the syntactic reflection is not always obligatory. This gives rise to the question as to what renders a volume-based (corresponding to a mass noun) or a number-based (corresponding to a count noun) interpretation of an unclassified noun in Mandarin. Bearing in mind this question, we will now present three approaches to mass-count in Mandarin Chinese: a lexico-syntactic approach (Doetjes 1997; 2012; Cheng & Sybesma 1998; 1999;

2012; Cheng 2012), a syntax-driven approach (Borer 2005), and a hybrid approach (Pelletier 2012).

## 2.2 Relevant approaches to the mass-count distinction in Mandarin Chinese

The lexico-syntactic approach allows lexical marking for countability. According to Cheng & Sybesma (1998; 1999; 2012; see also Sybesma 2007; Cheng et al. 2008; Cheng 2012), nouns come out of the lexicon either with or without counting units. If a noun has a discrete counting unit in its lexical-semantic denotation, it is interpreted as count; if, on the contrary, its lexical-semantic denotation does not include such a counting unit, its interpretation is mass. Allowing similar lexical markedness, Doetjes (1996; 1997) distinguishes four types of nouns in the lexicon. They are count singular nouns (e.g., *bird*), count plural nouns (e.g., *birds*), count mass nouns (e.g., *furniture*), and mass mass nouns (e.g., *water*), which are argued to have different domains of denotation. Count singulars refer to a set of singularities e.g., *a, b, c*, etc., and count plurals refer to the set of pluralities that are formed on the basis of the set of atoms, e.g.,  $\{a, b\}$ ,  $\{a, c\}$ ,  $\{a, c\}$ ,  $\{a, b, c\}$ , etc. Count mass nouns may refer to both the set of singularities and the set of pluralities built on it, e.g., *a, b, c*,  $\{a, b\}$ ,  $\{a, c\}$ ,  $\{a, c\}$ ,  $\{a, b, c\}$ , etc. Finally, mass mass nouns do not have atomic reference but denote portions of matter, which have, what she calls, the *part of*-relation, with each other.<sup>2</sup> In Doetjes' view, only the three count noun types (count singulars, count plurals, count mass nouns) come out of the lexicon with counting units. In contrast, mass mass nouns are not marked for countability in the lexicon.

According to the lexico-syntactic approach, the distinction between count and mass nouns in terms of countability at the lexical level must be syntactically visible. In other words, lexically marked countability must agree with syntactic marking of countability. In number-marking languages such as English, this syntactic marking is realized by, for instance, plural morphology. In classifier languages such as Mandarin, which lack plural morphology, it is achieved through count classifiers. Thus, for Cheng, Sybesma, and Doetjes, the presence of count classifiers in Chinese is merely a syntactic realization of the lexically marked countability of certain nouns. This means that the interpretation of unclassified nouns in Mandarin should rely on the semantic information that is already present in their lexical denotation.

Different from the lexico-syntactic approach presented above, Borer (2005) argues that nouns do not contain any semantic information in the lexicon: they are unmarked for either count or mass. This implies that ontology does not play a role (contra Quine 1960 and Jackendoff 1993). Instead, Borer proposes that the mass-count distinction is purely structural. In the presence of what Borer calls a *dividing structure*, realized as a *classifier phrase* (henceforth CLP) in the syntax, nouns become count and are assigned a number-based interpretation. In contrast, the absence of a CLP gives rise to a mass noun, with a volume-based interpretation. Languages differ as to how they project CLPs. Borer argues that in number-marking languages such as English, CLPs are projected by, for instance, the plural morpheme. In classifier languages such as Mandarin Chinese, CLPs are headed by classifiers. Thus, in Borer's view, both classifiers and plural morphology count as classifier inflection, projecting CLPs, and being responsible for a number-based interpretation of nouns. However, not all classifiers can project CLPs. Adopting the two types of classifiers distinguished in the literature on Mandarin (see Subsection 2.1), Borer further argues that only count classifiers have the grammatical function to head CLPs, while massifiers do not. Syntactically, massifiers behave the same as measure words in English (see Borer

<sup>2</sup> We refer the reader to Doetjes (1997) for a detailed illustration of the *part-of*-relation, and its three properties: transitivity, reflexivity, and asymmetry.

2005: 96–97). This means that all nouns, across all languages, become mass nouns and receive a volume-based interpretation in the absence of a CLP. For Mandarin Chinese, this means that nouns receive a number-based reading only when modified by a count classifier. When appearing with a massifier, or, crucially for our study, without any classifiers, Mandarin nouns must only have a volume-based interpretation.

A more recent account of the mass-count distinction is proposed in Pelletier (2012). Pelletier's approach to the mass-count distinction involves the interaction between four features at two levels: two syntactic features, namely,  $+COUNT_{syn}$  and  $+MASS_{syn}$ , and two semantic features, namely,  $+COUNT_{sem}$  and  $+MASS_{sem}$  (and hence its hybrid nature). In line with Borer, but contra Quine and Jackendoff, ontology plays virtually no role in Pelletier's view. Furthermore, similar to Borer, Pelletier argues that nouns are unspecified in the lexicon for their count or mass denotations. However, a crucial difference with Borer is that for Pelletier nouns are semantically both count and mass, which is realized by the presence of the two semantic features on the noun. In other words, all nouns are in principle flexible. They can refer to individual objects with clear boundaries as well as substances without clear boundaries, just as *rope* or *chocolate*. In contrast, Pelletier argues that nouns are lexically unspecified for syntactic count and mass features. When nouns enter the syntax, either  $+COUNT_{SYN}$  or  $+MASS_{SYN}$  can be introduced. When  $+COUNT_{SYN}$  or  $+MASS_{SYN}$  is introduced, the opposite semantic feature on the noun (i.e.,  $+MASS_{sem}$  or  $+COUNT_{sem}$ ) is deleted, resulting in a number-based or volume-based interpretation, respectively. Acknowledging the syntactic relevance of the mass-count distinction at the level of classifiers in Mandarin Chinese, Pelletier suggests that the syntactic features  $+COUNT_{SYN}$  and  $+MASS_{SYN}$  can only be introduced at the entire level of *classified noun phrases* (henceforth CNP). In particular, CNPs headed by a count classifier introduce  $+COUNT_{SYN}$ , and those headed by a massifier introduce  $+MASS_{SYN}$ . Thus, Mandarin nouns get a number-based reading in the presence of a count classifier and receive a volume-based interpretation in the presence of a massifier. As such, Pelletier's account makes the prediction that in the absence of classifiers, Mandarin nouns can get either a number-based or a volume-based interpretation (since neither  $+COUNT_{sem}$  nor  $+MASS_{sem}$  is deleted).

### 2.3 Previous empirical findings

Although there are several experimental studies on the (L1 acquisition of the) mass-count distinction in number-marking languages such as English, Dutch, Hebrew, etc. (Barner & Snedeker 2005; Hacoen 2010; van Witteloostuijn 2013; van Witteloostuijn & Schaeffer 2014; this volume; among others), there are very few on classifier languages such as Mandarin Chinese. Most experimental studies on the mass-count distinction in Mandarin Chinese that we know of aim to investigate whether Mandarin speakers, both adults and children, are sensitive to the syntactic cues to the mass-count distinction that Mandarin employs, namely, classifiers (Li et al. 2008; Cheung et al. 2009), and how the presence of classifiers may influence the speakers' interpretation as mass or count (Li et al. 2010; Cheung et al. 2012).

To the best of our knowledge, there is only one study in which the interpretation of Mandarin nouns without classifiers is investigated, namely, Study 1 in Cheung et al. (2012). In this study, the authors examined how adult speakers of Mandarin Chinese from Taiwan interpreted nouns of different types with respect to their number-based or volume-based denotations in a Quantity Judgment Task (QJT; Barner & Snedeker 2005). Four noun types were included: count nouns such as *balls*, mass nouns such as *water*, and two types of flexible nouns, namely, nouns such as *apple(s)*, and nouns such as *string(s)*. Each of these four conditions was administered to a different group of 14 adult native speakers of Mandarin Chinese. While being presented with photographs of two characters,

one with two large individual objects or two large portions of substances and the other with four small individual objects or four small portions of substances, the participants were asked to answer a question in Mandarin Chinese of who had more. As illustrated in (11), the question contained a bare noun, which appeared without any classifiers.

- (11) Shui you bijiao duo [noun]?  
 who have relatively more [noun]  
 ‘Who has more [noun]?’

The results showed that number-based judgments were most frequent for count nouns, i.e., 100%, and least frequent for mass nouns, i.e., 0%. When confronted with the two flexible noun types, the number-based judgments were in-between: 75% for *apple*-type flexible nouns and 62.5% for *string*-type flexible nouns.

Cheung et al. interpret these results in light of their previous findings on the mass-count distinction in English, a number-marking language, and Japanese, a classifier language (Barner et al. 2009: Experiment 1). These findings with English and Japanese monolinguals were obtained in QJTs as well, in which participants were asked to answer the question *Who has more X* by giving a quantity judgment in the similar experimental setting as Cheung et al.’s Study 1. The critical question in the Japanese QJT is presented in (12), adapted from Inagaki & Barner (2009: (4)). The Japanese critical question contained a bare noun too, with no classifiers.

- (12) dotira-no hito-ga [noun]-o yori-ooku motteiru desyoo?  
 which-GEN person-NOM [noun]-ACC more-many/much have POLITE  
 ‘Who has more [noun]?’

The English QJT was administered to a total of 64 English monolinguals, who were equally divided into four quantity judgment conditions, representing four noun types: count nouns like *pens*, mass nouns like *bread*, flexible count nouns like *eggs*, and flexible mass nouns like *egg*. Since Japanese is a classifier language and does not have obligatory plural morphology similar to Mandarin Chinese, the Japanese QJT did not distinguish between flexible count and flexible mass nouns (*eggs* vs. *egg*, respectively), and hence only involved three test conditions: *count*, *mass*, and *flexible*. A total of 63 native speakers of Japanese participating in the Japanese experiment were divided into one of these three test conditions. Results of the English and Japanese QJTs are summarized in Table 1 (data adopted from Barner et al. 2009).

**Table 1:** Percentages of number-based judgments in Barner et al.’s QJTs.

	Count	Mass	Flexible
English	100%	6.3%	72.5% (flexible count); 1.9% (flexible mass)
Japanese	94.8%	20.9%	56.8%

Comparing their Mandarin QJT results with those obtained in English and Japanese as reported in Table 1, Cheung et al. (2012) conclude that the semantics of Mandarin nouns do not fundamentally differ from that of nouns in number-marking or other classifier languages. The authors argue that their quantity judgment results show that semantic differences at the lexical level drive syntax, and thus support the lexico-syntactic approach.

However, there are several limitations of the above-presented QJTs in the two classifier languages, namely Mandarin and Japanese, which make it impossible to draw disentangle the three theoretical approaches described in Subsection 2.2. A major concern is that the

noun types included in these studies (four types in the Mandarin QJT, and three types in the Japanese QJT) were not administered to the same group of participants. If each participant only received one noun type, he or she could develop an automatic quantity judgment strategy, giving rise to one and the same interpretation of that noun type over and over again. This prevents comparison between the different noun types within the same participants. Another shortcoming is that no child participants took part in the QJTs. Thus, no conclusions can be drawn on possible interpretational patterns of unclassified nouns in classifier languages during acquisition or explanations in this respect. Third, nouns of the *object-mass* type (e.g., *furniture*), which represents a crucial ontological type in the mass-count literature, was not included in Cheung et al.'s Mandarin QJT or Barner et al.'s Japanese QJT. Moreover, the quantity judgment question in both the Mandarin and the Japanese QJTs was presented in written, rather than oral form as in Barner & Snedeker's (2005) original QJT. We consider the mode of stimuli presentation highly relevant to examining the interpretation of unclassified nouns in classifier languages because written language (e.g., characters in Mandarin Chinese) may convey meaning through their iconicity, which can potentially influence participants' quantity judgments. Such influence is unavoidable in Mandarin. In Japanese, it depends on the character type. If logographic kanji was used in the Japanese quantity judgment question, similar influence was expected as in Mandarin Chinese since kanji is adopted from Chinese characters. The mode of stimuli presentation is moreover crucial to the current study due to the following reasons. First, compared to written stimuli, orally presented stimuli generally render more spontaneous and natural speech, which is what we aim to investigate in the current study. Second, stimuli in written form cannot be used with young children.

Filling the methodological gaps of the previous QJTs in two classifier languages, the current study explores empirical data to differentiate between various theoretical approaches to the mass-count distinction in Mandarin Chinese. In the next section we present the predictions that the three theoretical approaches make for adult and child Mandarin Chinese regarding the interpretation of unclassified nouns.

#### 2.4 Predictions

The three theoretical approaches described in Subsection 2.2 make different predictions not only with respect to the interpretation of unclassified nouns in Mandarin Chinese but also regarding possible preferences in terms of interpretation. Empirically testing the interpretation of unclassified nouns in Mandarin-speaking adults and Mandarin-acquiring children will have crucial theoretical implications. In (13), we list our predictions.

- (13) Predictions for the interpretation of unclassified nouns in Mandarin Chinese:
- (i) Doetjes (1997), Cheng & Sybesma (1998): Unclassified nouns that are lexically specified for counting units are always interpreted based on number; unclassified nouns that are not lexically specified for counting units are always interpreted based on volume.
  - (ii) Borer (2005): Unclassified nouns always receive a volume-based interpretation, irrespective of their ontological types.
  - (iii) Pelletier (2012): Unclassified nouns allow both a number-based and a volume-based interpretation, irrespective of their ontological types.

The three theoretical approaches also make different predictions regarding speakers' interpretational consistency. As the lexico-syntactic approach attributes the interpretation of unclassified nouns in Mandarin Chinese to the lexical-semantic information of



the nouns (i.e., 13(i)), it predicts consistency in speakers' interpretations of the same unclassified nouns with respect to their mass-count denotations. Interpretational consistency is also expected when we follow Borer's syntax-driven approach. Since unclassified nouns in Mandarin Chinese lack a CLP, they should be consistently interpreted as having a mass reading. In contrast, assuming all nouns to be semantically both count and mass at the lexical level, Pelletier's hybrid approach does not guarantee similar interpretational consistencies. Speakers may show different interpretations when confronted with the same unclassified nouns. This gives rise to another question that we need to address if we do find such interpretational preferences: how do we explain these?

Although Pelletier's approach allows both number- and volume-based interpretations of the same unclassified nouns, it does not provide an explicit explanation for potential preferences in this respect. We hypothesize that linguistic experience plays a role here. The term *linguistic experience* is inspired by Borer's concept of *convention*, which we interpret as speakers' experience with nouns appearing in different types of syntactic structures in the input. In particular, we hypothesize that linguistic experience accounts for speakers' preferences for certain nouns to appear in certain syntactic structures, which, in turn have certain preferred interpretations by the speakers. The more often a noun appears with a count classifier or a massifier, the stronger a speaker's preference is for a number-based or a volume-based interpretation of the noun, respectively.

Given that children have less linguistic experience than adults do, we predict a difference between adult and child speakers of Mandarin when it comes to the interpretational preferences of unclassified nouns. Adults are predicted to show a preference for either a number-based or a volume-based interpretation, depending on how often they have encountered a number-based or volume-based interpretation of the relevant noun in the input, whereas children are predicted to equally allow number-based and volume-based interpretations of unclassified nouns due to little linguistic experience. We list the predictions regarding interpretational consistency following from the three theoretical approaches in (14).

- (14) Predictions regarding interpretational consistency of unclassified nouns in Mandarin Chinese:
- (i) Doetjes (1997), Cheng & Sybesma (1998): All unclassified nouns – irrespective of their ontological types – are consistently interpreted as having either a number-based or a volume-based interpretation on the basis of their lexical countability in both adult and child Mandarin Chinese.
  - (ii) Borer (2005): All unclassified nouns – irrespective of their ontological types – are consistently interpreted as having a volume-based interpretation due to the absence of a CLP in both adult and child Mandarin Chinese.
  - (iii) Pelletier (2012) combined with our own hypothesis on linguistic experience: Interpretational consistency is not warranted; under the influence of linguistic experience, adult speakers of Mandarin Chinese show preferences for either a number-based or a volume-based interpretation of unclassified nouns, 7, whereas child speakers may equally allow both number-based and volume-based interpretations of unclassified nouns, irrespective of their ontological types, due to little linguistic experience.

In the next section, we describe the methods to test these predictions.

### 3 Methods

#### 3.1 Quantity Judgment Task (QJT)

##### 3.1.1 Participants

A total of 27 adult native speakers of Mandarin Chinese (aged 30–60; 15 females) and 55 monolingual Mandarin Chinese children (2;11–5;09; 30 girls) participated in the current experiment.<sup>3</sup> The adult participants were recruited from a security company and an insurance company in a Mandarin-speaking area in northeast China; the child participants were recruited from a kindergarten in the same area. In order to track potential development, we divided our child participants into two age groups: a younger group of 23 two- and three-year-olds (2;11–3;11;  $M = 3;06$ ;  $SD = 0;4$ ; 13 girls), and an older group of 32 four- and five-year-olds (4;02–5;09;  $M = 4;10$ ;  $SD = 0;5$ ; 17 girls).

##### 3.1.2 Materials

Based on Barner & Snedeker's (2005) Quantity Judgment Task (see also Hacquard 2010; van Witteloostuijn 2013), we developed a Quantity Judgment Task (henceforth QJT) for Mandarin. In the original QJT, participants were first presented with actual scenes in which two characters were given a certain object/substance  $X$  of different numbers and volumes, for example, one large plate versus three small plates (of which the overall volume was smaller than that of the large plate). After that, they were asked to answer the question of who had more  $X$ , i.e., plates, in this example. If the participant pointed to the character with more plates in terms of individual items (namely the three small ones), s/he was considered to make a quantity judgment based on number of individual items, representing a number-based interpretation. In contrast, if the participant pointed to the character with more plates in terms of volume (namely, the single large one), the response was categorized as a volume-based interpretation.

Following Barner & Snedeker's paradigm, we also used two characters, namely *niuzai* 'cowboy' and *qishi* 'rider' (see also Hacquard 2010 and van Witteloostuijn 2013). Both characters always simultaneously appeared on a laptop screen, with the cowboy consistently in the left bottom corner and the rider consistently in the right bottom one. Both characters were assigned the same object  $X$  but of different numbers and volumes. One character had more  $X$  in terms of individual items whereas the other one had more  $X$  in terms of volume. After hearing the target question *Who has more X?* participants had to point to one of the characters on the laptop screen, indicating their answer. The target questions, which all had the form in (15), were pre-recorded on an MP3 player by a thirty-year-old female native speaker of Mandarin.

- (15) Shei de  $X$  duo?  
 who GEN  $X$  more  
 'Who has more  $X$ ?'

The literal translation of the Mandarin target question is 'Whose  $X$  is more?'<sup>4</sup> Although the noun has a possessive, namely *shei de* 'whose', it is not accompanied by a classifier, making it an unclassified noun. This manipulation is crucial to our examination of the interpretation of unclassified nouns in Mandarin with respect to their number-based or volume-based denotations.

<sup>3</sup> Eight out of the 27 adult controls had received English lessons at middle school (between age 14 and 19); however, none of these participants have ever worked, studied or lived in an English-speaking environment.

<sup>4</sup> As the critical reader may notice, the target question in the current QJT, i.e., (15), is different from the one in Cheung et al.'s (2012) QJT with bare nouns, i.e., (11). We used (15) instead of (11) because five Mainland Chinese adult informants of Mandarin (including one of the authors of the present study) considered (15) to be more natural.

Following Barner & Snedeker (2005), the current QJT examined four ontological noun types, representing four test conditions.<sup>5</sup> They include nouns of the ontological type *count* (*qiu* ‘balls’), nouns of the ontological type *mass* (*niunai* ‘milk’), nouns of the *flexible* type (*shitou* ‘stone(s)’), and nouns of the type *object-mass* (*jiaju* ‘furniture’). We also included a filler condition. Table 2 provides an overview of the different conditions in the current QJT. Seven of the 20 filler items appeared in the experiment twice, resulting in a total of 49 items in the current QJT.

**Table 2:** Experimental design.

Condition	Example	Number of stimuli
Count	<i>qiu</i> ‘balls’	7
Mass	<i>niunai</i> ‘milk’	7
Flexible	<i>shitou</i> ‘stone(s)’	9
Object-mass	<i>jiaju</i> ‘furniture’	6
Fillers	<i>xiangjiao</i> ‘bananas’	20
<b>TOTAL</b>		<b>49</b>

In Appendix I we provide one example of each condition. Different from the four test conditions, the filler condition only contained nouns of the *count* type. However, it was different from the *count* condition in that only the numbers of *X* given to the two characters differed, while the sizes, i.e., volume of the items were the same. Appendix II presents the nouns (both test and filler items) employed in our QJT.

### 3.1.3 Procedure

The experiment was conducted individually and took place in a quiet corner of the participants’ workplace or at their home (in the case of the adult participants), or in a quiet classroom in the kindergarten (in the case of the child participants). One female experimenter was present during the experiment. She first invited a participant for a game, and then explained to the participant how the game proceeded and what s/he needed to do in the game. The instruction of the QJT is given in (16).

- (16) *Zanmen jintian lai wan yige youxi. Zhege youxi limian you liangge ren. Yige shi Niuzai, yige shi Qishi. Deng yihui ne, wo jiu gei tamen fen dongxi. Dan tamen dedao de dongxi kebushi yiyang duo. Na wo wen ni shei de dongxi duo de sihou, ni neng zhigei wo kan sheide dongxi duo ma?*

‘Today we will play a game together. There are two characters in this game. One is Cowboy and the other is Rider. In a moment, I will give them something. But one will not get as much/many as the other. If I then ask you who has more, can you then point to the character who has more?’

Each participant was presented with six trials (the same manipulation as in the filler condition) to get familiar with both the experimenter and the game (i.e., the QJT). When the participant showed that s/he was able to answer the target question, the experi-

<sup>5</sup> Barner & Snedeker (2005) examined two flexible noun types: they were flexible count nouns (e.g., *strings*), and flexible mass nouns (e.g., *string*). However, since the critical question of the Mandarin version of the QJT does not involve any syntactic cues to count or mass denotations, the two flexible noun types (i.e., *strings* versus *string*) cannot be distinguished from each other in the current experiment. Thus, only one flexible condition was included.

ment started. Each visual stimulus was accompanied simultaneously by a pre-recorded target question. During the experiment the experimenter kept track of the participant's responses on a pre-designed answer sheet. It took an average of five minutes for the adult participants to finish the QJT. As for the child participants, the task lasted approximately eight minutes for the four- and five-year-olds, and about ten to eleven minutes with the younger children.

### 3.2 Corpus study

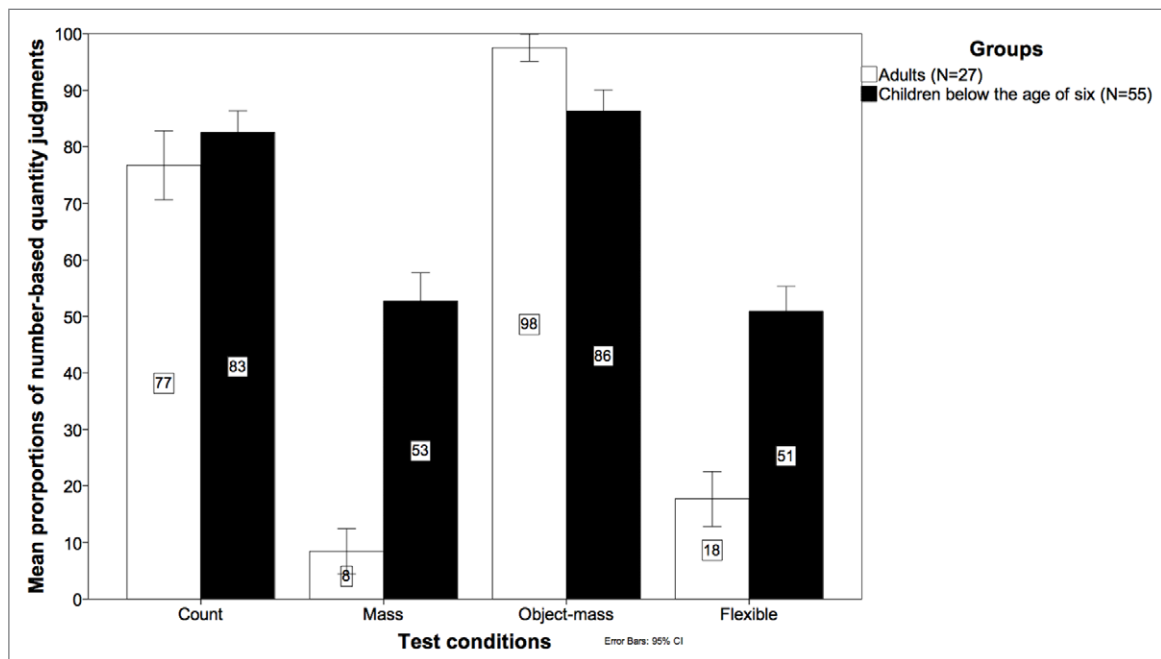
As noted in Subsection 2.2, volume-based or number-based interpretations can be influenced by convention, or, as we call it, linguistic experience. Linguistic experience refers to how often speakers hear particular linguistic elements in particular constructions. In the Mandarin mass-count case, it refers to how often Mandarin speakers hear particular nouns with count and/or mass classifiers, and how often without any classifiers. In order to investigate linguistic experience in this respect, we examined the syntactic distribution of all our test items (see Appendix II) in the Chinese Internet Corpus, containing 280 million words (tokens), compiled by Serge Sharoff from the Internet in February 2005 (CIC; <http://corpus.leeds.ac.uk/query-zh.html>; Sharoff 2006). For each test item, approximately 500 utterances containing the target were analysed, and further divided into three syntactic categories depending on the syntactic environment in which a test item was used: unclassified appearances, appearances with a count classifier, and appearances with a massifier. We assume that the CIC data represent Mandarin speaker's linguistic experience with respect to mass-count, and the language input in this respect.<sup>6</sup>

## 4 Results

### 4.1 Quantity Judgment Task

For each test condition, we calculated the mean proportion of number-based quantity judgments per participant group. In order to investigate the effect of age group (adults, two- and three-year-olds, and four- and five-year-olds) and test condition (Count, Mass, Flexible, Object-mass) on the participants' preferences in their quantity judgments, we performed a two-way ANOVA. Results of the two-way ANOVA show a significant interaction between the effects of these two factors on the participant's quantity judgment performance as well ( $F(6, 2367) = 24.090, p = .000$ ). Moreover, there is a significant effect of age group ( $F(2, 2367) = 49.978, p = .000$ ) and a significant effect of test condition ( $F(3, 2367) = 244.241, p = .000$ ) on the quantity judgment preferences of the participants. Multiple comparisons based on age groups reveal that there is no significant difference between the two child groups ( $p = .559$ ). In contrast, we attest a significant difference between the adult group on the one hand, and each of the two child groups on the other ( $p = .000$  in both cases). In other words, our data do not show any significant development by age in Mandarin speaking children below the age of six. We therefore no longer distinguish two child groups but collapse all child results. Figure 1 displays the average proportion of number-based quantity judgments by condition.

<sup>6</sup> We opted for an adult corpus instead of a corpus containing child-directed speech, for instance, the CHILDES database (MacWhinney 2009), for the following reasons. First, we needed an adequate representation of the distribution of the tested nouns in Mandarin not only for children but also for adults. Second, language input to children does not merely contain child-directed speech. Adult-to-adult speech also contributes to what counts as input. Finally, we were unable to attest sufficient occurrences of each tested noun in a pilot search in the child-directed Mandarin speech of CHILDES to determine frequency.



**Figure 1:** Mean proportions of number-based judgments in adult and child Mandarin Chinese per test condition.

The adult results show the following pattern. In all conditions but the object-mass condition, adults allow both number-based and volume-based judgments. Nevertheless, there are clear preferences for one of the two interpretations in the count, mass and flexible conditions. In the *count* (e.g., *balls*) condition the adult Mandarin speakers clearly prefer number-based quantity judgments (77%). When confronted with unclassified nouns of the ontological type *mass* (e.g., *milk*) and those of the *flexible* type (e.g., *stone(s)*), the adult participants show a preference for volume-based quantity judgments, as the average proportions of number-based judgments are merely 9% and 18%, respectively. Results of One-Sample t-tests confirm that the preference of the adult control group in none of the four test conditions is explained by chance. The proportions of number-based quantity judgments by the adults significantly differ from 0.5 in all test conditions, as shown in Table 3.

As indicated by the proportion of 98%, the object-mass condition virtually always renders a number-based interpretation for the adults. Turning to the child results, we observe two patterns. On the one hand, as early as the age of three, children already clearly prefer number-based quantity judgments in the *count* (e.g., *balls*) and *object-mass* conditions (e.g., *furniture*). The mean proportions of number-based quantity judgments in these two test conditions are both above 80%. One-sample t-tests revealed that the children performed significantly above chance (0.5) in both conditions (Table 4), which resemble the adult findings in these conditions (see Table 3).

On the other hand, similar adultlike performance is absent with the ontological types *mass* (e.g., *milk*) and *flexible* (e.g., *stone(s)*). Whereas the adult speakers of Mandarin significantly prefer volume-based quantity judgments in the *mass* and *flexible* conditions (see Table 3), the child participants do not appear to have quantificational preferences when presented with unclassified nouns in the two relevant conditions. In both of the two test conditions, the mean proportions of number-based judgments attested with the child participants hover around 50%, i.e., chance, as shown by the results of One-Sample t-tests provided in Table 4.

**Table 3:** Result summary of One-Sample t-tests with adult participants per test condition.

Condition	Test Value = 0.5					
	N	Mean	SD	t	df	Sig. (2-tailed)
Count	189	.77	.424	8.669	188	.000
Mass	189	.08	.279	-20.458	188	.000
Object-mass	162	.98	.156	38.864	161	.000
Flexible	243	.18	.382	-13.168	242	.000

**Table 4:** Result summary of One-Sample t-tests with child participants per test condition.

Condition	Test Value = 0.5					
	N	Mean	SD	t	df	Sig. (2-tailed)
Count	384	.83	.380	16.786	383	.000
Mass	385	.53	.500	1.070	384	.285
Object-mass	329	.86	.344	19.144	328	.000
Flexible	495	.51	.500	.404	494	.686

## 4.2 Corpus study

In our corpus study, we counted how often the four ontological types corresponding to the conditions of our experiment occurred with a count classifier, with a massifier, or without any classifiers, i.e., unclassified. The results are presented in Table 5.<sup>7</sup> The reader is referred to Appendix III for results at the item level.

Our CIC results demonstrate two characteristics of the syntactic distribution of Mandarin nouns. One is that unclassified nouns frequently appear in the language, as indicated by the high numbers in the row “unclassified” in Table 5. Of all the nouns coded for the different ontological types, the *count* type occurs without a classifier 76% of the time (1684 out of 2208), the *mass* type 80% of the time (2360 out of 2939), the type *object-mass* 89% of the time (2264 out of 2543), and finally, the *flexible* type 75% of the time (2422 out of 3250).

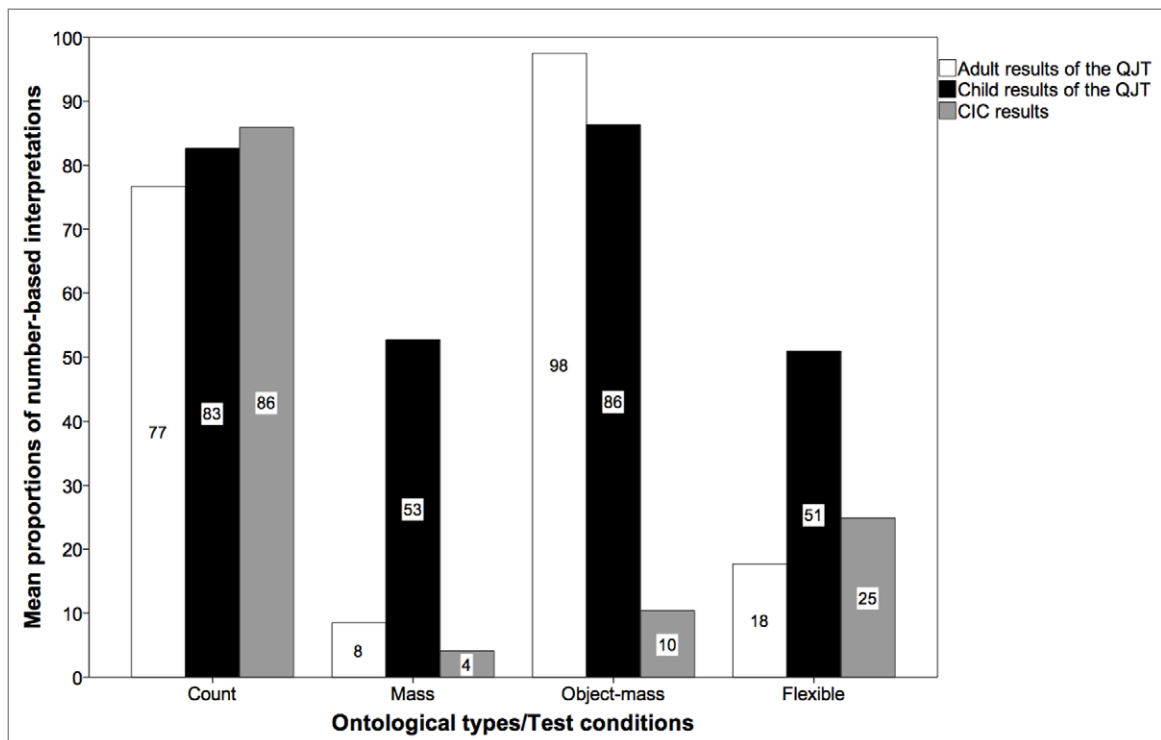
A second characteristic is that all nouns in Mandarin, in spite of their ontological basis, appear with both count and mass classifiers, although different ontological types prefer different types of classifiers. Nouns of the ontological type *count* are attested much more often with a count classifier than with a massifier (i.e., 364 out of 2208 vs. 60 out of 2208); whereas nouns belonging to the *mass* type and those of the type *object-mass* are used much more often with a massifier than with a count classifier (i.e., 555 out of 2939 vs. 24 out of 2939, and 250 out of 2543 vs. 29 out of 2543, respectively). As for the

<sup>7</sup> Idiomatic use and modification use of tested nouns (e.g., (i) and (ii), respectively) were excluded from the total frequency. Instances of tested nouns used as proper names (e.g., (iii)) were excluded as well. Repetition of the same utterance was counted once.

- (i) ye-liang-ru-shui  
night-cold-as-water  
'cool in the night'
- (ii) mianfen-dai  
flour-bag  
'flour bags'
- (iii) Jinzi-ge bu shuohua.  
gold-brother NEG talk  
'Brother Gold did not response.'

**Table 5:** Syntactic distribution of different ontological types in the CIC (absolute frequencies).

Syntactic environment	Ontological type/Test conditions			
	Count	Mass	Object-mass	Flexible
Unclassified	1684	2360	2264	2422
With a count classifier	364	24	29	206
With a massifier	60	555	250	622
<b>TOTAL</b>	2208	2939	2543	3250

**Figure 2:** Comparison of the proportions of number-based interpretations of the participants in the QJT and the syntactic count environments in the CIC.

ontological type *flexible*, they are used more often with a massifier than with a count classifier as well, although the difference between the two is smaller than for mass and object-mass type nouns: 622 with a massifier out of 3250 vs. 206 with a count classifier out of 3250. The difference between the four ontological types in their preferences for different types of classifier is statistically significant, as confirmed by the result of a chi-square test ( $X^2(3, N = 2110) = 884.323, p = .000$ ).

#### 4.3 A comparative look: The QJT results and CIC frequency data

In order to compare the interpretational patterns attested in our QJT and the CIC results that may represent the participants' linguistic experience with mass-count, we combined both the QJT results and the CIC data in Figure 2. On the x-axis, the different ontological categories are distinguished. The y-axis represents the proportions of number-based interpretations.

As for the CIC results, the proportions of number-based interpretations include all nouns with a count classifier with respect to the total number of nouns with a classifier. Unclassified nouns were not included in this calculation, because nouns appearing

without any classifiers do not contribute to speakers' linguistic experience under Pelletier's account (see Subsection 2.2).

## 5 Discussion

Our QJT results show the following generalizations (see Figure 1). When confronted with unclassified nouns of the *count* condition, both the adult and the child speakers of Mandarin Chinese assign both a number-based and a volume-based interpretation, although the adults as well as the children significantly prefer a number-based interpretation. As for unclassified nouns of the ontological categories *mass* and *flexible*, again, both the adult and the child participants assign a number-based as well as a volume-based interpretation, but the adult speakers significantly prefer a volume-based interpretation, whereas the children equally allow number-based and volume-based interpretations. Regarding the ontological type *object-mass*, the results are different. The adult speakers of Mandarin Chinese virtually only assign a number-based interpretation (98%) to nouns of this type. Although the child participants show a strong preference for a number-based interpretation (86%), they occasionally allow nouns of the *object-mass* type to have a volume-based interpretation as well.

Turning to our CIC results, they reveal that Mandarin nouns – despite their ontological basis – can appear with both count and massifiers. However, different ontological types display different frequencies in terms of co-occurrence with count or mass classifiers (see Figure 2). Whereas nouns of the ontological type *count* are attested with count classifiers more frequently than with massifiers, nouns of the *mass*, *object-mass*, and *flexible* categories all occur more often with mass than with count classifiers. Against this background, we now evaluate the predictions in (13) and (14), which we made given the three theoretical approaches.

The lexico-syntactic approach to the mass-count distinction in Mandarin Chinese (Doetjes 1997; Cheng & Sybesma 1998) predicted that unclassified nouns that are lexically specified for counting units are always interpreted as count nouns, and that unclassified nouns that are not lexically specified for counting units are always interpreted as mass nouns (13(i)). This prediction is not borne out. Our QJT results of both the adult and the child participants show that even nouns of the *count* type can receive a volume-based interpretation, and that those of the *mass* type can receive a number-based interpretation. Furthermore, the lexico-syntactic approach predicted consistency in the interpretations of unclassified nouns in both adult and child Mandarin Chinese, as all unclassified nouns should be consistently interpreted on the basis of their lexical countability (14(i)). The response patterns attested with both the adult and the child participants in our QJT fail to support this prediction as well.

Regarding the child data, one could argue that within the lexico-syntactic approach there is a developmental or learning stage in which the child is not sure of which nouns are lexically specified for counting units and which ones are not (see Bale & Barner 2012). However, this would predict random meaning assignments to all noun types during this stage. This is clearly not what the results show: while our Mandarin child participants do assign random meanings to the nouns in the classical mass condition and to the nouns in the flexible condition, they do not do so in the classical count and object-mass conditions. Thus, somehow, the children do make some distinctions between the different types of nouns. We elaborate on this later in the discussion.

We now continue discussing our results under Borer's (2005) syntax-driven approach. Recall that this approach predicted that unclassified nouns should always receive a volume-based interpretation due to the absence of a CLP (13(ii)). Our QJT results show that the adult and the child participants can assign number-based as well as volume-based



interpretations to unclassified nouns of all ontological types, except for, perhaps nouns of the *object-mass* type, and thus do not support this prediction. Furthermore, Borer's (2005) approach predicted consistency in interpreting unclassified nouns as having a volume-based interpretation in not only adult but also child Mandarin (see (14(ii))). However, such interpretational consistency is not attested. Instead, we find that both the adult and the child participants allow both number-based and volume-based interpretations in all the test conditions except for *object-mass* condition.

Finally, let us evaluate the predictions following from Pelletier's (2012) hybrid account. The first prediction was that unclassified nouns in Mandarin can have both a number-based and a volume-based interpretation (13(iii)). Our QJT results of the *count*, *mass* and *flexible* conditions confirm this prediction: both the adult and the child participants allow the unclassified nouns in these conditions to have both interpretations. Only the nouns of the *object-mass* type do not seem to follow this pattern: although the children occasionally allow a volume-based interpretation (14%), the adults virtually always opt for a number-based interpretation: 98%. We will elaborate on this result below.

The second prediction, following from a combination of Pelletier's hypothesis of lexical flexibility and our own hypothesis of linguistic experience, was that adult speakers of Mandarin may show preferences for either a number-based or a volume-based interpretation of unclassified nouns under the influence of linguistic experience, whereas child speakers, due to relatively little linguistic experience, should allow both interpretations of unclassified nouns more equally (14(iii)). This prediction is borne out when looking at the results of the *mass* and *flexible* conditions in the QJT. The adult speakers of Mandarin show a clear preference for a volume-based interpretation when presented with unclassified nouns of the types *mass* and *flexible* (92% and 82%, respectively), whereas the Mandarin-acquiring children do not show any interpretational preference but equally assign a number-based and a volume-based reading to the unclassified nouns in the target question (53% and 51%, respectively). Moreover, as can be seen in Figure 2, there is a clear convergence between the adults' preferences for a volume-based interpretation of nouns of the types *mass* and *flexible* and the CIC frequency data representing the linguistic experience. Nouns of the ontological types *mass* and *flexible* are attested with a massifier in our corpus survey 96% and 75% of the time, respectively. Thus, linguistic experience (as reflected by the CIC data) influences the interpretational preferences of the adults. In contrast, the children have less linguistic experience, and thus are less influenced by it. They therefore equally assign volume-based and number-based interpretations to unclassified nouns of the *mass* and *flexible* types, as predicted by the lexical flexibility in Pelletier's account.

The adult results in the *count* condition also confirm prediction (14(iii)). In this condition, a strong preference for a number-based interpretation is attested (77%). This interpretational preference clearly reflects the adults' linguistic experience, as witnessed by the CIC frequency data showing that nouns of the ontological type *count* appear with a count classifier 86% of the time and hence have a number-based interpretation much more often than a volume-based reading (see the grey bar above "Count" in Figure 2). At first sight, the child results in the *count* condition seem to provide counterevidence against prediction (14(iii)). Due to their little linguistic experience, we predicted that Mandarin children would show no preferences for number-based or volume-based interpretations. Yet, in the *count* condition of our QJT, the child participants do show a strong preference for a number-based interpretation, just like the adults.

We believe the key to an explanation of this unexpected child result can be found in the developmental pattern of classifiers in child language. Under the hybrid approach of Pelletier, the syntactic features of +COUNT and +MASS can only be introduced at the

entire level of CNPs in Mandarin. Since CNPs are headed by either a count classifier or a massifier, the knowledge of classifiers is crucial to analysing the syntactic environments that eventually give rise to a certain interpretation of Mandarin nouns. This means that children need to have acquired the classifier system in Mandarin before they are able to apply this knowledge to make the distinction between mass and count, i.e., to analyse the nouns in the input as having number-based or volume-based interpretations. The literature so far has shown that Mandarin Chinese children acquire different types of classifiers at different ages. Whereas typical count classifiers are acquired before the age of three (i.e., the default *ge*, and those that provide much shape and animacy information like *gen* or *tou*), massifiers seem to be acquired only after the age of six (see e.g., Huang & Chen 2009; Li et al. 2010; Wang et al. 2013; see also a summary of relevant production and comprehension results in Li & Cheung 2017). The early acquisition of count classifiers, which takes place already around age three, facilitates children's early intake of syntactic cues for a number-based interpretation in the input (i.e., linguistic experience). For nouns of the ontological types that appear much more frequently with count than volume-based classifiers, namely nouns of the type *count* (see further Figure 2), this gives rise to an early emergence of an adultlike preference for a number-based interpretation in child language, as we attested in our QJT. However, the late acquisition of massifiers, i.e., non-sensitivity to massifiers until age six, prevents children to pick up on the syntactic cues for volume-based interpretations in the input. This explains the absence of adultlike preferences for a volume-based interpretation until the age of six with the ontological types *mass* and *flexible*, which are attested much more often with a mass than a count classifier, as discussed above. Thus, the acquisition of count classifiers and massifiers in Mandarin is a determining factor in the emergence of adultlike mass-count preferences in child language development.

Let us finally consider the *object-mass* condition of the QJT. When presented with unclassified nouns of this test condition, the adult participants virtually only allow a number-based interpretation (98%) of unclassified nouns of the ontological type *object-mass*. As mentioned above, this number-based-only interpretation goes against Pelletier's (2012) first prediction that all unclassified nouns in Mandarin are lexically both count and mass (13(iii)). Moreover, the adult participants' number-based-only interpretation of unclassified nouns of the type *object-mass* does not reflect their linguistic experience at all, since this ontological type appears in syntactic environments that give rise to a number-based interpretation (namely, with a count classifier) only 10% of the time, as witnessed by the CIC data (see the grey bar above "Object-mass" in Figure 2). This divergence between the adult QJT results and the CIC frequency data of the ontological type *object-mass* fails to support prediction (14(iii)) as well. The child results on *object-mass* nouns are slightly different in that the children allow volume-based interpretations to some extent (14%). Nevertheless they show a strong preference for a number-based interpretation, something we do not see in the *mass* and *flexible* condition results. But where does this preference come from? Assuming that children are much less influenced by linguistic experience, we had predicted that our child participants would show no interpretational preferences and would equally allow a number-based and a volume-based reading of unclassified nouns of the ontological type *object-mass* (i.e., 14(iii)). Even if the child participants were influenced by linguistic experience, we would expect them to show an interpretational preference that reflects their linguistic experience, which would be a volume-based reading, since unclassified nouns of the *object-mass* type almost always occur with a massifier.

To explain the results of the *object-mass* condition, we follow an idea proposed in Bale & Barner (2009) and Barner & Snedeker (2005). Somewhat similar to Borer (2005), Barner

& Snedeker (2005) and Bale & Barner (2009) argue that “the mass-count distinction is explained by a single positive feature, +individual, with the important result that mass syntax is a default category without a unique feature to define its interpretation” (Barner & Snedeker 2005: 60). However, the crucial difference with Borer (2005) is that they propose this +individual feature to be assigned by the syntax to nouns of the *count* and *flexible count* types, whereas for nouns of the *object-mass* type such as *furniture*, the +individual feature is part of the lexical feature inventory. We borrow the latter idea from Barner & Snedeker (2005) in assuming that nouns belonging to the ontological *object-mass* type – unlike those of other ontological types – are lexically marked for individualization, realized by a +individual feature on the noun. Under this assumption, the number-based interpretation of nouns of the *object-mass* type comes from the lexical feature +individual and is not derived from the syntactic environment in which they appear. As such, their interpretation is not dependent on linguistic experience either. This explains why the adult speakers of Mandarin virtually only assign a number-based interpretation to the *object-mass* type – despite the overwhelming evidence for a volume-based interpretation of this ontological type according to their linguistic experience. As for the children, we propose that the acquisition of object-mass lexemes automatically includes the lexical +individual feature, rendering an adultlike preference for a number-based interpretation of nouns of the relevant ontological type from early on. The adult results follow from this account as well: regardless of whether and how often the object-mass noun occurs with a count classifier, a massifier or without a classifier in the linguistic experience, the lexical +individual feature ensures a number-based-only interpretation.

Compared to Cheung et al.’s (2012) QJT with Mandarin speakers from Taiwan (see Subsection 2.3), and Barner et al.’s (2009) QJT with monolinguals of Japanese, another classifier language, our results clearly show different patterns. The participants in the Mandarin QJT gave 100%, 0%, and an average of 68.75% number-based judgments when presented with the *count*, *mass*, and *flexible* types, respectively, and those in the Japanese QJT gave 94.8%, 20.9%, and 56.8% number-based judgments in the test conditions of *count*, *mass*, and *flexible*, respectively; whereas the adult participants in our QJT provided 77%,<sup>8</sup> 8%, and 18% number-based judgments in the relevant conditions. These discrepancies may be due to the various methodological differences between the studies, as discussed in Subsections 2.3 and Section 3. Moreover, since our study shows that the interpretation of unclassified nouns of the types *count*, *mass*, and *flexible* is influenced by speakers’ linguistic experience, the discrepancies between previous Mandarin and Japanese results and those obtained in the current study can also be attributed to different linguistic experiences of speakers of different languages or regions.

In fact, Inagaki & Barner (2009) report another Japanese QJT, which is methodologically similar to the current Mandarin QJT, except for the non-participation of child subjects. Results of 22 native adult speakers of Japanese show the following pattern: 92%, 2%, 48%, and 90% number-based judgments in conditions *count*, *mass*, *flexible*, and *object-mass*, respectively, which represents a different pattern than that observed with the adult speakers of Mandarin in the current study (i.e., 77%, 8%, 18%, and 98% number-based judgments in corresponding test conditions). Again we interpret these differences as a consequence of different linguistic experiences of the speakers of different languages, given the influence of linguistic experience in speakers’ interpretation of unclassified nouns as

<sup>8</sup> Although we included the nouns such *apple* and *watermelon* in our *count* condition (which Cheung et al. 2009 put in a different condition), the responses to these stimuli did not skew the average proportion of number-based responses in our *count* condition. *Apple* and *watermelon* rendered 85% and 78% number-based responses, respectively.

supported by our corpus and experiment results. In other words, no conclusions can be drawn before we have more information about how the nouns tested in Inagaki & Barner's Japanese QJT are distributed in the language with respect to their interpretations.

## 6 Conclusion

This paper tested three theoretical approaches to the mass-count distinction in Mandarin Chinese by empirically investigating the interpretation of unclassified nouns in adult and child language. Results obtained from a total of 83 native speakers of Mandarin (including 55 children; 2;11–5;09) in a Quantity Judgment Task, together with frequency data collected from the Chinese Internet Corpus (CIC; Sharoff 2006) provide the strongest psycholinguistic evidence for Pelletier's (2012) claim that Mandarin nouns are semantically both count and mass at the lexical level, and receive a number-based or a volume-based interpretation when syntactically appearing with a count or a mass classifier, respectively. In the absence of any classifiers, i.e., syntactic cues for the mass-count distinction, Mandarin nouns are ambiguous between a number-based and a volume-based interpretation, as evidenced by both our adult and child results. These results speak against a lexico-syntactic approach as proposed by Doetjes (1997) and Cheng & Sybesma (1998), predicting that unclassified nouns should consistently receive either a number-based or a volume-based reading, reflecting their semantic denotations at the lexical level. They also contradict Borer's (2005) syntax-driven approach, in which unclassified nouns are argued to always receive a volume-based reading because of the absence of a so-called "divider", realized by classifiers in Mandarin Chinese. Moreover, the adult speakers' interpretational preferences for a number-based reading of unclassified nouns belonging to the ontological type *count*, and their preferences for a volume-based interpretation of unclassified nouns of the ontological types *mass* and *flexible* were argued to reflect linguistic experience.

As for the age at which an adultlike interpretational preference emerges for a number-based or volume-based reading of nouns of different ontological types in child Mandarin, we argued that the acquisition of different classifiers is a determining factor. As count classifiers are acquired much earlier than massifiers, linguistic experience becomes relevant, and therefore influences how children prefer to interpret unclassified nouns of the *count* type at a younger age. This explanation gives rise to a prediction that once children have fully acquired the classifier system (including massifiers) between six and seven years old (see references in Section 5), linguistic experience starts to play a role. Children from this age should no longer equally allow both number-based and volume-based readings when presented with unclassified nouns of the ontological types *mass* and *flexible*, but display an adultlike preference for a volume-based interpretation. Further research may therefore focus on six- and seven-year-olds to investigate the relation between children's knowledge of different types of classifiers and their interpretational preferences of unclassified nouns in Mandarin Chinese.

Finally, nouns of the ontological *object-mass* type such as *furniture* turned out to be an exception. Adult speakers virtually only allow a number-based interpretation of *furniture*-nouns in a Quantity Judgment Task, despite the fact that they almost always use such nouns with a mass rather than a count classifier, as witnessed by the CIC data. Young children also strongly prefer a number-based reading of the *object-mass* type. Adopting Barner & Snedeker's (2005) and Bale & Barner's (2009) approach to *object-mass* nouns, we explained these results as a consequence of the lexical + individual feature of the type *object-mass*. The lexical markedness for individualization gives rise to a number-based interpretation of nouns of the *object-mass* type in both adults and children, regardless of the syntactic environments in which they appear, and thus regardless of linguistic experience.

## Additional Files

The additional files for this article can be found as follows:

- **Appendix I.** Example test and filler items. DOI: <https://doi.org/10.5334/gjgl.406.s1>
- **Appendix II.** Experimental items per test or filler condition. DOI: <https://doi.org/10.5334/gjgl.406.s1>
- **Appendix III.** Syntactic distribution of tested nouns in the Chinese Internet Corpus (Sharoff 2006). DOI: <https://doi.org/10.5334/gjgl.406.s1>

## Abbreviations

ACC = accusative, CL = classifier, DE = *de*, GEN = genitive, NOM = nominative, PAR = particle, PERF = perfective marker

## Competing Interests

The authors have no competing interests to declare.

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