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Reclassifying Mandarin Chinese Classifiers Based on Non-quantifiable Nouns and Quantifying Boundaries: A Century-long Study (1924-2024)

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Abstract

From new perspectives of non-quantifiable nouns and quantifying boundaries, this study proposes a hierarchical, dynamic, and four-layered sorting system for Mandarin Chinese classifiers (Cls): [Mandarin Chinese Cls Sub-property Cls/Kind Cls [Non-sub-property Cls [Cls for [+RB] nouns RB Cls/Individual Cls [Non-RB Cls Collective Cls Partitive Cls]][Cls for [-RB] nouns Natural Cls/Individuating Cls [Non-natural Cls Container Cls Standard Cls]]]. This system focuses on the relation between Cls and nouns, and utilizes a unified sorting standard called 'boundaries', which renders the system more conducive to Cl research in syntax and semantics. It addresses three issues: 1. Clarifying why Kind Cls have no restrictions on nouns, whereas others do; 2. Mediating the longstanding debate on whether Mandarin Chinese nouns exhibit count-mass distinction; 3. Providing a unified explanation for why Cls like *pian* '(literally) slice' and *dui* 'heap' belong to multiple types.

Keywords: Numeral classifiers, Mandarin Chinese, Non-quantifiable nouns, Quantifying boundaries, Cognition, Kind classifiers, Individual classifiers

1. Introduction

Numeral classifiers (Note 1) (Cls for short) in Mandarin Chinese, such as *ben* 'volume' and *di* 'drop' in example (1), are a classic research topic, particularly in terms of their classification. Interestingly, Cl classification studies in China have often lacked clear goals, while those outside China have been limited, with a prevailing assumption that existing classification schemes are sufficient for the current Cl research. However, these schemes prove to be unsuitable for exploring Cl syntax. For instance, they fail to explain why Kind Cls (e.g., *lei*

'type' in (1c)) contrast with other types of Cls with respect to noun selection constraints.

(1) a. *san* *ben* *shu*
three CL_{volume} book
'three books'
b. *si* *di* *shui*
four CL_{drop} water
'four drops of water'
c. *wu* *lei* *shu/shui*
five CL_{type} book/water
'five types of books/water'

We believe that this unsuitability arises because current classification proposals fail to capture the intrinsic nature of Cls. First, these studies have paid scant regard to the relation between Cls and nouns. Second, there has been a default assumption that all Chinese nouns are quantifiable. Third, although the quantifying boundaries (QBs) for nouns have been observed, they have not been sufficiently explored.

Therefore, in order to uncover the intrinsic nature of Cls, we will initiate Cl sorting research, focusing on the Cls-nouns relation and incorporating two new perspectives: non-quantifiable nouns (as shown in (2a)) and quantifying boundaries. This approach is justified for two reasons: 1. The limitations between quantifiable nouns and non-quantifiable nouns are highly likely to reveal what Cls exactly are; 2. The quantifying boundaries universally used in nominal quantification by humans could enable us to uncover the essence of Cls in a more direct and effective way.

(2) a. *dongfang* *qianqi* *duifang*
east early phase counterpart

b. * *san* *ge* *dongfang*
three CL-General east

c. * *san* *ge* *qianqi*
three CL-General early phase

d. * *san* *ge* *duifang*
three CL-General counterpart

This paper aims to develop a classification system of Mandarin Chinese Cls to promote Cl research, and would also benefit Cl teaching to Chinese L2 learners. The structure is as follows: we first review the diverse classifications of Mandarin Chinese Cls in the literature from 1924 to 2024, then we spell out the proposal of how we sort them, and particularly, we introduce a crucial sorting element, namely, referential boundaries. In the final two sections, we discuss the advantages of our classification system for Mandarin Chinese Cls, and

conclude our findings.

2. Literature Review

In the current literature, a large number of works have discussed the classification of Mandarin Chinese Cls (Note 2). These works can be broadly divided into two groups based on their classifying standards: static or dynamic. The static standard focuses solely on Cls themselves, while the dynamic one considers the relationship of Cls with nouns or numerals.

For the dynamic group, Ma (1990) categorized Chinese Cls into two types: Cardinal-number Cls and Ordinal-number Cls according to the nature of numerals co-occurring with Cls; Based on the mutual semantic selection between Cls and nouns, Shao (1993) proposed three sorts of Cls: Shape-characterized Cls, Non-shape-characterized Cls, and Macro-container Cls.

The static group includes Chao (1968), Lü (1980 [1999]), Zhu (1982), Z. Zhang et al. (1982), Xing (1996), He (2000), Yu (2003), and N. Zhang (2013). Apart from Xing (1996), which focused on a phonological standard and divided Chinese Cls into two main types (Note 3), Monosyllabic Cls and Multi-syllabic Cls, all other works employed mixed standards—such as the origin, semantics, and syntax of Cls—to propose diverse classifications as follows:

1) Chao (1968) (Note 4) divided Mandarin Cls into seven types: Individual Cls, Group Cls, Partitive Cls, Container Cls, Temporary Cls, Standard Cls, and Quasi Cls.

2) Lü (1980[1999]) suggested eight types: Individual Cls, Collective Cls, Partial Cls, Standard Cls, Temporary Cls, Independent Cls, and Compound Cls.

3) Zhu (1982) proposed six kinds: Individual Cls, Collective Cls, Standard Cls, Temporary Cls, Undetermined-quantity Cls, and Quasi Cls.

4) Z. Zhang (1982) obtained five sorts: Individual Cls, Collective Cls, Standard Cls, Container Cls, and Temporary Cls.

5) He (2000) claimed seven types: Individual Cls, Collective Cls, Partial Cls, Standard Cls, Temporary Cls, Specific Cls, and Borrowed Cls.

6) Yu (2003) assumed nine sorts: Individual Cls, Collective Cls, Standard Cls, Container Cls, Shaping Cls, Ration Cls, Kind Cls, Undetermined-quantity Cls, and Compound Cls.

7) N. Zhang (2013) followed Croft (1994, pp.151-152) and divided Mandarin Cls into seven types: Individual Cls, Individuating Cls, Standard Measures, Container Measures, Kind Cls, Partitive Cls and Collective Cls.

Given the influence of Chao's (1968) classification, we conduct a detailed examination, as illustrated in (3)-(9).

				Types of Mandarin Cls	Chao's (1968) definitions
(3)	*liu*	*tiao*	*xianglian*	Individual Cls	modify nouns according to

	six	CL_{strip}	necklace		the entity's shape, or other properties
	'six necklaces'				
(4)	*wu*	*pai*	*qiche*		
	five	CL_{row}	car	Group Cls	used for a group or collection of individuals
	'five rows of cars'				
(5)	*si*	*pian*	*xigua*		
	four	CL_{piece}	watermelon	Partitive Cls	represent portions of things
	'four pieces of watermelon'				
(6)	*san*	*ping*	*hongjiu*		
	three	CL_{bottle}	wine	Container Cls	container nouns used as measures
	'three bottles of wine'				
(7)	*liang*	*shou*	*you*		
	two	CL_{hand}	oil	Temporary Cls	use the outside extent of objects to measure quantity
	'both hands covered in oil'				
(8)	*yi*	*mi*	*bu*		
	one	CL_{meter}	cloth	Standard Cls	range from measure units for weight, length, volume and so on
	'one meter of cloth'				
(9)	*man*	*cheng*	*lü-shu*		
	full	CL_{city}	green-tree	Quasi Cls	autonomous, do not belong to a noun or certain nouns
	'a city full of green trees'				

Chao's categories of Temporary and Quasi Cls are inappropriate, as they can be subsumed under other types. For instance, the Cl *shou* 'hand' in (7) and *cheng* 'city' in (9) can both be categorized as Container Cls.

Comparing with Chao's (1968) Cl sorting system, N. Zhang's (2013, pp. 36-37) (Note 5) introduces two new types: Individuating and Kind Cls, as shown in (10) and (11).

				Types of Mandarin Cls	N. Zhang's (2013) definitions
(10)	*wu*	*di*	*you*		
	five	CL_{drop}	oil	Individuating Cls	offer counting units for massive nouns
	'five drops of oil'				
(11)	*wu*	*zhong*	*shui*		
	five	CL_{kind}	water	Kind Cls	no definition
	'five kinds of water'				

The Cls like *di* 'drop' in (10), generally classified as Partitive Cls (Note 6) in Chao (1968), are regarded as a distinct type called *Individuating Cls* in N. Zhang (2013). Similarly, while Chao (1968) categorizes Kind Cls as Collective Cls (Note 7), N. Zhang (2013) treats them as an independent Cl type. This treatment is supported by many others such as Huang & Ahrens (2003), Yu (2003), and N. Yang (2004), and we endorse it.

Despite the large number of sorting proposals for Mandarin Cls, many studies (e.g., S. Zhou, 2006; Bi, 2013) have identified two major flaws in the literature. First, the majority overlooked the relation of Cls with numerals or nouns. Second, most proposals adopted mixed criteria, leading to: 1. potential overlaps between Cl types, such as between Temporary Cls and Borrowed Cls, and between Collective Cls and Undetermined-quantity Cls; 2. multi-identities of a Cl, such as the Cl *pian* '(literally) slice' and *dui* 'heap', as seen in (12) and (13).

					In Chao's (1968) sorting system
(12)	a.	*san*	*pian*	*shuye*	
		three	CL	leaf	Individual Cls
		'three leaves'			
	b.	*san*	*pian*	*huluobo*	
		three	CL_{slice}	carrot	Partitive Cls
		'three slices of carrot'			
	c.	*san*	*pian*	*qiche*	
		three	CL_{group}	car	Group Cls
		'three groups of cars'			

In N. Zhang's (2013) sorting system

(13) a. *shi* *dui* *tu*

ten CL_{heap} earth Individuating Cls

'ten heaps of earth'

b. *shi* *dui* *shu*

ten CL_{heap} book Collective Cls

'ten heaps of books'

The Chinese Cl *pian* '(literally) slice' generally describes a thin shape. Based on Chao's (1968) definitions, *pian* is Individual Cls in (12a) because it expresses exactly the shape of what the referent of *shuye* 'leaf' has. In (12b) *pian* is Partitive Cls, since it denotes the part that belongs to the whole entity of *huluobo* 'carrot'. In (12c) *pian* is Group Cls, in that it refers to a collection of some entities, and in this case, the collection consists of some objects of *qiche* 'car'.

The multi-identity of the Cl *pian* has also been observed by many others (S. Liu, 1965; Ma, 1990; Yu et al., 2003; Chu & Wei, 2005; Meng & Li, 2011), yet the existing literature fails to provide a unified explanation for this issue. More precisely, the reason for classifying the Cl *pian* as Individual Cls cannot account for its classification as both Partitive and Group Cls. The same is true of the Cl *dui* 'heap'.

While acknowledging the issues highlighted by S. Zhou (2006) and Bi (2013) in the existing literature, we greatly appreciate the scholarly contributions made therein, based on which, we obtain seven types of Mandarin Chinese Cls as follows: Individual Cls, Collective Cls, Partitive Cls, Container Cls, Standard Cls, Individuating Cls, and Kind Cls, as illustrated in Figure 1.

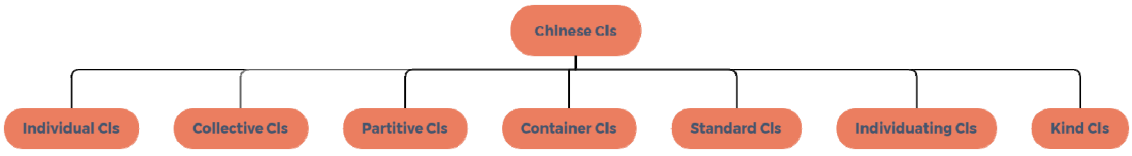

Figure 1. Traditional classification system of numeral classifiers in Mandarin Chinese

3. Reclassification of Mandarin Chinese Cls

Given the research gap indicated in Section 2, it is necessary to develop a more refined classification system of Mandarin Chinese Cls that could accurately capture their syntactic and semantic behaviors. To achieve that, the core task is to identify the ideal classification

criteria. We propose considering three dimensions: linguistic forms, cognitive principles, and research gaps.

From a perspective of linguistic forms, the sorting criteria for Chinese Cls should:

1) Be conducive to research on their syntax and semantics. Particularly, for the syntactic aspect, it is reasonable to establish a sorting standard based on the relation of Cls with other linguistic elements in the basic quantifying pattern 'Numeral+Classifier+Noun'. In other terms, the sorting criteria should be made on the relation of Cls with numerals or nouns.

2) Be related exactly to nouns. There are two reasons: first, the multi-identity of Cls like *pian* '(literally) slice' and *dui* 'heap' has already implied that the identity of a Cl results from its related noun. Second, there has been a proposal that nouns determine Cls in the literature (Liao, 1946); Another proposal is that Cls are the assistant of nouns (Gao, 1948; Lü, 1953). Besides, Shao (1993) has paid attention to the mutual selective relation between nouns and Cls, and W. Zhang (1995) (Note 8) has focused on how nouns restrict Cls. These two works both imply that nouns determine Cls.

3) Be at least related to the dividing line between quantifiable nouns and non-quantifiable nouns in Mandarin Chinese. This is because, logically speaking, observing X from the complement domain where X is, may capture things that cannot be captured only in the domain where X is.

From a perspective of cognitive principles, the sorting criteria for Mandarin Cls should be related to quantifying boundaries (QBs for short). This is derived from the universal principle of nominal quantification: when human beings begin to quantify things, the first step is to establish a quantifying boundary for objects or substance to be counted or measured. Only after this basic step can nominal quantification realize. Therefore, QBs are a prerequisite for quantifying a noun.

Based on the research gap in the classifications of Mandarin Chinese Cls, the sorting criteria for these Cls should be coherent, which would make the dividing lines between Cl types as explicit as possible, and thereby minimize the number of Cl types and the overlap between them.

To sum up, we propose unified criteria for sorting Mandarin Cls. These criteria should relate to nouns, particularly concerning the limitations between quantifiable nouns and non-quantifiable nouns, and should consistently focus on QBs.

3.1 The First-layer Division: Kind Cls and Non-kind Cls

Regarding the first dividing line for Mandarin Chinese Cls, we propose that Kind Cls are distinct from the other six types of Cls, namely, Individual Cls, Collective Cls, Partitive Cls, Container Cls, Standard Cls, and Individuating Cls. Furthermore, the latter six types together form a set that has a parallel relation to Kind Cls. For simplicity, we call this set Non-kind Cls. In summary, we separate Kind Cls from Non-kind Cls (Note 9), as seen in Figure 2.

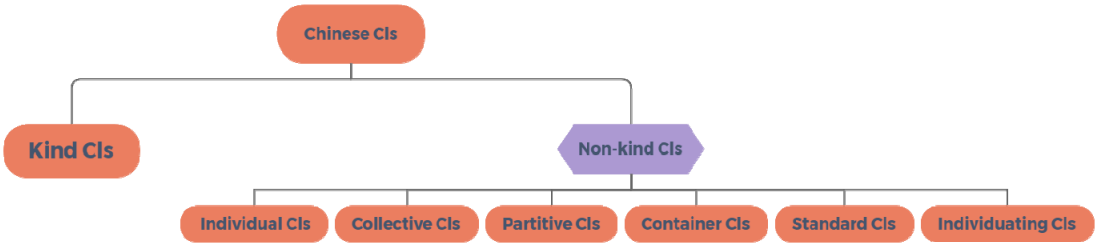

Figure 2. Classification system of numeral classifiers in Mandarin Chinese: 1st layer

This arises from two aspects. First, Kind Cls are commonly recognized as an independent type of Cls in Mandarin (e.g., Huang & Ahrens, 2003; N. Yang, 2004; X. Li, 2013). Second, from a perspective of non-quantifiable nouns, the aforementioned sortation is compatible with two dimensions of nominal quantification hypothesis (Note 10). That is, human beings quantify nouns in two dimensions: the number of instantiated property (i.e., instances) and the number of sub-properties (i.e., kinds) of nouns' referents.

The two dimensions above are distinct from one another in many aspects. Firstly, in the dimension of instantiated property (i.e., instances), referents to be quantified possess the crucial property of a noun. Secondly, the quantifying basis is how much space (Note 11) is occupied by these referents. Thirdly, the quantifying results are the number of physical boundaries or abstract ones. On the other hand, in the dimension of sub-properties (i.e., kinds), first, referents to be quantified have a sub-property that presupposes the existence of the crucial property of a noun. Second, the quantifying basis is how much abstract space is occupied by these referents. Third, the quantifying results are the number of abstract boundaries. Note that these abstract boundaries are identified according to the sub-property.

For example, the crucial property of the noun *shu* 'book' in (14) is book-property. Therefore, in the dimension of instantiated property, the target to be quantified is referents with book-property, and in accordance with physical space taken by these referents (book-entities), we can obtain an expression *shi'er ben shu* 'twelve books' where the numeral *shi'er* 'twelve' results from the number of the physical boundaries of these referents. In contrast, the sub-property of this noun in (14) is color property which is premised on the existence of the crucial property mentioned above (book-property). According to this sub-property of color—green, white, and red—we can identify three boundaries. These boundaries really exist, although they cannot be directly sensed (seen, smelt, touched etc.). Based on these three abstract boundaries in dimension of sub-properties, we can produce the expression *san zhong shu* 'three kinds of books'.

(14) *Zhuozi-shang you shi'er ben shu: san ben lüde,*

table-on have twelve CL_{volume} book three CL_{volume} green

si ben baide, wu ben hongde, yigong san zhong shu.

four CL_{volume} white, five CL_{volume} red in-total three CL_{kind} book

'There are twelve books on the table: three green ones, four white ones, and five red ones. In total, three kinds of books.'

Through the detailed explanation of example (14), Kind Cls and Non-kind Cls can be named in another way: Sub-property Cls and Non-sub-property Cls, as illustrated in Figure 3. This division is essentially based on the two quantifying dimensions of nouns. In other words, the classification criterion for Mandarin Cls is which dimension we select for QBs to quantify nouns.

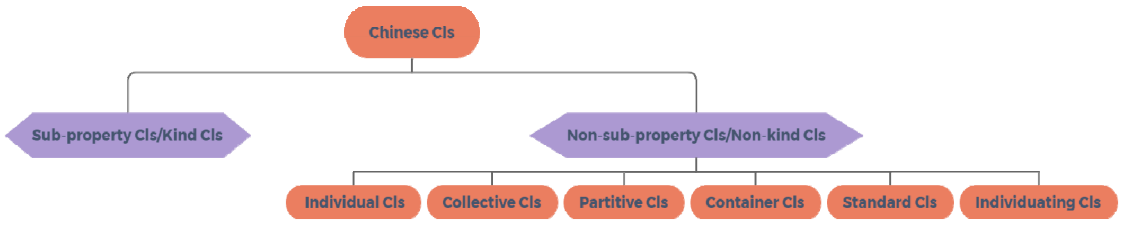

Figure 3. Classification system of numeral classifiers in Mandarin Chinese: 1st layer

To summarize, we firstly argue that Mandarin Cls can be categorized into two fundamental types: Sub-property Cls (Kind Cls) and Non-sub-property Cls (Non-kind Cls); and the latter includes: Individual Cls, Collective Cls, Partitive Cls, Container Cls, Standard Cls, and Individuating Cls. Second, the first sorting criterion for Mandarin Cls we propose is which dimension is selected for QBs to quantify nouns.

3.2 The Second-layer Division: Cls for [+RB] Nouns and Cls for [-RB] Nouns

3.2.1 RBs, a Key Sorting Standard

The second dividing criterion is definitely related to nouns' QBs, but the question lies in which aspect of QBs would be the better choice. To answer this, we should first introduce the notion referential boundaries (RBs for short) proposed by Ruan (2018) in details.

According to this nominal RB hypothesis, Mandarin Chinese nouns like *shu* 'book' possess boundaries in mental lexicon. When they are in the process of quantification, their boundaries function as a referential point and are ready for being compared with QBs denoted by Cls. In this sense, Ruan (2018) denominated nominal boundaries as referential boundaries (RBs). To verify this nominal RB hypothesis, Ruan (2018) has provided four arguments from the perspectives of literature review, philosophy, syntax, and diachronic linguistics, respectively.

3.2.2 Cls for [+RB] Nouns and Cls for [-RB] Nouns

Based on the aforementioned nominal RB hypothesis, Mandarin Chinese nouns are divided into two types: those with RBs, like *shu* 'book' and *xiangjiao* 'banana', and those without RBs, like *you* 'oil' and *zhengqi* 'steam'. They are expressed as [+RB] nouns and [-RB] nouns, if we adopt the terminology of linguistic features. Accordingly, the sorting criterion of Cl classification at the second layer is the types of nouns that are served by QBs. More precisely, we pay attention to whether Cls denoting QBs occur with [+RB] nouns or not.

On the basis of this sorting standard, Non-sub-property Cls (Non-kind Cls) we conclude at the first layer are further divided into two sub-sets: Cls for [+RB] nouns and Cls for [-RB] nouns. Our Cls for [+RB] nouns include five traditional types: Individual Cls, Collective Cls, Partitive Cls, Container Cls, and Standard Cls. While our Cls for [-RB] nouns involve three traditional types: Individuating Cls, Container Cls, and Standard Cls, as shown in Figure 4.

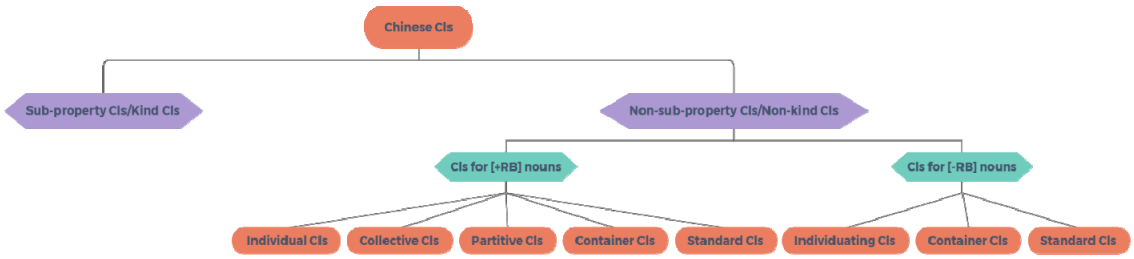

Figure 4. Classification system of numeral classifiers in Mandarin Chinese: 2nd layer

In contrast to the traditional Cl sorting system shown in Figure 1, we create a new classification layer, that is, the distinction between Cls for [±RB] nouns, which is motivated by the well-known hypothesis that the count-mass distinction in nouns is cross-linguistically valid.

The reason why Individual Cls, Collective Cls, and Partitive Cls are included in our Cls for [+RB] nouns is that nouns modified by these Cls possess RBs, whereas the reason why Individuating Cls are put into our Cls for [-RB] nouns is that their related nouns all have no RBs. Whether or not nouns have RBs, they can be modified by both Container Cls and Standard Cls. Therefore, these two traditional types of Cls are included both in Cls for [+RB] nouns and in Cls for [-RB] nouns.

To conclude, based on Ruan (2018)'s nominal RB hypothesis, Non-sub-property Cls (Non-kind Cls) are divided into two sub-types at the second layer: Cls for [+RB] nouns and Cls for [-RB] nouns. The former includes five types of traditional Cls: Individual Cls, Collective Cls, Partitive Cls, Container Cls, and Standard Cls; And the latter contains three: Individuating Cls, Container Cls, and Standard Cls. The second sorting criterion of Mandarin Chinese Cls is whether Cls denoting QBs occur with [+RB] nouns.

3.3 The Third-layer Division: RB Cls and Non-RB Cls; Natural Cls and Non-natural Cls

At this layer, we propose two sorting criteria: one is for dividing Cls for [+RB] nouns, and the

other for Cls for [-RB] nouns. Utilizing these criteria, we obtain the sorting result, as illustrated in Figure 5. Both criteria are related to the origins of QBs.

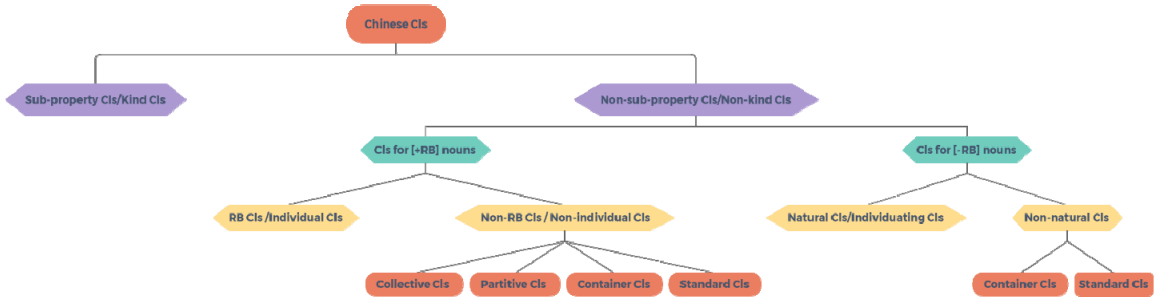

Figure 5. Classification system of numeral classifiers in Mandarin Chinese: 3rd layer

For sorting Cls for [+RB] nouns, the criterion is still related to QBs and RBs. More precisely, based on the aforementioned nominal RB hypothesis, we focus on whether nominal RBs are selected as QBs.

According to this classifying standard, Cls for [+RB] nouns we obtain at the second layer are divided into two sub-sets. In one set, nominal RBs are chosen as QBs, that is, inherent boundaries that nouns possess in mental lexicon are used as quantifying units to quantify these nouns. In this sense, only Individual Cls can be put into this set. This is because Individual Cls are the only type that represents nominal RBs.

While in the other set, nominal RBs are not selected as QBs, in other words, the intrinsic boundaries of nouns are not selected as quantifying units to quantify these nouns, but the extrinsic boundaries are. Accordingly, this set collects the remaining traditional four types: Collective Cls, Partitive Cls, Container Cls, and Standard Cls. This is because these four types of Cls solely denote the non-referential boundaries of their associated nouns.

In brief, we divide Cls for [+RB] nouns into two sub-types: the Cls that denote nominal RBs and those that do not. Consequently, we call the former RB Cls, the latter Non-RB Cls. For consistency with existing literature, they are also named Individual Cls and Non-individual Cls. Also, Non-individual Cls include the traditional Collective Cls, Partitive Cls, Container Cls, and Standard Cls.

In fact, the separation of RB Cls (Individual Cls) from Non-RB Cls (Non-Individual Cls) is compatible with Croft (1994), N. Zhang (2013). Croft (1994) has proposed two types of numeral Cls, one is inherent state Cls which are real numeral Cls, and the other is temporary state Cls which are also called numeral pseudo Cls. N. Zhang (2013) has mentioned that it is the type of Individual Cls that separates Cl languages like Chinese from non-Cl languages like English.

For sorting Cls for [-RB] nouns, the criterion we suggest is whether QBs are natural or artificial. Here, *natural* means that the quantifying boundaries for nouns come from nouns' referents themselves, but these QBs are not nominal RBs that are saved in mental lexicon.

For example, *di* ‘drop’ is a natural QB for nouns like *shui* ‘water’ and *you* ‘oil’, but this natural QB is not RB for these nouns. This is not the case for nouns like *shu* ‘book’ that has a natural boundary *ben* ‘(literally) volume’, and this natural boundary is also RB for this noun. Based on the notion of *natural*, here *artificial* involves all QBs that are neither RBs nor natural boundaries (NBs).

Following this sorting criterion, Cls for [-RB] nouns are divided in two sub-types of Cls: Natural Cls and Non-natural Cls. Since the traditional Individuating Cls denote the natural boundaries of nouns, they belong to Natural Cls; whereas the traditional Container Cls and Standard Cls denote the unnatural boundaries with respect to nouns, these two types are put into Non-natural Cls, as illustrated in Figure 5**.**

To sum up, regarding the classification of Mandarin Chinese Cls at the third layer, based on the criterion of whether nominal RBs are selected as QBs, Cls for [+RB] nouns are divided in two sub-types: RB Cls (Individual Cls) and Non-RB Cls (Non-individual Cls). The former includes only Individual Cls, and the latter contains four: Collective Cls, Partitive Cls, Container Cls, and Standard Cls. According to the criterion of whether QBs are natural or artificial, Cls for [-RB] nouns are separated into two sub-types: Natural Cls and Non-natural Cls. The former involves Individuating Cls, and the latter contain two: Container Cls and Standard Cls. The sorting criteria of Mandarin Cls at the third layer concern the origins of QBs.

3.4 The Fourth-layer Division: Collective Cls and Partitive Cls

At the fourth layer, since both RB Cls and Natural Cls contain only one type of Cls, Non-RB Cls and Non-natural Cls remain to be classified. However, as the classification of Non-natural Cls is complex due to involving a special quantifying dimension, it will not be discussed in this study. Therefore, at the fourth layer, we will focus solely on dividing Non-RB Cls (Non-individual Cls).

The criterion for dividing Non-RB Cls still relates to the relationship between RBs and QBs, more precisely, between the RBs of nouns and the QBs denoted by Cls. However, the focus shifts to the quantitative rather than qualitative aspects in the fourth-layer division. This quantitative relationship between RBs and QBs is exactly the ratio of the QBs denoted by Cls to the RBs of nouns. According to this ratio, we obtain the fourth-layer classification shown in Figure 6.

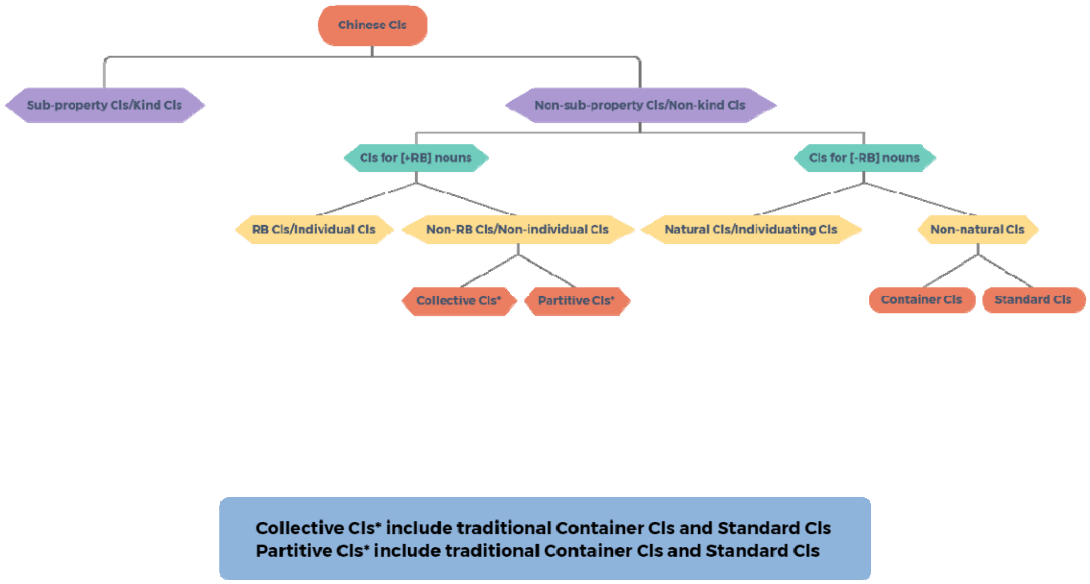

Figure 6. Classification system of numeral classifiers in Mandarin Chinese: 4th layer

As elaborated, Non-RB Cls include four traditional sub-types: Collective Cls, Partitive Cls, Container Cls, and Standard Cls, as illustrated in Figure 5.

On one hand, the traditional Collective Cls and Partitive Cls are still reserved as Collective Cls and Partitive Cls in our classifying system. This is derived from the sorting criterion of boundary ratios of Cls to nouns. More precisely, if the boundary ratios are more than one, that is, the QBs denoted by Cls are bigger (usually multiple) than the RBs that nouns possess (in mental lexicon), these Cls are Collective Cls. If the boundary ratios are less than one, that is, the QBs denoted by Cls are partial compared to the RBs that nouns possess, these Cls are Partitive Cls. On the other hand, our Collective Cls and Partitive Cls are far more than the traditional corresponding ones, we suggest putting the traditional Container Cls and Standard Cls into our Collective Cls and Partitive Cls. This is because the QBs they denote always have a boundary ratio with respect to the RBs of nouns, as shown in (15) (Note 12).

(15) a. *yi* *xiang* *pingguo*

one CL_{box} apple Our Collective Cls Traditional Container Cls

'one box of apples'

b. *yi* *wan* *pingguo*

one CL_{bowl} apple Our Partitive Cls Traditional Container Cls

'one bowl of apple'

c. *yi* *gongjin* *pingguo*

one CL_{kilo} apple Our Collective Cls Traditional Standard Cls

'one kilo of apples'

d. *yi* *ke* *pingguo*

one CL_{gram} apple Our Partitive Cls Traditional Standard Cls

'one gram of apple'

If the QBs denoted by Container Cls are bigger (usually multiple) than the nominal RBs, these Cls are Collective Cls, as show in (15a) and (15c). If the QBs denoted by Container Cls are partial compared to the nominal RBs, these Cls are Partitive Cls, as show in (15b) and (15d). Note that here we do not consider the case where the boundary ratio of QBs to nouns equals one because of the Principle of Economy: if this boundary ratio equals one, then nominal RBs will be generally used as QBs. The same is true of Standard Cls.

To summarize, for the fourth-layer division of Mandarin Chinese Cls, based on the criterion of the ratio of the QBs denoted by Cls to the RBs of nouns, i.e., the boundary ratio of Cls to nouns, Non-RB Cls are separated into two sub-types: Collective Cls and Partitive Cls. Note that our Collective Cls include not only traditional Collective Cls, but also traditional Standard Cls and Container Cls. This all depends on the boundary ratio of the QBs denoted by Cls to the RBs of nouns. The same is true of our Partitive Cls.

4. Advantages of the Reclassification of Mandarin Chinese Cls

This system has advantages as follows:

1) Kind Cls are conceptualized as parallel to the set of other types of Cls, which can spell out many linguistic phenomena. For instance, Kind Cls have no restrictions on their related nouns, whereas others do, as seen in (16).

(16) a. *san* *zhong* *shui*

three CL_{kind} water

'three kinds of water'

b. * *san* *tiao* *shui*

three CL_{strip} water

Intended: 'three stripes of water'

c. *san* *zhong* *diannao*
three CL_{kind} computer
'three kinds of computers'

d. * *san* *kou* *diannao*
three $CL_{mouthful}$ computer

More precisely, first, Kind Cls can occur with both (semantically) count nouns and mass nouns, whereas others cannot. For example, we cannot say *san tiao shui*/three CL_{strip} water/Intended: 'three stripes of water'. In this sense, the proposal of Cheng and Sybesma (1998) is not completely right. Therefore, we claim that the distinction of count-mass nouns in Mandarin Chinese is reflected through Cls which must exclude Kind Cls. In other words, this distinction is not reflected by means of Kind Cls.

Second, Kind Cls can occur with any nouns, whereas other Cls are limited to those that are lexically compatible with them. For instance, expressions like *san kou diannao*/three $CL_{mouthful}$ computer are ungrammatical.

The two special behaviors of Kind Cls above can be easily explained: for the first behavior, the reason is that Kind Cls has nothing to do with the semantic atomicity of nouns in terms of instantiated property, in which nouns are divided into count group and mass group. In fact, the nouns that are modified by Kind Cls all have (abstract) atomicity in terms of sub-properties, that is, these nouns are all semantically countable in dimension of sub-properties.

For the second behavior, the reason lies in the fact that Kind Cls do not describe what the quantifying boundaries (QBs) look like, so they do not add lexical information to their related nouns, whereas others generally do. This lexical addition is allowed only if the added information is compatible with what the relevant noun denotes in terms of boundaries.

2) Our nominal RB hypothesis—Mandarin nouns can be [+RB] or [-RB]—can mediate different, even contrary viewpoints about the old issue: count-mass distinction of nouns. Syntactically speaking, Mandarin nouns are all of mass, if we only consider the judging standard of numerability (to adopt N. Zhang's (2013) term), that is, the capacity of directly combining with numerals. However, it cannot be denied that Mandarin nouns are semantically divided into count and mass nouns. But note that this separation is more convincing if it is explained by nominal RB hypothesis rather than the classical assumptions such as atomicity in the literature.

This is because, [±RB] forms an inner feature of nouns conserved in mental lexicon, which can account for the countability of English words both like *book*, *water* and like *furniture*, whereas atomicity is influenced by an artificial operation (i.e., boundary division). This cannot explain the above-mentioned issue in a correct way.

Precisely speaking, for the above words, book is mentally with [+RB], water with [-RB], and furniture with [-RB]. These nominal RB features are compatible with syntactic behaviors of nouns: book is countable, whereas water and furniture are both massive. In light of atomicity, book is atomic, whereas water is un-atomic. These two judgments are identical to ours. However, we do not regard furniture as atomic, because it is not the noun *furniture* that has atomicity, but the components of furniture such as nouns *bed*, *table* that have atomicity. In fact, the false atomicity of *furniture* is derived from a boundary division that has already happened to the noun *furniture*. If the boundary division is not operated, *furniture* is not atomic.

3) Our classification of Mandarin Chinese Cls is dynamic, especially at the fourth layer, whereas traditional classifications are mostly static. This dynamism arises because our classification reflects the boundary relation between the QBs denoted by Cls and the RBs possessed by nouns (if any), whereas the traditional classifications do not. This dynamic system can account for the issue of multi-identity of some Cls, such as *pian* '(literally) slice' and *dui* 'heap', which traditional systems fail to do. For instance, in reference to the noun *huluobo* 'carrot', *pian* serves as a Partitive Cl, while for the noun *qiche* 'car', it functions as a collective one; Another example is *dui* 'heap', when paired with [+RB] nouns like *shu* 'book', it acts as a collective Cl, but with [-RB] nouns like *tu* 'earth', it is an individuating type.

5. Conclusions

In this paper, we investigated the classification of Mandarin Chinese Cls from two new perspectives: non-quantifiable nouns and quantifying boundaries. Unlike previous research, we made a classification system which would be more conducive to Cl research. Specifically, we focused on the relation between Cls and nouns, and adopted a set of unified classifying criteria. These criteria pertain to boundaries (QBs, RBs and NBs), following which we propose a hierarchical, dynamic, and four-layered classifying system for Mandarin Chinese Cls:

1) According to whether quantifying boundaries (QBs) denoted by Cls regard sub-properties (i.e., kinds) of nouns, Mandarin Cls are divided into Kind Cls and Non-kind Cls.

2) Based on whether Cls denoting QBs occur with [+RB] nouns, Non-kind Cls are grouped into Cls for [+RB] nouns and Cls for [-RB] nouns.

3) In light of whether nominal RBs are selected as QBs, Cls for [+RB] nouns are divided in two sub-types: RB Cls and Non-RB Cls (Non-individual Cls); While considering whether QBs are natural or artificial, Cls for [-RB] nouns are separated into Natural Cls and Non-natural Cls.

4) Based on whether the boundary ratio of QBs to nominal RBs is more than one, Non-RB Cls (Non-individual Cls) are divided into Collective Cls and Partitive Cls. Note that our Partitive Cls, illustrated in Figure 6, include not only the traditional Partitive, but also Standard and Container ones. The same is true of our Collective Cls.

For the whole classification system with Mandarin Chinese examples, see Figure 7.

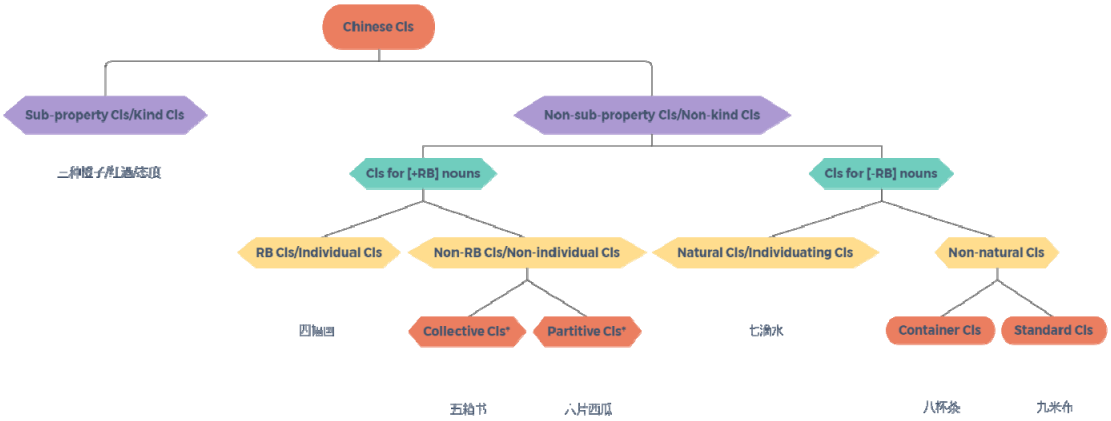

Figure 7. Classification system of numeral classifiers in Mandarin Chinese

The advantages of our classification lie in accounting for numerous linguistic phenomena:

1) For the first division, Kind Cls are distinct from other traditional types. This is compatible with the distinct behaviors of Kind Cls in terms of their co-occurrence with nouns: Kind Cls have no restrictions in combining with nouns, whereas Non-kind Cls do.

2) For the third division, the sorting criterion involves nominal RBs. The sorting system thus adequately demonstrates the count-mass distinction between Mandarin Chinese nouns in terms of syntax. More precisely, nouns that can co-occur with RB Cls (Individual Cls) are countable, otherwise uncountable.

3) Due to the unified dividing criterion termed 'boundaries' (QBs, RBs and NBs), our classification is hierarchic and dynamic, in the sense that the relationships between these types of Cls are usually unparallel, and that whether a Cl belongs to a specific type depends on its related noun. This dynamic mechanism uniformly explains the multiple identities of certain Cls, such as *pian* '(literally) slice' and *dui* 'heap'.

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Notes

Note 1. Numeral classifiers in Mandarin Chinese are also called *liang-ci* ‘quantity-word’ in J. Li (1924), *danwei-ci* ‘unit-word’ in Lü (1942), *danwei-liangci* ‘unit-measure words’ in L. Wang (1943), *fu-mingci* ‘vice-noun’ or *danwei-ci* ‘unit-word’ or *liang-ci* ‘quantity-word’ in Lü (1953), *shu-liang-ci* ‘numeral-quantity-word’ in Z. Zhang (1953), *zhu-mingci* ‘assistant-noun’ in Lu (1956), and *measures* in Chao (1968). Unless otherwise specified, we use ‘Cls’ to refer to ‘numeral classifiers’ in this study.

Note 2. In the present work, we use Cls to cover all sorts of formatives that occupy the middle slot of the basic pattern of numeral expressions in Mandarin Chinese, namely, “Numeral+Cl+Noun”.

Note 3. In fact, Xing (1996) also mentioned Compound Cls and Quasi Cls.

Note 4. In fact, Chao (1968) has done a sorting job for all of the Mandarin Cls (*measures* in Chao’s term), including not only numeral Cls but also verbal Cls. He has listed nine types as follows: Individual Cls, Individual Cls in V(erb)-O(bject), Group Cls, Partitive Cls, Container Cls, Temporary Cls, Standard Cls, Quasi-Cls, and Verbal Cls. As our central work is numeral Cls, we will not discuss Individual Cls in V-O and Verbal Cls in this paper.

Note 5. The author followed Croft (1994, pp. 151-152) and divided Mandarin Cls into seven types as follows: Individual Cls, Individuating Cls, Standard Measures, Container Measures, Kind Cls, Partitive Cls and Collective Cls.

Note 6. *Partitive Measures* in Chao's term.

Note 7. *Group Measures* in Chao's term.

Note 8. Cited from Bi (2013, p. 9).

Note 9. This separation of Kind Cls from Non-kind Cls may be cross-linguistically valid.

Note 10. In Ruan (2018), this two-dimensional hypothesis for nominal quantification has been proposed from the perspectives of linguistic philosophy and based on the distinction between non-quantifiable nouns and quantifiable nouns in Mandarin Chinese. For more details, see Ruan (2018, p. 59).

Note 11. From a philosophical perspective, referents of all nouns occupy a certain space, regardless of what type of space it is: spatial, temporal, mental and so on.

Note 12. Note that the boundary ratios of Cls to nouns in this example are calculated with no context.

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