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Grammatical and contextual factors affecting the interpretation of superordinate collectives in child and adult Mandarin

Abstract: The semantics of superordinate collectives (superordinates hereafter) such as English *furniture* are argued to be count or mass, or to allow both count and mass readings. When tested experimentally, however, it has repeatedly been reported that superordinates denote individuals in a wide range of typologically distinct languages, including Mandarin. A close examination of the experimental method and design commonly used in previous research suggests, however, that the attested individual-denoting reading might only be the preferred reading in neutral contexts rather than the only reading that superordinates allow. In the present study, using a Truth Value Judgment Task we investigate the interpretation of Mandarin superordinates by Mandarin-speaking adults and 4–6-year-old children. We found that bare superordinates can convey both individual-denoting and non-individual-denoting readings depending on specific contexts provided, but such contextual manipulation cannot override morphosyntax (the presence of an individual classifier that selects an individual-denoting reading only). Taken together, our experimental data indicate that both contextual and morphosyntactic information play an important role in the interpretation of Mandarin superordinates, but that they function in different ways. In a word, the present study contributes new data and opens new perspectives for further investigation in the interpretation of superordinates in Mandarin as well as in other languages.

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1 Introduction

The study of superordinate collectives has been the subject of much debate in the literature.[1] For ease of composition, we simply use the term 'superordinates' to refer to this specific type of nouns hereafter. This term is used in two different ways. In a broad sense, superordinates are defined as "higher-level categories in natural kind and artifact taxonomies containing perceptually diverse members" (Wisniewski et al. 1996: 270). To illustrate, the superordinate *furniture* in English can denote a range of distinct lower-level entities that are used to furnish our homes, including chairs, beds, tables and wardrobes, etc. These categories at a lower level constitute the subtypes of the superordinate and inherit its properties, e.g., the function of furnishing home (Grimm and Levin 2012). Other examples of superordinates include words like *vegetable*, *fruit*, *animal*, *vehicle*, *clothing*, *jewelry*, *hardware*, *silverware*, etc. (Wisniewski et al. 1996: 273). In number marking languages such as English, superordinates are subdivided into mass superordinates (e.g., *furniture*) and count superordinates (e.g., *animals*); while in classifier languages such as Mandarin Chinese (Mandarin hereafter), such a count-mass distinction is irrelevant as there are no distinct markers for count and mass nouns.

More recently in the literature in number-marking languages, the focus has been predominantly on mass superordinates, e.g., *furniture* in English. Apparently, mass superordinates involve a syntax-semantics mismatch. Syntactically, these superordinates are encoded as mass and as such, they cannot be pluralized and directly modified by numerals (e.g., **three furnitures*). Semantically, however, it has been argued that mass superordinates can be count nouns (denoting individuals), or mass nouns (denoting non-individuals), or allow both count and mass readings (see Section 2). To clarify, we assume that individuals are entities that "possess built-in modes, however arbitrary, of dividing their reference" (Quine 1960: 91) and they provide a natural unit of measurement and are quantified via cardinality (e.g., Bale and Barner 2009). In other words, individuals can be characterized as 'atoms' in the sense of join semi-lattices (cf. Link 1983). By contrast, non-individuals are defined as lacking the defining properties of individuals (Bloom 1990); thus, non-individuals do not provide a natural unit of measurement, and, as a result, they quantify over continuous and non-numerical dimensions of measurement (e.g., mass and volume).

Mass superordinates have been named in the literature with various terms, e.g., 'count mass' (Doetjes 1997), 'object mass' (Bale and Barner 2009; Barner and

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1 'Collectives' is sometimes also used in the literature for nouns that are excluded in the present study, namely group nouns like *family* and *committee*, whose references are sets of particular kinds of objects. These nouns do not necessarily contain subtypes of categories (cf. Wiese 2012: 55).

Snedeker 2005, 2006), 'fake mass' (Chierchia 2010), 'atomic mass' (Rothstein 2010), and 'functional aggregate' (Grimm and Levin 2012). They have been mainly studied in number marking languages because, as clearly stated by Chierchia (2010: 111), superordinates may not even exist in classifier languages such as Mandarin, given that these languages do not mark the count-mass status of nouns.

In our view, however, it is important to also investigate superordinates in classifier languages, using the abovementioned broad definition of superordinates provided by Wisniewski et al. (1996). This touches upon a general issue of noun semantics from a crosslinguistic perspective (e.g., Barner et al. 2009; Cheng et al. 2008; Cheng and Sybesma 1998, 1999; Cheung et al. 2010; Inagaki and Barner 2009). In particular, Inagaki and Barner (2009) have investigated the interpretation of superordinates in a classifier language such as Japanese (e.g., *kagu* 'furniture', *hoosekirui* 'jewelry', *yuubinbutu* 'mail', *irui* 'clothing') and concluded, based on their experimental results, that when it comes to the interpretation of superordinates, classifier languages do not differ from number marking languages. According to the authors, superordinates are lexically specified as denoting individuals and the count-mass syntax does not affect the interpretation of superordinates (see also Bale and Barner 2012; Wiese 2012 for a crosslinguistic discussion on superordinates).

In the present study, we would like to extend this line of research to yet another classifier language, namely, Mandarin, in an attempt to revisit this issue. Like Japanese, Mandarin is a classifier language in which superordinates can be used in a 'bare' nominal form, i.e., with no grammatical marker for their count/mass status. We will explore all the possible factors that may affect the interpretation of bare superordinates in Mandarin in order to reach a deeper understanding of this phenomenon.

In the psycholinguistic field, the study of Barner and Snedeker (2005) contributed a new method, which we dub the *question-answering Quantity Judgment Task* (QJT) (e.g., 'who has more silverware?'), and found that English-speaking adults and children quantify mass superordinates such as *silverware* by cardinality, leading to the conclusion that mass superordinates in English denote individuals. The results of this research have been taken as evidence that mass superordinates in English have count semantics, despite their mass syntax (e.g., Bale and Barner 2009; see also Inagaki and Barner 2009; Yin and O'Brien 2018 for similar findings). Since then, the same experimental methodology and design used in Barner and Snedeker (2005) have been employed to investigate superordinates in Mandarin (Lin and Schaeffer 2018; Liu 2014) and many other typologically distinct languages (Hacohen 2008; Inagaki and Barner 2009; Lima 2018; MacDonald and Carroll 2018; Van Witteloostuijn and Schaeffer 2018). These studies all found that mass (or bare) superordinates predominantly denote

individuals, just as in Barner and Snedeker (2005). The general assumption is that the + *individual* feature is encoded as the only inherent lexical property, for both mass superordinates in number marking languages and bare superordinates in classifier languages (Bale and Barner 2009; Barner and Snedeker 2005; Inagaki and Barner 2009; Lin and Schaeffer 2018; MacDonald and Carroll 2018; Van Witteloostuijn and Schaeffer 2018).

Upon closer examination of the experimental method and design used in previous research, we speculate that the widely attested individual-denoting interpretation may simply be considered as a preferred reading in neutral contexts, and not the only reading that mass/bare superordinates can have (see Section 3).

In addition to contextual information, we explore other possible factors that affect the interpretation of superordinates. To do so, we investigate the interpretation of Mandarin superordinates by Mandarin-speaking children and adults. In three experiments, we adopted a method which is the combination of two different tasks, namely the Truth Value Judgment Task (Crain and Thornton 1998) and the Quantity Judgment Task (Barner and Snedeker 2005). Crucially, we consider morphosyntax (i.e., presence/absence of a classifier) and contextual information (i.e., substance-oriented contexts versus individual-oriented contexts) in our experimental design. With this new experimental design, we found that in both Mandarin-speaking children and adults, bare superordinates can be assigned multiple readings depending on the context: they are assigned individual-denoting readings in individual-oriented contexts, and substance-denoting readings in substance-oriented contexts. By contrast, when superordinates are preceded by an individual classifier, only individual-denoting readings are available independently of the contexts used. Our results thus show that both morphosyntactic and contextual information are relevant when it comes to the interpretation of Mandarin superordinates. Our study contributes new data and uncovers a complex picture of the interpretation of Mandarin superordinates. From a crosslinguistic perspective, it would be worth applying our experimental design to the study of superordinates in English and Japanese and other languages, which in turn may shed new light on the theoretical study of this controversial topic.

The remaining parts of the paper are arranged as follows. Sections 2 and 3 introduce the theoretical and empirical studies of superordinates from a crosslinguistic perspective. Section 4 reviews previous research on superordinates in Mandarin. Sections 5 and 6 provide our alternative account and report the three experiments on the interpretation of Mandarin superordinates by Mandarin-speaking children and adults. Section 7 discusses the experimental findings and Section 8 concludes the paper.

2 Superordinates: a crosslinguistic perspective

In this section, we would like to further underline the importance of studying superordinates from a crosslinguistic perspective. On the syntactic side, superordinates in number marking languages such as English are marked either count or mass. In classifier languages such as Japanese and Mandarin, however, superordinates can be used in bare forms, i.e., with no grammatical marking for their count-mass status. On the semantic side, for both number-marking languages and classifier languages, the interpretation of superordinates is highly controversial. We believe that the study of superordinates from a crosslinguistic perspective can shed light on how syntax and semantics interplay to affect the interpretation of superordinates in general.

Taking into account the complexity involved in the issue of superordinates, the present study investigates superordinates and their interpretation in Mandarin, as compared to the interpretation of superordinates in English, which is a typical language with number marking. Indeed, in the literature, the study of Mandarin superordinates has been greatly influenced by the study of English superordinates, as will be detailed later. This said, we first introduce both the theoretical accounts and empirical studies of English superordinates (see Sections 3 and 4) before we present the accounts of Mandarin superordinates (see Sections 4 and 5).

For the interpretation of superordinates in English, with a particular focus on mass superordinates, there are three distinct accounts in the literature. The first account holds that mass superordinates denote a group of individuals (e.g., Bale and Barner 2009; Barner and Snedeker 2005, 2006; Chierchia 1998a, 2010; Inagaki and Barner 2009; Landman 2011; Wiese 2012). Individuality is assumed to be part of their inherent lexical properties. This *superordinates-as-individuals* view is explicitly spelled out in Chierchia (1998a: 68), in which mass superordinates like *furniture* are taken as atomic discrete physical objects, equivalent to the denotation of count nouns like *table*.[2] A similar claim is made in Bale and Barner (2009), in which *more furniture* and *more equipment* are treated as having the same denotational meanings as *more pieces of furniture* and *more pieces of equipment* respectively (see [1] and [2]), and *more footwear* is taken as having the same interpretation as *more shoes and boots* (see [3]).

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2 In another study, Chierchia (1998b) discusses *furniture* in English. In this study, he uses *furniture* to illustrate the denotational properties of mass nouns. According to him, *furniture* is true "in an undifferentiated manner of singular pieces of furniture, as well as of pluralities thereof" (p. 347). That is, Chierchia treats mass nouns on a par with plurals in his theory of count-mass. Moreover, in this article Chierchia argues that nouns in Mandarin are mass.

(1)　　*Esme has more furniture than Seymour.*
　　　　'Esme has more pieces of furniture than Seymour.'

(2)　　*Esme has more equipment than Seymour.*
　　　　'Esme has more pieces of equipment than Seymour.'

(3)　　*Esme has more footwear than Seymour.*
　　　　'Esme has more shoes and boots than Seymour.'
　　　　(Bale and Barner 2009: 228–229)

This account is supported by an influential empirical study offered by Barner and Snedeker (2005). An important finding of this study is that English-speaking adults and children quantify mass superordinates such as *silverware* by cardinality, which ultimately suggests that mass superordinates in English denote individuals. Note that these superordinates are called *object-mass nouns*, as distinguished from substance-mass nouns (e.g., *sand* or *oil*). Thus, this approach claims that mass superordinates are semantically count nouns, even though they exhibit the morphosyntactic distribution of mass nouns. We will examine this study in more detail in Section 3, where we suggest that the experimental data may not exhibit the complete picture of English-speaking children's and adults' interpretation of mass superordinates.

　　The second account holds that the syntactic status of mass superordinates determines their semantic interpretation: they denote groups of non-distinct, uncountable, and 'non-individual' things (Bloom 1990; Middleton et al. 2004; Wisniewski et al. 1996, 2003). This view of superordinates as non-individuals is based on a cognitive individuation hypothesis: count nouns refer to entities that speakers conceptualize as kinds of individuals, whereas mass nouns refer to entities that they conceptualize as non-individuals (Bloom 1990: 134–135). Under this hypothesis, a cognitive process called *construal* is assumed to serve as an intermediate level between the mappings from entities in the real world to the use of count-mass terms. At this intermediate level, an entity could be construed as an individual or as a non-individual, depending on specific communicative purposes. The studies of Bloom and Wisniewski et al. cited above, refer to data from property inference tasks, in which English-speaking adults interact with entities that are associated with count and mass superordinates, or judge or rate the perceptual similarity of the entities. For instance, in Bloom (1990), participants were asked to rate the perceptual similarity of the category members associated with count and mass superordinates. To illustrate, for the category *sporting equipment*, if participants think the members of this category look alike, they will rate the category as

"very similar"; if instead they think the members look different from each other, they will rate the category as "very different".

The third account claims that mass superordinates allow both individual-denoting and non-individual-denoting readings. This account has been originally proposed by McCawley (1975: 318), who states that "*furniture* will have to be taken to be unspecified as to any individuation". More recently, Rothstein (2017) contends that individual-denoting readings of mass superordinates may be more salient and thus more easily accessed in neutral contexts, but non-individual-denoting readings are nevertheless also available in appropriate contexts (see also Rothstein and Pires de Oliveira 2020). Rothstein uses sentence (4) to illustrate the existence of non-individual-denoting readings of *furniture* in a context in which John and Bill are moving into a new place with trucks (which provides a clear indication that volume of furniture matters): John needs to move 4 big pieces of furniture (including a grand piano, a large sofa, a double bed and a heavy wardrobe), while Bill needs to move 6 small pieces of furniture (including four folding chairs, a small table, and a rolled-up mattress). In this context, sentence (4) is judged by her informants to be a true description of the scenario. On this interpretation, the quantity judgment is based on volume, as the volume of John's furniture is indeed larger than that of Bill's furniture. This volume-denoting reading is a non-individual-denoting reading. By contrast, sentence (5), which contains the phrase '*more pieces of furniture*', is judged to be false in this context, as this sentence contains only the individual-denoting reading.

(4)   *John has more furniture than Bill, so he should use the larger moving truck.*

(5)   *John has more pieces of furniture than Bill.*
       (Rothstein 2017: 122)

The interpretation of *furniture* as described by Rothstein in (4) and (5) has yet to be confirmed with more robust empirical data (see Section 7); however, some supporting evidence for this account can be found in Grimm and Levin (2012). In this study, both individual-denoting and non-individual-denoting readings are attested in the interpretation of mass superordinates such as *furniture*, *jewelry*, *change*, *luggage*, *mail*, and *ammunition*. Importantly, this study shows that the design of function-oriented contexts, e.g., furnishing a space for the use of *furniture*, boosts the availability of non-individual-denoting readings. We will introduce this study in more detail in Section 3 below, where we see how psycholinguists address the theoretical controversy on superordinates.

3 Previous empirical studies on superordinates[3]

A very influential paper that had a great theoretical and empirical impact on studies of superordinates is the one by Barner and Snedeker (2005). This study reported the results of three experiments to investigate 4-year-old English-speaking children's and adults' interpretation of mass superordinates such as *silverware*, as compared to their interpretation of count object nouns (e.g., *shoes*) and substance nouns (e.g., *toothpaste*).[4] A question-answering Quantity Judgment Task (QJT) was used to compare the number of entities owned by two characters. To illustrate, in a typical trial testing the mass superordinate *silverware*, two characters own different objects: Character 1 has a big fork and a big knife, while Character 2 has three small forks and three small knives; the volume of forks and knives owned by Character 1 is, however, greater than that of Character 2. Similarly, to test count object nouns such as *shoe*, the scenario is such that Character 1 has a large shoe, while Character 2 has three tiny shoes, and to test substance mass nouns such as *toothpaste*, Character 1 has a big pile of toothpaste, whereas Character 2 has three small piles of toothpaste. In each case, the participants were asked to answer a question such as 'who has more___?'

It was found that both adults and children quantified mass superordinates via cardinality (adults: 97.9% of the time; children: 91.7% of the time). To illustrate, in a typical trial Character 2 (who had six small forks and knives) was judged to have *more silverware* than Character 1 (who had a big fork and a big knife). Similarly, the quantity judgment was based on cardinality in the interpretation of the count object nouns (adults: 93.8% of the time; children: 97.9% of the time). By contrast, in the substance noun condition, the quantity judgment was generally not based on cardinality (adults: 0% of the time; children: 39.6% of the time). Rather, the quantity judgment in the substance noun condition was made based on the volume of substance. That is, Character 1 (who had a big pile of toothpaste) was judged to have *more toothpaste* than Character 2 (who had three small piles of toothpaste). In a word, the participants interpreted mass superordinates in the same way as they interpreted count object nouns but significantly differed from their quantity judgment in the substance noun condition. These experimental data

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3 There are some studies on the early production of English mass superordinates such as *furniture* in an experimental setting (Gordon 1985: Experiment 3) or in spontaneous speech (Bloom 1990: Chapter 6). We cannot exactly tell from these early production studies how English-speaking children interpret mass superordinates. We would not review these studies here, due to space limitations.

4 Barner and Snedeker (2005) use the term of 'mass-object nouns' in their study. For the ease of exposition, we keep the use of 'mass superordinate' here.

are widely taken as important evidence for the argument that mass superordinates in English have count semantics, despite their mass syntax (e.g., Bale and Barner 2009; see also Inagaki and Barner 2009; Yin and O'Brien 2018 for similar findings).

The same conclusions, that mass or bare superordinates predominantly denote individuals, were also drawn by a number of subsequent studies; these studies extend the study of superordinates to a wide range of typologically distinct languages (i.e., with or without the grammatical count-mass distinction), including Mandarin (Lin and Schaeffer 2018; Liu 2014), Japanese (Inagaki and Barner 2009), Dutch (Van Witteloostuijn and Schaeffer 2018), Yudja, a Brazilian indigenous language (Lima 2018), Korean (MacDonald and Carroll 2018), and Hebrew (Hacohen 2008), and they get similar results as reported in Barner and Snedeker (2005). Interestingly, all these studies adopted the same methodology and experimental design, the question-answering QJT originally used in Barner and Snedeker's (2005) paper.

As shown above, the question-answering QJT is designed to tease apart count and mass uses of nominal expressions by making a distinction between two modes of quantification: cardinal quantity versus non-cardinal (volume) quantity. These two distinct modes of quantification reflect important semantic interpretations associated with the count-mass distinction, an idea that dates back to Jespersen (1924) (cf. Bale and Barner 2009, 2018; Gathercole 1985). The question-answering QJT is also sensitive to an alternation between mass and count syntax, as shown by studies on the countability of flexible nouns (i.e., nouns that can easily shift between count and mass uses) (Bale and Barner 2018; Barner and Snedeker 2005, 2006). These are the unique features of this experimental method (Bale and Barner 2018), as compared to other alternative methods previously used in the literature (e.g., Bloom 1990; Gordon 1982, 1985).

Getting back to the general findings that mass or bare superordinates denote individuals, we contend that this reading might just constitute a preferred reading in neutral contexts and not the only reading these nouns may have. Our reasoning is based on two observations about the use of the question-answering QJT in the previous studies. First, the question-answering QJT requires participants to choose one character over the other when they are presented with the question "who has more ___?". In such an experimental procedure involving a forced choice between two candidates, the result can be taken to indicate a strong preference for one interpretation, and therefore does not necessarily rule out the possibility that participants also have a less favored interpretation of superordinates, namely the non-individual-denoting interpretation. In other words, the less favored reading may also be part of their grammar but does not have a chance to emerge (Cf. This is analogous to the potential preference problem involved in the Act-out Task and

other forced-choice tasks in general, as discussed in Crain and Thornton 1998: 218–219). This potential problem of the question-answering QJT becomes especially obvious in situations that are not salient for the triggering of the less favored interpretation. This brings us to the second concern about the experimental task and design.

The kind of context used in the abovementioned studies is not salient for the triggering of non-individual-denoting readings. In those experiments, individual entities are provided: while one character has more items in general (cardinality), the other character has more substance (but fewer individual items). Even though the information about volume is available to the participants, as it is the one relative to the cardinality, the experimental setting does not indicate any specific purpose for the quantity judgment. In this kind of neutral context, the dimension of measurement is unspecified. Under this circumstance, we speculate that participants may tend to base their quantity judgments on cardinality for reasons that we clarify below.

In quantity judgments, the cardinality of individual entities coincides with their discrete natural boundary (i.e., shape) (cf. Beviláqua et al. 2016; Lima and Gomes 2016). When one measures the volume of individuals, however, one has to compute the overall substance of the individual entities, which extends over their natural boundaries and thus requires more processing load. Relevant evidence comes from studies that show that the shape-bias is active in the interpretation of nominal expressions by young children and adults (Landau et al. 1988). To facilitate participants to override their shape bias and trigger non-individual-denoting readings, we need to provide salient contexts that highlight non-cardinal dimensions of measurement, such as the volume or substance of entities, and thus alleviate the processing costs of accessing that reading (cf. Rothstein 2017). However, such salient contexts were not provided in the experimental settings in the previous studies mentioned above, and this lack might have led the participants to prefer the individual-denoting readings, simply because it was more accessible.

We can support our speculation above with the findings from two empirical studies: Grimm and Levin (2012) and Beviláqua and Pires de Oliveira (2014). Both studies highlight the importance of contextual information for the interpretation of superordinates. In particular, Grimm and Levin (2012) investigate the interpretation of six English mass superordinates by English-speaking adults, including *furniture*, *jewelry*, *change*, *luggage*, *mail*, and *ammunition*. When salient contexts were provided, a much higher proportion of non-individual-denoting readings was found, as compared to when neutral contexts were used. To illustrate, in a neutral context Dealer A and Dealer B bought furniture at an antique auction. Dealer A bought a sofa, an easy chair, a coffee table, and a small bookcase, and Dealer B bought one table and four chairs. Against this context, the participants were asked

'which dealer bought more furniture at the auction?' The data indicated that they considered Dealer B having more furniture 75% of the time, a quantity-judgment response made via cardinality. This reveals the preference for the individual-denoting reading, as in Barner and Snedeker (2005). By contrast, in a function-oriented context highlighting the function of furniture, e.g., furnishing a room, the opposite result was found. To illustrate, in a situation in which somebody was visiting two friends, Friend A had a sofa, an easy chair, a coffee table, and a small bookcase in his room, while friend B had a table and four chairs in his room. In this function-oriented context, the participants were asked 'whose room has more furniture?' The results indicate that for English-speaking adults, Friend A's room had more furniture 65% of the time; this quantity judgment was made via the dimension of 'fulfillment of function', as Friend A's room had more kinds of furniture and thus satisfied better the purpose of furnishing the room. This is a significant increase, as compared to the percentage of the non-individual-denoting reading (only 25% of the time) obtained in the neutral contexts.

Similarly, Beviláqua and Pires de Oliveira (2014) showed the importance of contextual information. In one test condition, they tested native adults' interpretation of what they call 'fake mass nouns', in Brazilian Portuguese. This study provided a context that favored the volume-denoting reading (which is a non-individual-denoting reading). In one scenario one character had two or three larger objects, while the other had three or four small objects of the same kind. The question sentence was presented as asking which character had more X to fill a basket. With this design, volume is explicitly specified as the dimension of measurement, and thus provides a context that favors the volume-denoting reading. The results show that the participants assigned the volume-denoting reading around 50% of the time in their interpretation of 'fake mass nouns' in Brazilian Portuguese.[5]

To summarize, we can claim that while superordinates tend to denote individual-denoting readings, non-individual-denoting readings can be triggered in appropriate contexts. However, based on previous research, we think three issues need to be addressed to further investigate the interpretation of superordinates. First, we should seek to implement a new experimental technique to avoid the preference problem of the question-answering QJT, thus giving the participants the possibility to access all the readings they have. We can draw conclusions about which interpretations a sentence allows, only if all the possible readings are accessible. Second, morphosyntax is an important factor in specifying countability and in guiding children's acquisition of the countability of nominal expressions

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5 The authors do not specify exactly the percentage in the texts, and we roughly estimated this percentage from what we read from their Figure 7 on page 271.

(e.g., Bale and Barner 2009; Barner and Snedeker 2005, 2006; Gathercole 1985; Gordon 1982, 1985), but it has not been empirically addressed in the interpretation of superordinates. A distinct typological feature of Mandarin allows us to do this. Differing from English, a language in which superordinates are grammatically specified as count or mass, Mandarin allows the use of bare superordinates (i.e., superordinates that are not grammatically encoded as count or mass). Taking advantage of this typological feature of Mandarin, we can examine the effects of morphosyntax on the interpretation of Mandarin superordinates, by comparing the interpretation of bare superordinates with that of superordinates co-occurring with an individual classifier (which functions similarly to plural morphology in English [Borer 2005]). This highlights the importance of studying Mandarin superordinates from a crosslinguistic perspective. Third, although context information has been proved to play an important role in the interpretation of superordinates (Beviláqua and Pires de Oliveira 2014; Grimm and Levin 2012), so far there is no study investigating how both contextual and morphosyntactic factors interact and affect the interpretation of superordinates.

In the present study, we attempt to address the three issues raised above. We implement a new experimental technique and investigate how contextual information and morphosyntax determine the interpretation of superordinates in Mandarin. Before reporting our experiments, let us review the relevant literature on Mandarin superordinates.

4 Superordinates in Mandarin

As previously mentioned, Mandarin superordinates can appear as bare nouns, without marking their count-mass status with a grammatical marker. They can also appear with count or mass classifiers. Based on the corpus data (Chinese Internet Corpus [CIC, Sharoff 2006]) reported in Lin and Schaeffer (2018), among the 2,543 tokens of superordinates found in the corpus, the ratio of the frequency of using superordinates with 'bare nouns', 'with a mass classifier' and 'with a count classifier' are 2,264: 250: 29. Thus, Mandarin superordinates are mostly used in bare forms; furthermore, Mandarin superordinates are used much more often with mass classifiers than count classifiers.

The interpretation of Mandarin superordinates is understudied, as compared with the abundant literature on English superordinates. As far as we know, there are only two empirical studies on this topic: Liu (2014) and Lin and Schaeffer (2018).

Consider Lin and Schaeffer (2018) first. Using the question-answering QJT (Barner and Snedeker 2005), this study tested 27 Mandarin-speaking adults and 55

2-to-5 Mandarin-speaking children with four types of bare nouns, including count nouns (e.g., *qiu* 'ball'), mass nouns (e.g., *mianfen* 'flour'), flexible nouns (e.g., *shengzi* 'string') and object-mass nouns (or superordinates in our terminology).[6] The test items of superordinates include *jiaju* 'furniture', *wenju* 'stationery', *gongju* 'apparatus', *shoushi* 'jewelry', *canju* 'tableware' and *yifu* 'clothes'. Subjects were shown two characters who had the same kind of entities but that were different in number and size: for instance, in the testing of *yifu* 'clothes', one character had two big pieces of clothes, while the other had five smaller pieces of clothes. After hearing the pre-recorded question *shei de X duo*? 'who has more X?', participants had to point to one of the characters, indicating their answer. As shown, the experimental setting is neutral, without indicating any specific purpose for the quantity judgment (see Section 3). We summarize their experimental results in Table 1 below.

Table 1: Mean percentage of number-based judgments in adult and child Mandarin (Lin and Schaeffer 2018).

Age groups	Count nouns	Mass nouns	Superordinates	Flexible nouns
Adults	77%	8%	98%	18%
Children	83%	53%	86%	51%

Lin and Schaeffer (2018: 16) describe the data in the following way. In the count noun condition, both adults and children assign a number-based and a volume-based interpretation, although they significantly prefer the number-based interpretation (adults: 77%; children: 83%). In the mass noun and flexible noun conditions, the adults significantly prefer the volume-based interpretation (mass nouns: 92%; flexible nouns: 82%), whereas children equally allow number-based and volume-based interpretations, around 50%. In the superordinate condition, the adults virtually only exhibit the number-based interpretation (98%); the

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6 Lin and Schaeffer (2018) do not provide an explicit definition for their use of *count nouns*, *mass nouns*, *flexible nouns* and *object-mass nouns*. They simply state that they borrow these terms from Barner and Snedeker (2005), and these four categories represent four "ontological noun types". As far as we can understand, Barner and Snedeker (2005) define these four terms based on the count/mass syntax of nouns in English: count nouns like *shoe* are usually marked with count syntax, mass nouns like *toothpaste* are marked with mass syntax, flexible nouns like *stone* can be used either as a count noun or a mass noun; object-mass nouns like *furniture* has mass syntax but count semantics (i.e., denoting individual objects). Without considering that Mandarin does not have grammatical categories to mark count or mass status of nouns, Lin and Schaeffer simply categorize these four Mandarin noun types according to the count/mass status of their English counterparts.

children show a strong preference for the number-based interpretation (86%), but they occasionally allow the volume-based interpretation (14%).

Lin and Schaeffer explain the participants' responses based on a survey of Chinese Internet Corpus (CIC, Sharoff 2006), which is taken as an indicator of linguistic experience, i.e., "speakers' experience with nouns appearing in different types of syntactic structure in the input" (Sharoff 2006: 9). The assumption is that the more often a noun appears with a count classifier or a mass classifier, the stronger a speaker's preference is for a number-based or a volume-based interpretation of the noun, respectively.

In particular, in the corpus data count nouns are used much more often with a count classifier than with a mass classifier (i.e., out of 2,208, 364 with a count classifier vs. 60 with a mass classifier). This observation is used to account for the preference of the number-based interpretation in the count noun condition in both the adult and child groups. On the other hand, mass nouns and flexible nouns in the corpus are used more often with a mass classifier than with a count classifier ('mass nouns': out of 2,939, 555 with a mass classifier vs. 24 with a count classifier; 'flexible nouns': out of 3,250, 622 with a mass classifier vs. 206 with a count classifier). The corpus data are used to explain the adults' preference for the volume-based interpretation in the mass noun and flexible noun conditions. As for the child data, Lin and Schaeffer assume that children are less influenced by linguistic experience, therefore assign both volume-based and number-based interpretations to mass nouns and flexible nouns. When it comes to the use of superordinates, the corpus data diverge from the experimental data. In the corpus, superordinates are used more often with a mass classifier than with a count classifier (out of 2,543, 250 with a mass classifier vs. 29 with a count classifier). In the experiment, however, both adults and children predominantly assigned the number-based interpretation to bare superordinates, as shown above. This is unexpected if participants' interpretation of nouns is taken as an indicator of their linguistic experience.

Following the approach of Barner and Snedeker (2005) and Bale and Barner (2009), Lin and Schaeffer conclude that "… Mandarin nouns are ambiguous between a number-based and a volume-based interpretation", and the preferences of either of these readings are attributed to linguistic experience as represented by the CIC corpus. However, Lin and Schaeffer contend that, unlike the other noun types (i.e., count nouns, mass nouns, and flexible nouns), superordinates "turned out to be an exception", and they "are marked for individuation in the lexicon" and denote individuals, regardless of linguistic experience (pp. 19–20).

We agree with Lin and Schaeffer that Mandarin nouns are ambiguous between number-based (individual-denoting) and volume-based (non-individual-denoting) interpretations. We also agree that children's interpretation of nouns may be affected by their linguistic experience of being exposed to the use of Mandarin classifiers (cf. Cheung et al. 2009; Li et al. 2008, 2010). However, it remains unclear why linguistic experience does not affect the interpretation of superordinates, but it

does affect the interpretation of the other three types of nouns (i.e., count nouns, mass nouns, and flexible nouns). In our view, it is premature to claim that superordinates are "an exception" before a more careful investigation is conducted to examine the interpretation of this type of nouns. Crucially, since Lin and Schaeffer tested Mandarin bare superordinates in neutral contexts using question-answering QJT, we suspect that the attested individual-denoting readings may only indicate the participants' preferred reading of Mandarin superordinates (cf. Section 3).

The same comments can be extended to Liu (2014), which tested 254 adult Chinese speakers in Taiwan and examined their interpretation of two bare superordinates *jiaju* 'furniture' and *shuiguo* 'fruit'. Adopting the question-answering QJT in a neutral context (Barner and Snedeker 2005), Liu found that *jiaju* and *shuiguo* are assigned the number-based interpretation 78.35% of the time (199/254 items) and 58.27% of the time (148/254 items), respectively. We can see that a certain degree of non-individual-denoting readings is actually identified in this study: 22% in the case of *jiaju* 'furniture', and 42% in the case of *shuiguo* 'fruit'. So Mandarin-speaking adults do quantify Mandarin superordinates by volume, as well as by cardinality, and *jiaju* is not necessarily categorized as a count noun. It is only a matter of preference.

To sum up, both Liu (2014) and Lin and Schaeffer (2018) used the question-answering QJT and tested the interpretation of bare Mandarin superordinates in neutral contexts; both report that the individual-denoting readings are favored in the interpretation of bare superordinates, but a certain degree of non-individual-denoting readings is attested in adults (as reported in Liu 2014) and children (as reported in Lin and Schaeffer 2018). Moreover, neither of these two studies examined the interpretation of Mandarin superordinates co-occurring with classifiers, even though the role played by classifiers is extensively discussed in Lin and Schaeffer (2018). Therefore, we should examine the interpretation of superordinates more carefully before claiming that this type of noun is semantically count and allows only individual-denoting readings. This is exactly what we attempt to do in our study. Before reporting our experiments, we turn to our alternative account on Mandarin superordinates.

5 Our account on Mandarin superordinates

Our account follows from the grammatical account proposed in the literature for the interpretation of Mandarin nouns in general (e.g., Borer 2005; Huang 2009; Huang and Lee 2009; Li 2013; Pelletier 2012). These proposals differ in various ways, but they share two main assumptions. First, the count-mass distinction is grammatically constructed (cf. Sharvy 1978). In the absence of a grammatical category marking countability, bare nouns are underspecified in countability, in

the sense that they are ambiguous with individual-denoting and non-individual-denoting readings. Furthermore, Mandarin classifiers function like English plural morphology in their encoding of countability (Borer 2005; Pelletier 2012).

In particular, we assume that, like other noun types, a bare Mandarin superordinate contains both count and mass features as part of their semantic value. The concept of semantic value is borrowed from Pelletier (2012). According to Pelletier, "the semantic value of every lexical noun contains *all* the values of which the noun is true." (Pelletier 2012: 19, [emphasis original]). In more technical terms, for a lexical noun *N*, its semantic value, *μ(N)*, is represented as below.

(6) $\mu(N) = \{N^o \cup N^m \cup N^s \cup N^{ss} \cup N^k \cup \ldots\}$
         (Pelletier 2012: p. 20)

The semantic value of *N* is the union of all the entities of which it is true. (N^o represents the objects that are *N*; N^m represents the material that *N* is true of; N^s are the standard servings of *N*; N^{ss} are the standard sizes of servings of *N*; N^k are the kinds of *N*; etc.). Thus, Pelletier contends that semantically speaking, lexical items are both count and mass. Syntactically, however, lexical items are "*unspecified* for the syntactic features +MASS/+COUNT" (p. 18, emphasis original). The count or mass status in the syntactic sense is "introduced in the construction of larger phrases" (p. 19).

Pelletier uses the lexical item *beer* to illustrate his account. This lexical item has all the semantic values as shown in (6) above. However, *beer* does not have any syntactic feature for +MASS or +COUNT. Rather, it becomes marked either +MASS or +COUNT when it occurs in phrases. For instance, when this lexical item is combined with the count determiner *a* to form the NP *a beer*, all the mass features in the semantic value of this lexical item are deleted in this count syntax. On the other hand, when *beer* occurs in a mass syntax, all the count features are deleted, and only mass features remain. Pelletier's explanation is quoted in (7) below.

(7)   (i)   *beer* lexically lacks any syntactic feature of + MASS/+COUNT.
         (ii)   *dark beer*, *beer on the table* (CNRs) lack any syntactic feature of + MASS/+COUNT.
         (iii) *beers* (a CNP) has the syntactic feature + COUNT.
         (iv)   *is beer* (PRED) has the syntactic feature + MASS.
         (v)   *a beer*, *many beers* (NPs) have the syntactic feature + COUNT.
         (vi)   *some beer*, *a lot of beer*, *beer* (DPs/NPs) have the syntactic feature + MASS.
         (Pelletier 2012: 18)

Pelletier (2012) proposes a similar account for the countability of nouns in classifier languages such as Mandarin. In particular, he suggests to "view the lexical nouns as unspecified for +MASS/+COUNT. The classifiers in these languages enforce the

+MASS/+COUNT distinction, but at the level of an entire 'classified noun phrase'" (p. 23). This brings the study of countability in classifier languages in parallel with the study of countability in number marking languages (cf. Borer 2005).

Following the account of Pelletier (2012), we think that superordinates in Mandarin work in the same way as other noun types in Mandarin. To illustrate, a superordinate in Mandarin such as *jiaju* 'furniture' contains count and mass semantic values associated with the denotational properties of this word, including the cardinality, volume of substance, or function of furniture, etc.[7] However, out of context none of these semantic values is salient. In this regard, we contend that bare superordinates are underspecified in countability, in the sense that bare superordinates are ambiguous with various semantic interpretations as contained in their semantic value.

The countability of superordinates in Mandarin can be specified in two ways. First of all, as Pelletier argues, countability is specified at the classifier noun (CLN) phrase. When superordinates co-occur with an individual classifier, only individual-denoting readings are possible. Second, when superordinates appear in a bare form, i.e., no morphosyntactic categories to mark their count or mass status, contextual factors can determine their countability. Depending on specific communicative purposes, contexts will make relevant semantic values salient (cf. Ware 1975). Thus, we argue that bare superordinates would allow individual-denoting readings and non-individual-denoting readings in appropriate contexts.[8]

To illustrate, let us consider Examples (8) and (9) below, which differ in the presence/absence of the individual classifier *ge*.

(8) *Qingwa   yaoguai   chi   le   gengduo   jiaju*
     Frog   Monster   eat   Asp   more   furniture
     'Frog Monster ate more furniture.'

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7 Our list of these semantic values of superordinates is based on previous research and our own study. In particular, the semantic values of *cardinality*, *volume of substance*, and *function* have been identified in the literature, as we reviewed in Sections 2 and 3. Relevant studies are listed below.

cardinality (Barner and Snedeker 2005, and many others)
volume of substance (Beviláqua and Pires de Oliveira 2014; Rothstein 2017)
function (Grimm and Levin 2012).

In the present study, we examine the semantic value of *volume of substance*, in addition to *cardinality*. More research needs to be done to explore other possible semantic values of superordinates.

8 Pelletier (2012: 24) states that in languages that are neither number-marking nor classifiers, context is used to determine the countability of nouns. We think context can also specify the countability of bare nouns in Mandarin.

(9) *Qingwa   yaoguai   chi   le   gengduo   ge   jiaju*
     Frog   Monster   eat   Asp   more   CL$_{ge}$ furniture
     'Frog Monster ate more pieces of furniture.'

The bare superordinate *jiaju* 'furniture' in (8) can denote both individual pieces of furniture and the overall volume of furniture. These two interpretations represent two distinct dimensions of the measurement of the same entities (i.e., cardinality versus volume), and they can be triggered in distinct contexts depending on specific perspectives.

By contrast, when *jiaju* is combined with the individual classifier *ge*, as in (9), *jiaju* allows only individual-denoting readings, quantified by the cardinality of furniture. The individual classifier specifies the cardinal quantity as the dimension of measurement, deleting other semantic values.

As shown, both morphosyntactic and contextual factors are involved in our account of Mandarin superordinates. Sentences (8) (with a bare superordinate) and (9) (a superordinate combined with an individual classifier) represent two types of test sentences in our experiments. Next, we proceed to investigate how morphosyntactic and contextual factors interact in the interpretation of superordinates in Mandarin-speaking children and adults.

6 Our experiments

In the present study, we conducted three experiments to investigate the interpretation of Mandarin superordinates by Mandarin-speaking children and adults. We examine how grammatical (i.e., morphosyntactic) and non-linguistic contextual factors influence the countability of Mandarin superordinates. To test the morphosyntactic effects, we used minimal pair sentences (with or without an individual classifier) to examine the role played by individual classifiers in specifying countability. To test the effects of contextual information, we provided two distinct contexts: individual-oriented contexts and substance-oriented contexts.

6.1 Experiment 1 (the interpretation of bare superordinates in two distinct contexts)

Experiment 1 attempts to address the issue of whether Mandarin-speaking children and adults assign individual-denoting and substance-denoting readings to bare superordinates upon our manipulation of context (substance-oriented contexts versus individual-oriented contexts).

6.1.1 Test sentences and test materials

Our test sentences contain a bare superordinate and make comparative quantity judgment with the term *gengduo* 'more', as exemplified in (8), repeated here as (10).

(10)   *Qingwayaoguai   chi   le   gengduo   jiaju*
       Frog Monster   eat   Asp   more   furniture
       'Frog Monster ate more furniture.'

6.1.2 Participants

We recruited twenty 4–6-year-old Mandarin-speaking children (age range: 4;11,04 to 6;04,11; mean age: 5;08,15) from a kindergarten affiliated to Soochow University, Jiangsu Province, P. R. China.[9] We also recruited twenty Mandarin-speaking adults aged between 18 and 24 years old. The adult participants were undergraduate and postgraduate students from Soochow University. It was a within-subject design, testing the same participants in two test conditions, which will be introduced shortly.

6.1.3 Experimental method and procedures

We incorporated a Truth Value Judgment Task (TVJT, Crain and Mckee 1985; Crain and Thornton 1998) into our use of the quantity judgment task (Barner and Snedeker 2005). This TVJT-based quantity judgment task goes like this. The task involves two experimenters. One experimenter narrates the stories using toys and props. The other experimenter plays the role of a puppet who watches the story alongside the child. After the story is presented, the puppet is invited to explain to the child what has happened in the story. The puppet's explanation concludes with a test sentence. The test sentences in our experiments are comparative structures invoking a quantity judgment. As will be shown shortly, the test sentences are statements like 'A ate more N than B'. The child's task is to judge whether the puppet says the right thing or not. If the child informs the puppet that s/he is wrong, then s/he is asked to explain "what really happened." When the puppet accurately describes what has happened in the story, the child is instructed to

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9 We randomly picked the 4–6-year-old child participants from the same kindergarten for the three experiments. Four-year-old is the youngest age that can be tested with the Truth Value Judgment Task (Crain and Thornton 1998). Among these three experiments, the children differed slightly in age range: Exp. 1: 4;11,04 to 6;04,11; Exp. 2: 5;07,21 to 6;06,30; Exp. 3: 4;08,01 to 5;09,26, but the mean age is pretty close, i.e., 5 years old (Exp. 1: 5;08,15; Exp. 2: 5;11,28; Exp. 3: 5;02,04).

reward him with a strawberry. However, sometimes the puppet doesn't pay close attention and makes a false statement. In that case, the child is instructed to give the puppet something to remind him to pay closer attention, e.g., a pepper. The TVJT was also used for Experiments 2 and 3.

The child participants were introduced to the task and tested individually. In order to familiarize the participants with the task, each child was given one practice trial, in which the participant was presented with one sentence that was obviously true, and another one that was obviously false. Only those participants who correctly responded in the practice trial were tested in the formal testing session.

In addition, before the formal testing session, we checked whether they knew the meaning of the three superordinates we tested, i.e., *jiaju* 'furniture', *gongju* 'hardware', and *canju* 'kitchenware'. To illustrate, in one trial the experimenter presented a ruler, a pencil and a chair, and asked the puppet *nayige shi jiaju*? 'which one is furniture?' and the puppet might or might not pick up the right thing. The participant was instructed to judge whether the puppet had picked up the right thing. All the children passed the test, and they could correctly judge whether an item is or is not the right one as denoted by the three superordinates. We then assume that they all know the lexical meanings of the three superordinates. The adult participants were tested with the same test materials and using the same methodology.

6.1.4 Test conditions and test materials

We had two distinct conditions, represented by two test contexts. Condition 1 includes a substance-oriented context. This condition was created by comparing the volume of entities that differ in size. On a typical trial, the scenario presented two monsters, i.e., Frog Monster and Black Monster. Participants were then told that the monsters like eating anything they can find. However, neither of them has teeth, and therefore they must use a grinder to grind up their food. They were then presented with a story of the following type. One day, Frog Monster found a big table and a big chair and ground them up into a big pile of food. He ate it and became full. Black Monster found two tiny tables and two tiny chairs, and he ground them up into a small pile of food. He ate the food, but he was still very hungry. The last scene of the story is shown in Figure 1 below.[10]

In the substance-oriented context, we made the volume of furniture salient with two design features. First, the volume of furniture is made the most significant dimension of measurement in the story. This result is achieved by highlighting the

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[10] We used two kinds of entities (e.g., tables and chairs in the example story) to embody the 'superordinate' nature of superordinates, following the practice of Experiment 2 in Barner and Snedeker (2005).
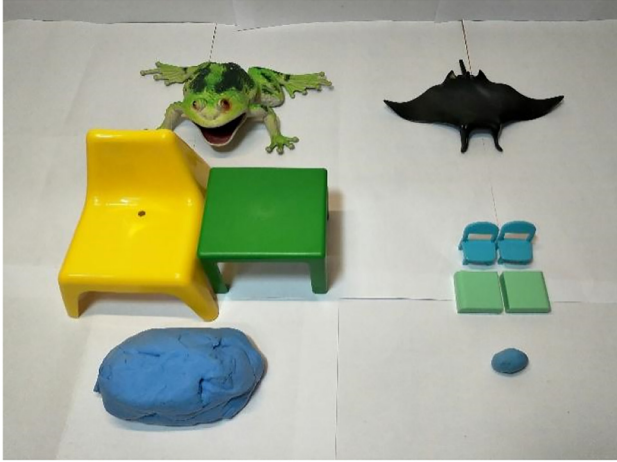
Figure 1: Last scene of the typical trial (the substance-oriented context).

distinct effects caused by the amount difference between the two monsters. That is, the big amount of furniture made Frog Monster full, and the small amount did not help relieve Black Monster's hunger. By doing this, we aimed to draw the participants' attention to the volume of furniture.

Another strategy we used to make the volume of furniture salient is to grind the furniture into furniture substance in the story. This design incorporates the idea of the thought experiment 'the Universal Grinder' as proposed in a classic philosophy study, i.e., Pelletier (1975). According to Pelletier, count and mass senses are part of the lexical specification for all nouns. For those nouns that tend to denote individuals, the concept of the Universal Grinder is used to envision a felicitous context for triggering the less favored mass interpretation, by presenting the substance of entities in a conspicuous way (i.e., grinding objects into the substance they are made of). The idea of the Universal Grinder can be extended to superordinates.[11] In our testing story, to make the story sound natural and give a good reason for the presentation of ground objects, we say that the two monsters have no teeth, and they must grind their food (see Beviláqua et al. [2016] on the empirical study of the Universal Grinder).

Thus, in the substance-oriented context, a salient furniture substance is provided, in addition to the information on the number of furniture pieces. Against this scenario, an experimenter asked the puppet (who was played by another experimenter) who ate *gengduo jiaju* 'more furniture', and the puppet answered the

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11 In a similar vein, Rothstein and Pires de Oliveira 2020: footnote 1) imagines a Universal Grinder scenery for the use of superordinates like *furniture*: "After the hurricane, furniture was strewn all over the village".

question by stating that Frog Monster (who ate the two big pieces of furniture) ate *gengduo jiaju* 'more furniture' than Black Monster (who ate the four tiny pieces of furniture), as shown in (11).

(11)   *Qingwayaoguai   chi   le   gengduo   jiaju*
         Frog Monster   eat   Asp   more   furniture
         'Frog Monster ate more furniture.'

The participants were invited to judge whether the puppet's statement was a true or false description of the story. If they accepted the sentence, their quantity judgment was thought to be based on volume: Frog Monster did eat more furniture than Black Monster in terms of the volume of furniture. In this case, the substance-denoting reading is assigned to the bare superordinate *jiaju*. On the other hand, if participants rejected the sentence, their quantity judgment was thought to be based on cardinality: it is Black Monster who ate more pieces of furniture. In this case, the individual-denoting reading is assigned to *jiaju*. Thus, we make both the individual-denoting reading and the substance-denoting reading available in this substance-oriented context, and the distinct 'YES' or 'NO' responses can tell which reading is assigned in this specific context. We expected that the participants would accept the test sentences and assign the substance-denoting reading in this substance-oriented context if they were sensitive to the context.

In Test Condition 2, we created an individual-oriented context by highlighting the cardinal quantity of entities. On a typical trial, Purple Fairy and Blue Fairy had a magic competition. Purple Fairy created a big table and a big chair with magic, and Blue Fairy created two tiny chairs and two tiny tables. The judge gave a gold medal to Blue Fairy and a dark cross to Purple Fairy. The last scene of the story is shown in Figure 2 below.

Figure 2: Last scene of the typical trial (the individual-oriented context).

In this scenario, the number of furniture pieces created by the two fairies determines which fairy can get a reward, and cardinality is thus the most important information for the quantity judgment. The salient information on cardinal quantity is reinforced using a gold medal versus a dark cross. Against this scenario, the experimenter asked the puppet who created *gengduo jiaju* 'more furniture', and the puppet answered the question by stating that Purple Fairy (who created the two big pieces of furniture) created *gengduo jiaju* than Blue Fairy (who created the four tiny pieces of furniture), as shown in (12) below.

(12) *Zi xiannv   bianchu   le   gengduo   jiaju*
      Purple Fairy   create   Asp   more   furniture
      'Purple Fairy created more furniture.'

If participants reject the sentence, they make their quantity judgment via cardinality, as Purple Fairy created only two pieces of furniture, and it is Blue Fairy who created more pieces of furniture. In this case, participants assign the individual-denoting reading to *jiaju* in the sentence. However, if participants accept the sentence, then they make their quantity judgment via volume, as the overall volume of furniture created by Purple Fairy was greater than that of Blue Fairy. In this case, participants assign the substance-denoting reading to *jiaju* in the test sentence. Thus, we again make both the individual-denoting reading and the substance-denoting reading available in this individual-oriented context, and the distinct YES or NO responses can tell which reading is assigned by the participants for the interpretation of the bare superordinate in this specific context. We expect that participants would reject the sentence and assign the individual-denoting reading in this individual-oriented context.

Note that, if participants are not sensitive to the provided contextual information, they would assign only individual-denoting readings in the two test conditions, since, according to the previous research (Lin and Schaeffer 2018; Liu 2014), this is the preferred reading assigned by Mandarin children and adults in neutral contexts.

In the actual testing, we had two stories: one story represented the substance-oriented context, and the other one represented the individual-oriented context. The same test items, including *jiaju* 'furniture', *gongju* 'household hardware', and *canju* 'kitchenware', were tested in the two stories. In the narration of the stories, the three test items were presented in three parts of the stories. In particular, in Story 1, Frog Monster and Black Monster found *jiaju* 'furniture' for breakfast, *gongju* 'household hardware' for lunch, and *canju* 'kitchenware' for dinner. In Story 2, Purple Fairy and Blue Fairy had three trials of magic competition, and using magic they created *jiaju* 'furniture', *gongju* 'household hardware', and *canju*

'kitchenware' in these trials. Each participant was presented with 6 test sentences (2 test conditions * 3 test sentences), for a total of 240 responses (2 groups * 20 participants * 2 test conditions * 3 test sentences). The order of narrating the two stories (i.e., the presentation of the two test conditions) was counterbalanced. The whole testing session lasted about 12–15 min for each participant. We present the details of the test materials in the Appendix. In addition to the test sentences, the puppet also produced two filler sentences before or after each test sentence. The filler sentences were obviously true or false. They served to obscure the purpose of the study and to ensure that children remained aware of the task (Crain and Thornton 1998).

6.1.5 Findings

The adults and the 4–6-year-old children exhibited the same response patterns in the two test conditions. In the substance-oriented condition, they predominantly accepted the test sentences (adults: 90% [54/60 trials]; children: 87% [52/60 trials]), thus accessing the substance-denoting reading. A Mann-Whitney test indicates that there is no significant difference between the children's and adults' assignment of the substance-denoting reading in this condition ($Z = 0.424$; $p = 0.671$). Note that participants also accessed, to a certain degree, the individual-denoting reading in this substance-oriented context (adults: 10% [6/60 trials]; children: 13% [8/60 trials]). A check of the individual data shows that only three children (their ages are 4;11,18, 5;03,01 and 6;00,25) and two adults assigned the individual-denoting reading by consistently (at least 2 out of 3 trials) rejecting the test sentences in this context. Nevertheless, both children and the adults strongly preferred the substance-denoting reading in this substance-oriented context: children accessed this reading 87% of the time (vs. 13% individual-denoting reading) and adults 90% of the time (vs. 13% individual-denoting reading). A Wilcoxon test confirmed that the difference between the two readings is significant for both the child group ($Z = -4.146$, $p < 0.5$) and the adult group ($Z = -4.243$, $p < 0.5$).

In the individual-oriented condition, the same adults and children rejected the test sentences 100% of the time (60/60 trials), thus accessing the individual-denoting reading. They gave appropriate justification for their rejection of the test sentences. For instance, the adult and child participants said that the Purple Fairy only created two pieces of furniture, or it is the Blue Fairy who made more furniture when they rejected the test sentence (12) *Zi xiannv bianchu le gengduo jiaju* 'Purple Fairy created more furniture'.

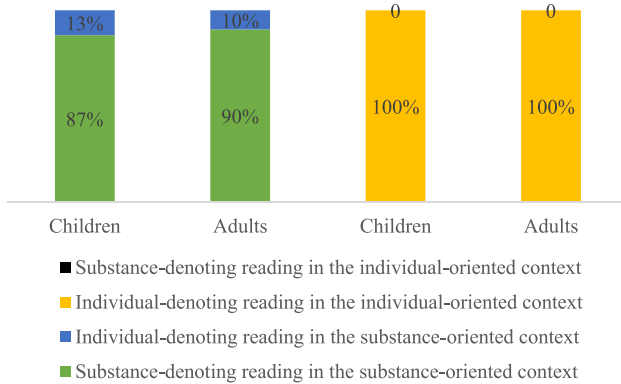The adult and child data are summarized in Figure 3 below.

Figure 3: The child and adult data in Experiment 1.

Based on the results, we conclude that both Mandarin-speaking adults and young children are sensitive to the contextual information and are able to assign the distinct substance-denoting and individual-denoting readings to bare superordinates upon our contextual manipulation. Therefore, in both the adult grammar and the child grammar, bare superordinates are underspecified in countability, and their interpretation is subject to change in distinct contexts. These experimental data thus offer compelling empirical evidence to support our characterization of Mandarin bare superordinates as proposed in Section 5.

6.2 Experiment 2 (the interpretation of superordinates co-occurring with an individual classifier)

Experiment 2 investigates how individual classifiers determine the countability of co-occurring superordinates in Mandarin. The research question is whether Mandarin-speaking children and adults know that Mandarin superordinates in the presence of an individual classifier receive only individual-denoting readings.

We recruited twenty 5-to-6-year-old Mandarin-speaking children (age range: 5;07,21–6;06,30; mean age: 5;11,28) from the same kindergarten as in Experiment 1, and twenty Mandarin-speaking adults (undergraduate and postgraduate students) from the same university. These participants are not the same ones as in Experiment 1.

The experimental design of Experiment 2 differs from that of Experiment 1 only in one aspect: the addition of an individual classifier in the test sentences, and everything else was the same. In particular, we designed the same test conditions: the

substance-oriented condition and the individual-oriented condition and examined the interpretation of the classifier-bearing sentences in these two contexts.

Consider the substance-oriented condition first. As in Experiment 1, this condition was designed to compare the volume of entities that differ in size. On a typical trial, Gorilla Monster and Hippo Monster like to eat, and they would eat anything. But they suffer from toothache and have to grind their food. One day they went out to look for food. Gorilla Monster found a big sofa and a big wardrobe and ground them into a big pile of food. He ate it and became very full. Hippo Monster found two tiny sofas and two tiny wardrobes and ground them into a small pile of food. He ate it but was still very hungry. Against this scenario, an experimenter asked the puppet (who was played by another experimenter) who ate *gengduo ge jiaju* 'more pieces of furniture', and the puppet answered the question by stating that Gorilla Monster ate *gengduo ge jiaju* 'more pieces of furniture', as shown in (13).

(13) | *Xingxingyaoguai* | *chi* | *le* | *gengduo* | *ge*[12] | *jiaju* |
      | Gorilla Monster | eat | Asp | more | CL | furniture |
      'Gorilla Monster ate more pieces of furniture.'

With the individual-denoting reading 'Gorilla Monster ate more pieces of furniture', the test sentence is not a true description of the story, as Gorilla Monster only ate two pieces of furniture, and it is Hippo Monster who ate more pieces of furniture. Thus, participants were expected to reject the test sentence in this scenario.

The individual-oriented context was designed to compare the number of entities, just as in Experiment 1. On a typical trial, Green Dino and Yellow Dino had a magic competition. Green Dino created a big wardrobe and a big sofa, and Yellow Dino created two tiny wardrobes and two tiny sofas. The judge gave a gold medal to

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12 In addition to the general individual classifier *ge*, some specific individual classifiers can be used with the three superordinates we tested. For instance, the individual classifier *jian* can co-occur with *jiaju* 'furniture' and *gongju* 'household hardware', and the individual classifier *liang* can co-occur with *jiaotonggongju* 'vehicle'. For two considerations, we used the general individual classifier *ge* in Experiment II for all of the three items, rather than using specific individual classifiers. First, since different specific individual classifiers go with different superordinates, using the same classifier (i.e., the general individual classifier *ge*) for the three items can avoid unnecessary variables in the experimental design. Second, the general individual classifier *ge* is widely reported as the first classifier that is acquired by Mandarin-speaking children, around 2 years old (e.g., Erbaugh 1986). Based on previous research, we assume that our child participants must have acquired this classifier by the age we tested them (i.e., 4–6-year-olds). However, if specific individual classifiers would have been used, we could not guarantee that they had been already acquired by the child participants. As reported in the literature, only about ten specific individual classifiers are acquired by the age of six or seven (Fang 1985; Hu 1993; Ying et al. 1983). For these two reasons, we chose to use the general individual classifier *ge* in Exp. 2 to investigate the function of individual classifiers in specifying countability of superordinates.

Yellow Dino and a dark cross to Green Dino. Against this scenario, an experimenter asked the puppet who created *gengduo ge jiaju* 'more pieces of furniture', and the puppet answered the question by stating that Green Dino created *gengduo ge jiaju*, as shown in (14).

(14)   *Lv konglong   bianchu   le   gengduo   ge   jiaju*
         Green Dino   create   Asp   more   CL   furniture
         'Green Dino created more pieces of furniture.'

With the individual-denoting reading 'Green Dino created more pieces of furniture', this sentence is a false description of the story, as Green Dino created only two pieces of furniture, fewer than Yellow Dino, who created four pieces of furniture. Participants were thus expected to reject the test sentence in this scenario.

In short, in the two test conditions, the information on the volume of substance and on cardinality were presented as two independent factors for the quantity judgment, just as we did in Experiment 1. However, due to the presence of the individual classifier *ge*, the test sentences in Experiment 2 unambiguously convey the individual-denoting reading, and the interpretation of superordinates is thus expected to keep constant in the two distinct contexts.

The way we conducted the actual testing in Experiment 2 is also the same as in Experiment 1. So, in Experiment 2, there were two stories, representing the two test conditions. The three superordinates, including *jiaju* 'furniture', *gongju* 'household hardware' and *jiaotong gongju* 'vehicle' were used in the two stories. Each participant was presented with 6 test sentences (2 test conditions * 3 test sentences), which amounts to 240 responses (2 groups * 20 participants * 2 test conditions * 3 test sentences). And the narration of the two stories was counterbalanced. We also tested whether participants understood the meaning of the three superordinates before the formal testing, in the same way we did in Experiment 1. And we provided simple filler sentences, in addition to the test sentences. The whole testing session lasted about 12–15 minutes for each participant.

Let us now consider the findings of Experiment 2. Both the adults and the children responded as we expected. Both groups rejected the test sentences in the substance-oriented context 100% of the time (60/60 trials) and gave a similar justification for their rejections of the test sentences. For instance, they pointed out that, in the example story, Gorilla Monster only ate two pieces of furniture, and it is Hippo Monster who ate more pieces of furniture. Similarly, in the individual-oriented context, both the adults and the children rejected the test sentences 100% of the time (60/60 trials), and appropriately justified their rejection. For instance, in the example story, they mentioned that Green Dino created only two pieces of furniture, or that it was Yellow Dino who created more pieces of furniture.

To conclude, in Experiment 2 both the children and adults were sensitive to the presence of the individual classifier *ge* in the test sentences. They assigned only

the individual-denoting reading to the superordinate nouns in the presence of the individual classifier *ge*, independently of the contexts used. Again, the experimental data confirm our characterization of Mandarin superordinates (see Section 5).

6.3 Experiment 3 (the interpretation of bare superordinates in situations with no ground objects)

Experiment 3 is a follow-up study of Experiment 1. In Experiment 1, we successfully triggered the substance-denoting reading in the substance-oriented contexts, in which individual entities were ground into substance. There are however two possible ways to interpret the data. One way is to consider the attested substance-denoting reading as a basic lexical meaning of bare superordinates (cf. Pelletier 1975, 2012).

Alternatively, one could argue that superordinates like *jiaju* 'furniture' are count nouns by default, denoting individuals; however, some nonlinguistic factors or real-world knowledge can transform those superordinates to mass nouns and as such they denote non-individuals. Indeed, Cheng et al. (2008) argue for a similar view on their interpretation of object nouns in Mandarin such as *pingguo* 'apple' and *juzi* 'orange'. They propose that these words are count nouns in general situations, based on their ontological properties. However, in some specific situations, e.g., in the salad context, these words can undergo a count-to-mass shift and convey a coerced 'ground' reading (which belongs to a non-individual-denoting reading), as triggered by this kind of specific nonlinguistic context. The relevant examples are given in (15).

(15) a. *Shala   li   you   pingguo/juzi*
      salad   in   have   apple/orange
      'There is apple/orange in the salad.'
   b. *Ni   lian   shang   you   pingguo/dan*
      you   face   on   have   apple/egg
      'There is apple/egg on your face.'
      (Cheng et al. 2008: Example 14)

Following the logic of Cheng et al. (2008), we assume that this account may argue that bare superordinates such as *jiaju* 'furniture' are count nouns, and the attested substance-denoting reading in our Experiment 1 is a coerced reading, as triggered by our contextual manipulation, i.e., the use of the Universal Grinder.

In Experiment 3 we attempted to examine which account fares better to account for the substance-denoting reading. Our research issue is whether the substance-denoting reading would be still available when no ground object is present. If so, we can assume that the substance-denoting reading attested in
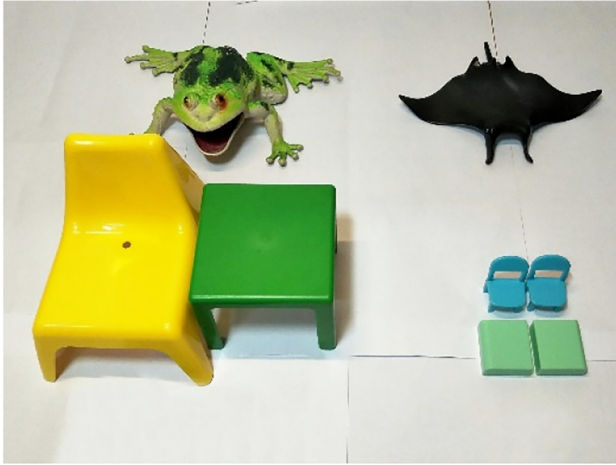
Figure 4: The last scene of the story.

Experiment 1 does not necessarily rely on the presence of a substance that is the result of grinding objects, but it is a basic lexical meaning of bare superordinates.

With the research purpose as stated above, we tested the interpretation of three bare superordinates in a substance-oriented context that has no ground objects. Thus, the experimental design of Experiment 3 differs from Experiment 1 (the substance-oriented condition) only in one aspect: the lack of ground objects. In particular, the same three test items (i.e., *jiaju* 'furniture', *gongju* 'household hardware', and *canju* 'kitchenware') were presented in the same eating story. In the story, there are two monsters, i.e., Frog Monster and Black Monster. They like eating and eat anything they can find. One day, Frog Monster found a big table and a big chair, and he gulped them up in whole pieces without chewing them and became very full. Black Monster found two tiny tables and two tiny chairs, and he also gulped them in whole pieces without chewing them, but he was still hungry. The last scene of the story is shown in Figure 4 below.

Noted that the context makes the volume of furniture salient for the quantity judgment as the big amount of furniture makes Frog Monster full, and the small amount does not help relieve Black Monster's hunger.[13] Against this new

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13 Like Barner and Snedeker (2005) and other previous studies as reviewed in Section 3, no ground objects are provided in this new substance-oriented context. However, this new context differs from previous research in one important aspect: the volume of substance is highlighted through the comparing of the different amounts of food eaten by the two monsters. Thus, we still expect the substance-denoting reading in this context, even though no ground objects are present.

substance-oriented context, an experimenter asked the puppet who ate *gengduo jiaju* 'more furniture', and the puppet answered the question by stating that Frog Monster ate *gengduo jiaju* than Black Monster, as shown in (16) below.

(16) *Qingwayaoguai   chi   le   gengduo   jiaju*
      Frog Monster   eat   Asp   more   furniture
      'Frog Monster ate more furniture.'

Then the participants were invited to judge whether the puppet had made a true or false description of the story. As in Experiment 1, the scenario is open to 'YES' or 'NO' responses, and the distinct responses can tell which reading (i.e., the substance-denoting reading or the individual-denoting reading) is assigned in this specific context for the interpretation of the bare superordinate *jiaju* 'furniture'. If participants accept the sentence, their quantity judgment is based on volume: Frog Monster did eat more furniture than Black Monster in terms of the volume of furniture. In this case, the substance-denoting reading is assigned to the bare superordinate noun *jiaju*. On the other hand, if participants reject the sentence, their quantity judgment is made based on cardinality: it is Black Monster who ate more pieces of furniture. In this case, the individual-denoting reading is assigned to *jiaju*.

The other two test items *gongju* 'household hardware', and *canju* 'kitchenware' were tested in the same eating story in the same way. We recruited twenty 4–5-year-old Mandarin-speaking children (age range: 4;08,01–5;09,26; mean age: 5;02,04) from the same kindergarten as in Experiments 1 and 2, and twenty Mandarin-speaking adults (undergraduate and postgraduate students) from the same university. These participants are not the same ones as in Experiments 1 and 2. Each participant was presented with three test sentences, for a total of 60 responses (20 participants * 3 test sentences) in this experiment. We also tested whether participants understood the meaning of the three superordinates before the formal testing, adopting the same way we used in Experiment 1. And we provided simple filler sentences, in addition to the test sentences. The whole testing session lasted about 6 min for each participant.

Now consider the results. In the new substance-oriented contexts in which no ground objects were presented, both children and adults predominantly accepted the test sentences and assigned the substance-denoting readings to the bare superordinate nouns (adults: 80% [48/60 trials]; children: 95% [57/60 trials]). The findings show that both children and adults predominantly assigned the substance-denoting readings in the new substance-oriented contexts. Checking the individual data, we found that only one child (age: 5;04,10) and four adults consistently rejected the test sentences and assigned the individual-denoting reading.

To examine whether the presence/absence of ground objects affects the assignment of the substance-denoting readings, we conduct a Mann-Whitney test to compare the data from Experiments 1 and 3. The statistic test indicates that there is no significant difference in the children's assignment of the substance-denoting readings between the two experiments (Experiment 1: 87% vs. Experiment 3: 95%; $Z = 1.014$, $p = 0.311$). In the same way, there is no significant difference in the adults' assignment of the substance-denoting readings between the two experiments (Experiment 1: 90% vs. Experiment 3: 80%; $Z = 0.874$, $p = 0.382$).

Based on the data analysis above, we conclude that the triggering of the substance-denoting reading does not necessarily rely on the existence of ground objects. This reading can be triggered as long as the participants' attention is drawn to the volume of entities. Therefore, we assume that the substance-denoting reading is a basic lexical meaning of bare superordinates, not a coerced reading (count-to-mass shift) triggered by non-linguistic factors (e.g., the Universal Grinder) (Pelletier 1975, 2012).

7 General discussion

In the present study, we conducted three experiments to investigate various factors that are involved in the interpretation of Mandarin superordinates. In Experiment 1 we found that both the child and adult participants predominantly exhibited the substance-denoting reading in the substance-oriented context and the individual-denoting reading in the individual-oriented context in their interpretation of the bare superordinates. By contrast, in Experiment 2 both children and adults assigned only the individual-denoting reading to the superordinates co-occurring with the individual classifier *ge* independent of the contexts used. In Experiment 3, we found that both children and adults predominantly assigned the substance-denoting reading to the bare superordinates in a substance-oriented context in which no ground objects were involved. The experimental results thus suggest that the assignment of the substance-denoting reading does not rely on the existence of ground objects, and the attested substance-denoting reading is a basic lexical meaning of bare superordinates, rather than a coerced reading (count-to-mass shift) triggered by the 'Universal Grinder' context.

Based on the experimental findings from the three experiments, we can draw one important generalization: in both the adult and child grammar, morphosyntax (i.e., presence/absence of an individual classifier) and non-linguistic contextual information play important roles in the interpretation of Mandarin superordinates, and they function in different ways. In particular, contextual information affects the interpretation of sentences containing bare superordinates. By contrast, with

the presence of the individual classifier *ge*, contextual manipulation does not take an effect. These patterns suggest that it is classifiers that determine the countability of superordinates, while bare superordinates on their own are underspecified in countability.

Our experimental data confirm our speculation that the predominant individual-denoting interpretation reported in Liu (2014) and Lin and Schaeffer (2018) reflect only participants' strong preference in interpreting bare superordinates in neutral contexts. The non-individual-denoting reading is indeed available when triggered in appropriate contexts, as shown in our experiments. Thus, Mandarin superordinates should not be taken as an exception, as argued by Lin and Schaeffer; rather, Mandarin superordinates allow both individual-denoting and non-individual-denoting interpretations, just like other types of Mandarin bare nouns ('count', 'mass' and 'flexible'). In this regard, we can reconcile Lin and Schaeffer's account and apply the grammatical account to the interpretation of all bare nouns in Mandarin, regardless of their ontological properties. That is, bare nouns are underspecified in countability, allowing both individual and non-individual-denoting interpretations depending on specific contexts.

Our empirical data are consistent with previous empirical studies on the countability of nominal expressions in Mandarin, as reported in Huang (2009) and Huang and Lee (2009). These studies also find that Mandarin-speaking preschoolers and adults are sensitive to the presence/absence of a classifier in their interpretation of object nouns such as *pingguo* 'apple', *yizi* 'chair', and *qingwa* 'frog', and assign distinct readings to these object nouns when they are used as bare nouns versus when they co-occur with an individual classifier. Thus, the present study contributes more data to show that classifiers play the decisive role of encoding the countability in Mandarin (Lin and Schaeffer 2018) and gives further support to the grammatical view on the countability of Mandarin (Borer 2005; Pelletier 1975, 2012).

In addition to the theoretical issues above, the present study also contributes several new techniques in experimental design for the study of superordinates and other types of nominal expressions. First, we tease apart the roles played by morphosyntax and contextual information and examine them separately as two independent variables in the experiments. In examining the function of classifiers, we compare the interpretation of minimal pair sentences, i.e., sentences with or without the individual classifier *ge*. In examining the role played by contextual information, we designed two distinct contexts: the substance-oriented context and the individual-oriented context, and examined whether or not the interpretation of superordinates is subject to change upon the contextual manipulation. Our study is consistent with Grimm and Levin (2012) and Beviláqua and Pires de Oliveira (2014) in that contextual information plays an important role in the interpretation of superordinates (see Section 3). The same entities can be

quantified via cardinal and non-cardinal dimensions of measurement, depending on specific contexts (cf. Rothstein 2017). Moreover, our data from Experiments 1 and 2 allow us to take a step further and claim that contextual manipulation only affects the interpretation of bare superordinates and cannot take control over the morphosyntactic factors that are associated with countability. As shown in our Experiment 2, the contextual manipulation does not affect the interpretation of superordinates in the presence of an individual classifier, which functions similarly to English plural morphology in encoding countability (Borer 2005; Pelletier 2012).

Second, we adopted a Truth Value Judgment Task (TVJT) (Crain and Thornton 1998), to invoke participants' comparative quantity judgment. Like many other studies using TVJT, our quantity judgment is made based on statements, judging whether the puppet's statement was a true description of the story scenario. In this way, we directly test whether a certain reading is available or not. This differs from the question-answering Quantity Judgment Tasks (QJT) that are widely used in the previous studies on the count-mass issue (e.g., Barner and Snedeker 2005, 2006; Inagaki and Barner 2009). Those tasks invoke forced choices, causing the potential 'preference' problem (cf. Section 3). Thus, our TVJT-based quantity judgment task not only incorporates the advantages of comparative quantity judgment (Bale and Barner 2009), but also avoids the 'preference' problem as found in the previous question-answering QJT. Moreover, the TVJT is useful to test the ambiguity of sentences by manipulating context (Crain and Thornton 1998). In our case, this experimental method allows us to test the availability of the distinct substance-denoting and individual-denoting readings in a single sentence and examine which reading is assigned in a specific context.

We have successfully triggered a much higher percentage of non-individual-denoting readings in our experiments than in previous research (e.g., Beviláqua and Pires de Oliveira 2014; Grimm and Levin 2012; Lin and Schaeffer 2018; Liu 2014). We believe both the experimental method (TVJT versus the question-answering QJT) and the contextual information (substance-oriented contexts versus neutral contexts) play an important role here (see Section 3). However, one may think that the high percentage of the non-individual-denoting reading in our experiments is due to the use of the verb *chi* 'eat', which would make participants pay more attention to the volume of entities. In our view, access to non-individual-denoting readings is surely affected by the type of events (Barner et al. 2008; Grimm and Levin 2012), and the same nouns may exhibit different degrees of non-individual-denoting readings when they co-occur with different verbs. However, the most crucial feature in our experiments is that, when the individual classifier *ge* is used with the same superordinates in the same eating event, the non-individual-denoting reading is not possible anymore despite the use of the same verb *chi* 'eat'

(Experiment 2). From this comparison, we can conclude that the countability of superordinates may be affected by the types of co-occurring verbs, but the most decisive factor is the presence/absence of an individual classifier: while bare superordinates are ambiguous, superordinates using with classifiers are not.

From a crosslinguistic perspective, one can extend our new experimental method and techniques to the testing of mass/bare superordinates in English and other languages. To illustrate, by adopting our TVJT-based quantity judgment task, one can compare the interpretation of sentences containing *more furniture* with those containing *more pieces of furniture* (cf. sentences [4] and [5] in Section 2) to examine whether English-speaking children and adults would draw a distinction between these two types of sentences and allow both individual-denoting and non-individual-denoting readings for *more furniture*, but only individual-denoting readings for *more pieces of furniture*. The results can help evaluate the distinct accounts on mass superordinates in English (and possibly in other languages). As introduced in Section 2, there are three distinct views: (i) superordinates-as-individuals; (ii) superordinates-as-non-individuals; (iii) the co-existence of individual-denoting readings and non-individual-denoting readings. If both individual-denoting and non-individual-denoting readings are attested in the interpretation of mass superordinates in English and other languages, which we highly expect, then the third account should be the most appropriate one to characterize superordinates. One can also examine how morphosyntax and contextual information interact and influence the interpretation of superordinates in specific languages and how the interplay of these factors is related to the presence/absence of the grammatical count-mass distinction in a language (cf. Lima 2018). We leave these broad crosslinguistic issues for future research.

8 Conclusion

We conducted three experiments to investigate the interpretation of Mandarin superordinates by Mandarin-speaking children and adults. We found that classifiers determine the countability of superordinates; without a classifier, bare superordinates are underspecified in countability. The experimental study provides compelling evidence to support our characterization of Mandarin superordinates. The present study also shows that both morphosyntax and contextual information are involved in the interpretation of superordinates, and leads us to conclude that the attested individual-denoting reading in previous research is only the preferred reading of Mandarin superordinates in neutral contexts. In addition to the theoretical contribution, the present study contributes several new experimental techniques for the study of the count-mass issue. From a crosslinguistic

perspective, our experimental data are consistent with the account that admits both individual-denoting and non-individual-denoting readings for the interpretation of mass/bare superordinates. Thus, the present study contributes new data and sheds new light on the study of superordinates and the count-mass issue in general.

Data availability: The experimental data underlying this article may be found at https://doi.org/10.5281/zenodo.6548670.

Appendix

Experiment 1

Stories	Scenarios and test sentences
Story 1: Food-eating (Substance-oriented context)	In the morning, Frog Monster ate a big table and a big chair, which were ground into a big pile of food, and became very full. Black Monster ate two tiny tables and two tiny chairs, which were ground into a small pile of food, and he still hungry.
	Qingwayaoguai chi le gengduo jiaju Frog Monster eat Asp more furniture 'Frog Monster ate more furniture.'
	At noon, Black Monster ate a big hammer and a big pair of pliers, which were ground into a big pile of food, and became very full. Frog Monster ate two tiny hammers and two tiny pairs of pliers, which were ground into a small pile of food. He was still hungry.
	Hei Yaoguai chi le gengduo gongju Black Monster eat Asp more household hardware 'Black Monster ate more household hardware.'
	In the evening, Frog Monster ate a big fork and a big spoon, which were ground into a big pile of food, and became very full. Black Monster ate two tiny forks and two tiny spoons, which were ground into a small pile of food. He was still hungry.

(continued)

Stories	Scenarios and test sentences
	Qingwayaoguai chi le gengduo canju Frog Monster eat Asp more kitchenware 'Frog Monster ate more kitchenware.'
Story 2: magic competition (Individual-oriented context)	Purple Fairy and Blue Fairy had a magic competition. In the first trial, Purple Fairy created with magic a big table and a big chair, and Blue Fairy created two tiny tables and two tiny chairs. Blue Fairy got a gold medal, and Purple Fairy got a dark cross. *Zixiannv bianchu le gengduo jiaju* Purple Fairy create Asp more furniture 'Purple Fairy created more furniture with magic.'
	In the second trial, Blue Fairy created a big hammer and a big pair of pliers, and Purple created two tiny hammers and two tiny pairs of pliers. This time, Purple Fairy won a gold medal, and Blue Fairy got a dark cross. *Lanxiannv bianchu le gengduo gongju* Blue Fairy create Asp more household hardware 'Blue Fairy created more household hardware with magic.'
	In the third trial, Purple Fairy created a big fork and a big spoon, and Blue Fairy created two tiny forks and two tiny spoons. Blue Fairy won a gold medal and Purple Fairy got a dark cross. *Zixiannv bianchu le gengduo canju* Purple Fairy create Asp more kitchenware 'Purple Fairy created more kitchenware with magic.'

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