Pluractionality via competition: VV in Mandarin Chinese[1]

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Abstract. This paper provides a pragmatic mechanism to derive pluractionality of the Mandarin VV sequence formed with certain types of verbs. We propose: (i) Syntactically, VV is an instantiation of V-(NUMERAL)-CLASSIFIER, with the second V serving as a cognate verbal classifier. (ii) Semantically, VV denotes an indefinite quantity of events, with the unit of counting being the event itself. (iii) Based on this semantic analysis, pluractionality of VV formed with certain verbs can be further derived through the competition with V-one-V. Additionally, our analysis of cognate classifiers can be extended to the nominal domain.

Keywords: verbal classifiers, countability, atomicity, cumulativity

1. Introduction

Verbs in Mandarin Chinese can be followed by what seems to be a reduplicative morpheme, forming a sequence that contains two occurrences of the same verb (henceforth VV). VV formed with certain verbs conveys event-internal pluractionality (cf. Deng, 2013). For example, *qiao qiao* ('knock knock') and *ti ti* ('kick kick') in (1) are used to convey that there are several knocks or kicks required to be performed by the addressee.

(1) a. ni **qiao qiao** men.
you knock knock door
'You give several knocks on the door.'

b. ni **ti ti** men.
you kick kick door
'You give several kicks to the door.'

At first sight, this conforms to the cross-linguistic connection between pluractionality and verb reduplication (See Newman, 2012 for an overview). However, there is much debate on the structure and meaning of VV, particularly regarding (i) whether VV is formed through morphological reduplication (Li and Thompson, 1981) or has a phrasal structure (Chao, 1968), and (ii) whether VV expresses aspectual (Wang, 1954) or quantitative meaning (Zhu, 1982). Here, we would like to further point out that none of the previous analyses can fully account for the following puzzles.

Puzzle I: Numerals and aspectual markers can occur in between the two Vs. For example, the numeral *yi* ('one') and the aspectual marker *le* can be inserted within VV, as in (2).

(2) a. ni **qiao** yi **qiao** men.
you knock one knock door
'You give several knocks on the door.'

b. ta **qiao**-le **qiao** men.
he knock-PERF knock door
'He gave several knocks on the door.'

Puzzle II: Not all verbs can form VV. Activities can form VV whilst statives and achievements cannot[2]; compare (1) with (3).

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[2] Accomplishments in Mandarin Chinese are expressed by phrases rather than simplex verbs (Huang, 2014). Given that VV tragets simplex verbs, our discussion will be focused on activities, achievements, and statives.

(3) a. *ta **shi shi** haoren.
he be be good.person
Int.: 'He is a good person.'

b. *ta **dao dao** lundun.
he reach reach London
Int.: 'He reaches London.'

Puzzle III: Not all instances of VV express pluractionality. For example, *deng deng* ('wait wait') in (4a) and *xiang xiang* ('think think') in (4b) cannot be construed as multiple occurrences of waiting events or thinking events, but rather as a single event that holds for an arbitrary time span, yielding sort of a durative reading.

(4) a. ni **deng deng** wo.
you wait wait me
'You wait for me for a while.'

b. ni **xiang xiang** zhe ge wenti.
you think think this CL issue
'You think about this issue for a while.'

Puzzle IV: It is unclear how pluractionality is derived in VV formed with certain activities. Note that the plural interpretation is not limited to VV formed with semelfactive verbs. VV formed with activities like *ca* ('wipe'), *rou* ('rub'), *mo* ('caress'), *zhuai* ('tug'), *dong* ('move'), *bo* ('tuck'), *tui* ('push'), *la* ('pull'), and *zhuan* ('turn') also exhibits pluractionality; see (5).

(5) a. ta **ca**-le **ca** zhuozi.
he wipe-PERF wipe table
'He gave the table several wipes.'

b. ta **rou**-le **rou** houbei.
he rub-PERF rub back
'He gave his back several rubs.'

c. ta **mo**-le **mo** wo-de tou.
he caress-PERF caress I-MOD head
'He gave several caresses to my head.'

d. ta **zhuai**-le **zhuai** ziji-de xiuzi.
he tug-PERF tug self-MOD sleeve
'He gave his sleeve several tugs.'

The goal of this research is to analyse the structure and meaning of VV and to derive pluractionality of certain VV. We first review the previous analyses in Section 2, then in Section 3 we argue that VV is actually an instantiation of V-(NUMERAL)-CLASSIFIER (henceforth V-NUM-CL), i.e., the second V is a cognate verbal classifier. That is why VV allows for the insertion of numerals and aspectual markers (**Puzzle I**). In Section 4, we propose that VV denotes an indefinite quantity of events with the unit specified as the event itself. **Puzzle II** and **Puzzle III** are attributed to cumulativity and stable atomicity of events, which are represented as functional heads in the projection of verbal classifiers. Our proposed semantics then enables us to derive the pluractionality of VV formed with certain activities through a pragmatic competition with V-one-V (Section 5), thereby solving **Puzzle IV**. Finally, in Section 6, we delve into the motivation for cognate verbal classifiers and extend our analysis to the nominal domain.

2. Previous analyses

2.1. Structure of VV: Reduplication vs. syntactic construction

VV has been viewed as reduplication (Li and Thompson, 1981; Paris, 2013) and assumed to be either stocked in the lexicon (Deng, 2013) or derived morphologically (Zhu, 1982). Nonetheless, the reduplication analysis encounters the challenges of **Puzzle I** and **Puzzle II**. First, the linearization problem of the inserted numerals and aspectual markers in (2) has been either left unresolved (Deng, 2013) or simply attributed to ad hoc phonological rules (Yang and Wei, 2017). Second, the reduplication analysis faces the difficulties in explaining the compatibility pattern of VV with different verbs in (3), given that reduplication is not supposed to be sensitive to the Aktionsart of verbs.

An alternative analysis is to consider VV as a syntactic construction, wherein the first occurrence of V is a verb, whilst the second occurrence of V is a verbal classifier (Fan, 1964; Chao,

1968; Xiong, 2016). The syntactic approach pinpoints not only the internal structure of VV but also the similarities among three associated sequences, i.e., VV, V-NUM-V, and V-NUM-CL. Verbal classifiers in Mandarin encode units for counting in the domain of events. For example, in (6a) the verbal classifier *xia* provides a unit for kicks, just as in (6b) the nominal classifier *ge* provides a unit for pears.

(6) a. ti san **xia**
kick three CL
'give three kicks'

b. san **ge** li
three CL pear
'three pears'

Verbal classifiers feature two subtypes that lexically encode the distinction between events and occasions (Cusic, 1981). Specifically, *xia* provides a counting unit for events, and *ci* provides a counting unit for occasions (Deng, 2013; Donazzan, 2013; Zhang, 2017; Liao, 2018), as exemplified by (7). In English, such a distinction manifests as scopal difference of *time*-expressions (Andrews, 1983), shown by (8). We will return to this distinction in Section 3.1 and 4.1.

(7) ta ti-le san **ci** men, mei ci ti si {**xia** / *__ci__}.
he kick-PERF three CL_{occ} door each CL_{occ} kick four CL_{evt} CL_{occ}
'He kicked the door on three occasions, and on each occasion he gave four kicks.'

(8) a. John kicked the door three times four times. (three events, four occasions)
b. John kicked the door four times three times. (four events, three occasions)

The syntactic approach presents two advantages over the reduplication analysis. First, the issue of the insertion of numerals and aspectual markers (**Puzzle I**) can be resolved, as the second V is viewed as a verbal classifier. Second, it may also provide a potential explanation for the compatibility pattern of VV with different verbs (**Puzzle II**) through the s-selection of a functional head. The details of the explanation will be further explored in Section 4.2. [3]

2.2. Meaning of VV: Aspect vs. Quantity

Within the aspect-based approach, VV has been assumed to carry certain aspectual information such as delimitativeness (Li and Thompson, 1981), short duration (Wang, 1954), or tentativeness (Chao, 1968; Yang and Wei, 2017). The delimitativeness view claims that the events conveyed by VV are low in frequency or short in temporal length. The short duration view underlines the latter. However, the denotation of VV is not necessarily tied to a small amount in frequency or duration. For instance, *ca ca* ('wipe wipe') and *xiang xiang* ('think think') can occur in contexts where the wiping and thinking take a considerable amount of time, as in (9) and (10). As for tentativeness, it is a context-dependent reading of VV observed only in irrealis contexts, as VV in (5) does not show tentativeness. Even in irrealis contexts, (9) and (10) demonstrate that the events denoted by VV can be mandatory.

(9) diban zheme zang, dei ca yi ge xingqi, ni haohao **ca ca**.
floor this dirty require wipe one CL week you sufficiently wipe wipe
'Such a dirty floor needs a week of wiping. You give it a sufficient number of wipes.'

(10) ni zixi **xiang xiang** zhe ge wenti, bu xiang qingchu jiu bie zou.
you carefully think think this CL issue not think clearly then not leave
'You think about this issue thoroughly. Otherwise, you cannot leave.'

[3] Another potential analysis within the syntactic approach contends that the second V is the phonological realisation of an aspectual head (cf. Yang and Wei, 2017). This hinges on the assumption that VV carries certain aspectual information which, as will be demonstrated in Section 2.2, is not firmly grounded.

Within the quantity-based approach, the meaning of VV is related to quantity such as small quantity in occurrences or duration (Zhu, 1982), indefinite quantity (Li, 1964), vague quantity (Cheng, 1988), or event plurality (Gu, 2008; Deng, 2013). The small quantity analysis is not solid. As we have seen in (9), the denotation of VV is not necessarily small in quantity. The other three analyses converge on acknowledging the pluractionality of certain VV. Here, we would like to add two pieces of evidence to amplify this point: (i) VV can be associated with *dou* that introduces universal quantification (cf. Lee, 1986; Lin, 1998; a.o.), shown by (11); and (ii) such VV is unacceptable in singular-event scenarios, shown by (12).

(11) ta **qiao**-le **qiao** men, dou qiao-zai-le boli-shang.
he knock-PERF knock door all knock-on-PERF glass-LOC
'He gave several knocks on the door, all of which were on the glass panel.'

(12) #baochi anjing. buyao qiao hao ji xia men, **qiao qiao** men.
keep quiet don't knock very several CL_{evt} door knock knock door
Int.: 'Keep quiet. Don't give multiple knocks on the door; give one knock on the door.'

However, the quantity-based approach still left **Puzzle III** and **IV** unsolved, i.e., why *qiao qiao* ('knock knock') conveys pluractionality while *deng deng* ('wait wait') does not.

To summarise, for the structure of VV, the syntactic approach has advantages over the reduplication analysis; for the meaning of VV, the quantity-based appoach is more solid than the aspect-based approach. On the basis of the syntactic appraoch and the quantity-based approach, we will further address the four puzzles introduced in Section 1. Now let us first elaborate on the syntactic structure of VV in Section 3.

3. Syntax of VV

3.1. VV: V-(NUM)-CL under the guise of reduplication

As mentioned in Section 2.1, treating VV as reduplication is deficient with respect to **Puzzle I** and **Puzzle II**. More evidence from Mandarin and the earlier stages of its development suggests that VV has an internal syntactic structure.

First, more than one word are allowed to occur in between the two Vs, such as the numeral *yi* ('one'), the perfective marker *le*, and the resultative predicate *shang*.

(13) ta **dan**-le yi **dan** shen-shang-de chentu.
he whisk-PERF one whisk body-LOC-MOD dust
'He gave several whisks to remove the dust from his body.'

(14) fanshi ren-de dongxi, beijingren dou neng **wan**-shang yi **wan**.
all human-MOD thing Beijinger all can play-RESULT one play
'For every handicraft, Beijingers can play with it for a while.'

Second, whereas the numeral between VV is limited to *yi* ('one') in Mandarin, numeral-insertion is productive in late Medieval and early Modern Chinese.

(15) jiang mashaoer qu na menxian-shang **qiao** san **qiao**.
take spoon go that threshold-LOC knock three knock
'Use the spoon to give three knocks on that threshold.'
(*Taohuanv po fa jia Zhougong*, Drama, 1200s A.D.)

Numeral insertion suggests that the second V of VV is a verbal classifier. We would like to present more evidence to demonstrate that VV is actually an instantiation of V-(NUM)-CL. First, the second V of VV stands in complementary distribution with NUM-CL.

(16) ta **qiao**-le **qiao** (*__ji__ **xia**) men jiu zou-le.
he knock-PERF knock several CL door then leave-PERF
'He gave several knocks on the door and then left.'

Second, VV and V-CL have the same licensing condition on *yi*-ellipsis. For V-NUM-V and V-NUM-CL, when the numeral is *yi* ('one') and not focused, *yi* is optional. [4]

(17) a. ni **qiao** (yi) **qiao** men.
you knock one knock door
'You give several knocks on the door.'

b. ni **qiao** (yi) **xia** men.
you knock one CL door
'You give several knocks on the door.'

Third, both VV and V-(NUM)-CL allow for *le*-insertion, whereas the aspectual marker *le* cannot be attached to the whole construction; compare (18) with (19). The position of *le* suggests that only the first V of VV occupies the V head.

(18) a. ta **qiao**-le **qiao** men.
he knock-PERF knock door
'He gave several knocks on the door.'

b. *ta **qiao** **qiao**-le men.
he knock knock-PERF door
Int.: 'He gave several knocks on the door.'

(19) a. ta **qiao**-le **xia** men.
he knock-PERF CL door
'He gave several knocks on the door.'

b. *ta **qiao** **xia**-le men.
he knock CL-PERF door
Int.: 'He gave several knocks on the door.'

Fourth, the second V of VV parallels *xia*, the event-counting classifier *xia*, as shown by (20). As mentioned in Section 2.1 and exemplified by (7), verbal classifiers in Mandarin differ in providing counting units for events (e.g., *xia*) and for occasions (e.g., *ci*). Thus, (20) demonstrates that VV conveys event counting rather than occasion counting.

(20) a. ta **qiao**-le **qiao** men, mei {*ci / xia} dou hen qing.
he knock-PERF knock door each CL_{occ} CL_{evt} all very gentle
'He gave several knocks on the door, and each knock was very gentle.'

b. ta **qiao**-le ji **xia** men, mei {*ci / xia} dou hen qing.
he knock-PERF several CL_{evt} door each CL_{occ} CL_{evt} all very gentle
'He gave several knocks on the door, and each knock was very gentle.'

Fifth, VV pairs with V-(NUM)-CL_{evt} in the compatibility with verbs, as attested by 170 verbs and summed up in the table below. Specifically, statives are rejected by VV and V-NUM-CL. Achievements are rejected by VV and V-NUM-CL_{evt} yet compatible with V-NUM-CL_{occ}. Activities are divided into two types. Activities I, like *qiao* ('knock'), can occur in VV and V-NUM-CL, and VV formed with Activities I is pluractional. Activities II like *deng* ('wait') can occur in VV and V-NUM-CL except plural event counting such as V-three-CL_{evt}, and VV formed with Activities II is not pluractional.

Class	Example	VV	V-one-CL_{evt}	V-three-CL_{evt}	V-NUM-CL_{occ}
Statives	*shi* ('be')	−	−	−	−
Achievements	*dao* ('reach')	−	−	−	+
Activities I	*qiao* ('knock')	$+_{pluractional}$	+	+	+
Activities II	*deng* ('wait')	$+_{singular}$	+	−	+

[4] Focused numerals are stressed in Mandarin, whereas the unfocused *yi* ('one') does not receive any stress. The same licensing condition on *yi*-ellipsis has also been observed in the nominal domain (cf. Jiang, 2018; a.o.).

Together, the evidence supports our claim that VV is in fact V-one-CL$_{evt}$ with an unfocused, elided *yi* ('one'). The second V of VV is a cognate verbal classifier providing a counting unit for events, which is comparable to the general verbal classifier *xia*. We will return to the semantics of cognate verbal classifiers in Section 4.2.

3.2. NUM-CL is an adjunct

In line with Huang, Li, and Li's (2009) adjunct-based analysis, we argue that NUM-CL$_{evt}$ in V-NUM-CL$_{evt}$ is an adjunct rather than a complement of the verb. First, NUM-CL$_{evt}$ is optional.

(21) a. ni **qiao** (yi **qiao**) men.
you knock one CL$_{\text{KNOCK}}$ door
'You give several knocks on the door.'

b. ni **qiao** (yi **xia**) men.
you knock one CL$_{evt}$ door
'You give several knocks on the door.'

Second, NUM-CL$_{evt}$ can co-occur with both the direct object and the indirect objects.

(22) a. ni **jiao** (yi) **jiao** wo shuxue.
you teach one CL$_{\text{TEACH}}$ me math
'You teach me math a bit.'

b. ni **jiao** (yi) **xia** wo shuxue.
you teach one CL$_{evt}$ me math
'You teach me math a bit.'

Third, NUM-CL$_{evt}$ does not display scope ambiguity with universal quantifiers. For instance, (23a) only has a reading where the object scopes over NUM-CL$_{evt}$. By contrast, the two objects in (23b) display free scopal relations. This contrast can be attributed to the adjunct status of NUM-CL$_{evt}$, since it is reasonable to assume that adjuncts do not undergo quantifier raising (cf. Landman, 2004). [5]

(23) a. ta **qiao**-le suoyou men **shi xia**.
he knock-PERF all door ten CL
'For all doors, he gave ten knocks.' ∀≫10; *10≫∀

b. ta **gei**-le suoyou ren **shi ben shu**.
he give-PERF all person ten CL book
'He gave everyone ten books.' ∀≫10
'There were ten books that he gave everyone.' 10≫∀

3.3. Structuring V-NUM-CL

We have argued that VV is an instantiation of V-(NUM)-CL$_{evt}$, and NUM-CL$_{evt}$ is an adjunct of V rather than its complement. Since NUM-CL$_{evt}$ encodes event counting instead of occasion counting, we assume that NUM-CL$_{evt}$ is situated structurally inside *v*P (cf. Cinque, 1999; Zhang, 2017). In the spirit of Borer (2005), we further propose that NUM-CL is represented as Quan(tity)P, as (24) illustrates.

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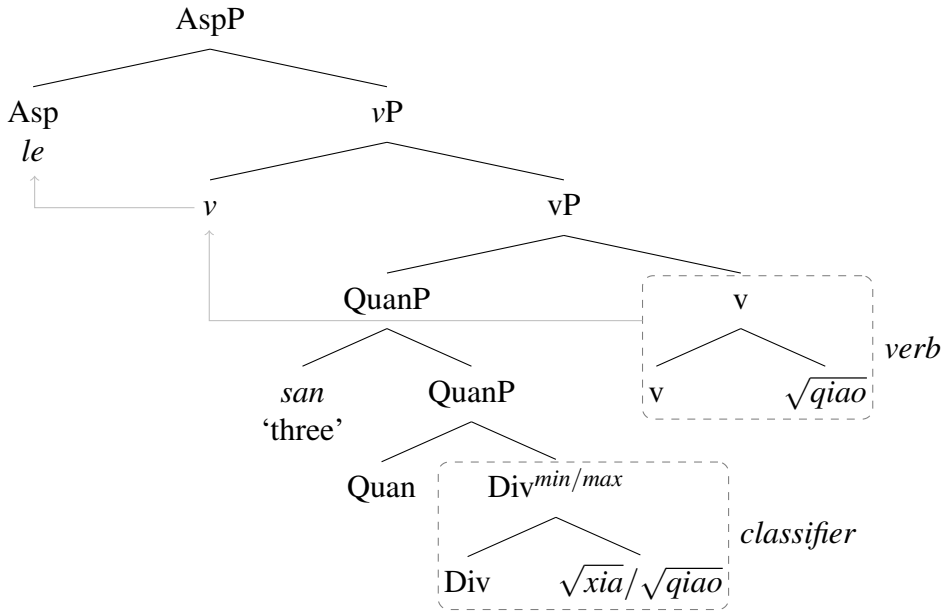
[5] Manfred Krifka (p.c.) points out that the lack of wide scope reading of NUM-CL$_{evt}$ could be due to the difficulty of identifying certain ten knocks in the context. However, in Mandarin we can use demonstratives such as *zhe* ('this') and *na* ('that') to identify events, and (i) below illustrates that the wide scope reading of NUM-CL$_{evt}$ is available with the occurrence of the demonstratives.

(i) ta qiao suoyou men-de **na shi xia** dou bei lu-xialai-le.
he knock all door-MOD that ten CL all PASS record-RESULT-PERF
'Those ten knocks that he gave on all doors are all recorded.' 10≫∀

(24)



QuanP is an adjunct to the verb. Internally, QuanP is headed by Quan that takes a numeral as its specifier and a verbal classifier Div(ision)$^{min/max}$ as its complement[6]. With respect to the linear order, we follow Huang et al.'s (2009) analysis and assume that the verb moves up to *v* and eventually lands in the Asp head. This gives us the desirable order of V-NUM-CL$_{evt}$ as well as the linear adjacency of the verb and the aspectual marker *le*, which solves the *le*-insertion problem in **Puzzle I**.[7]

As for verbs and verbal classifiers, we adopt core assumptions from Distributed Morphology (Marantz, 2007; Embick and Marantz, 2008; a.o.), and assume that terminal nodes can be decomposed into roots and categorizers. The categorizer provides a categorial label for the root, and the root encodes lexical information. In this way, a verb and a verbal classifier are syntactically isomorphic, and the same root, e.g., $\sqrt{qiao}$ ('knock'), can merge with the verbal categorizer (v) or the categorizer for classifiers (Div), which accounts for the identical lexical form of the cognate verbal classifier and the verb.

4. Semantics of V-NUM-CL

4.1. Ontology of events

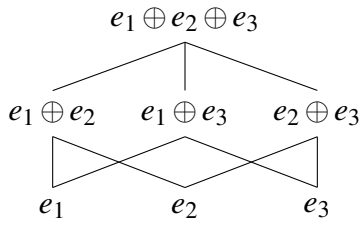
Before discussing the semantics of V-NUM-CL, let us elaborate on the background assumptions about events and verbs.

First, following the general assumption that a verb denotes a set of events (Parsons, 1990; Krifka, 1992; a.o.), and Krifka's (1989) idea that there is a semi-lattice structure in the domain of events, we assume that a verb denotes a structured set of events, as schematised in (25). That is, the denotation of a verb may include atomic events and complex events. Atomic events have no sub-events, while complex events consist of at least two atomic events.

[6] Following Chomsky (1995), a functional category can be both maximal and minimal. Hence, it is plausible to assume that Div$^{min/max}$ is a complex head which is simultaneously maximal and minimal.

[7] We do not treat the verbal classifier as a head in the Extended Projection of V, contra Zhang (2017). Empirically, we have argued that NUM-CL$_{evt}$ is an adjunct in Section 3.2. Technically, treating the verbal classifier as a head would block the V-to-*v*-to-Asp movement and thus fails to account for the linear adjacency of V and *le*, as in (18) and (19), and the linear order of V-NUM-CL$_{evt}$-O, as in (20b).

(25)



Second, verbs with different lexical aspects can be characterized by different types of event sets, as (26) illustrates. Statives like *shi* ('be') denote a set of states (notated as *s*) rather than events (notated as *e*). Achievements (and accomplishments) like *dao* ('reach') denote a set of atomic events. Given that achievements express a single punctual event, two achievement events cannot be cross-temporally indentical when they count as the same event for the purpose of enumerating events (Lund, 2021), namely, there are no complex achievement events. Activities like *qiao* ('knock') and *deng* ('wait') denote a set of events consisting of both atomic events and complex events, since activity events can be cross-temporally identical.

(26)
$[\![shi]\!] = \{s_{be1}, s_{be2}, s_{be3}, \ldots\}$ Statives
$[\![dao]\!] = \{e_{reach1}, e_{reach2}, e_{reach3}, \ldots\}$ Achievements
$[\![qiao]\!] = \{e_{knock1}, e_{knock2}, \ldots, e_{knock1} \oplus e_{knock2}, \ldots\}$ Activities
$[\![deng]\!] = \{e_{wait1}, e_{wait2}, \ldots, e_{wait1} \oplus e_{wait2}, \ldots\}$ Activities

Third, occasions, at least in Cusic's (1981) sense, can be characterised as groups of events by Landman's (2006) groupification operator $\uparrow$[8]. A group of events contains at least one atomic event or one complex event; see (27).

(27) Group of events: $\uparrow(e), \uparrow(e_1 \oplus e_2), \ldots$ Occasions

The well-known event-internal vs. event-external distinction can now be reformulated in terms of events and groups of events. As introduced in Section 2, such a distinction is lexically manifested in verbal classifiers in Mandarin – *xia* (CL_{evt}) provides a counting unit for events whereas *ci* (CL_{occ}) provides a counting unit for groups of events.

4.2. Composition of V-NUM-CL

In this section, we deal with the semantic composition of V-NUM-CL, taking *qiao san xia* and *qiao san qiao* in (28) as examples.

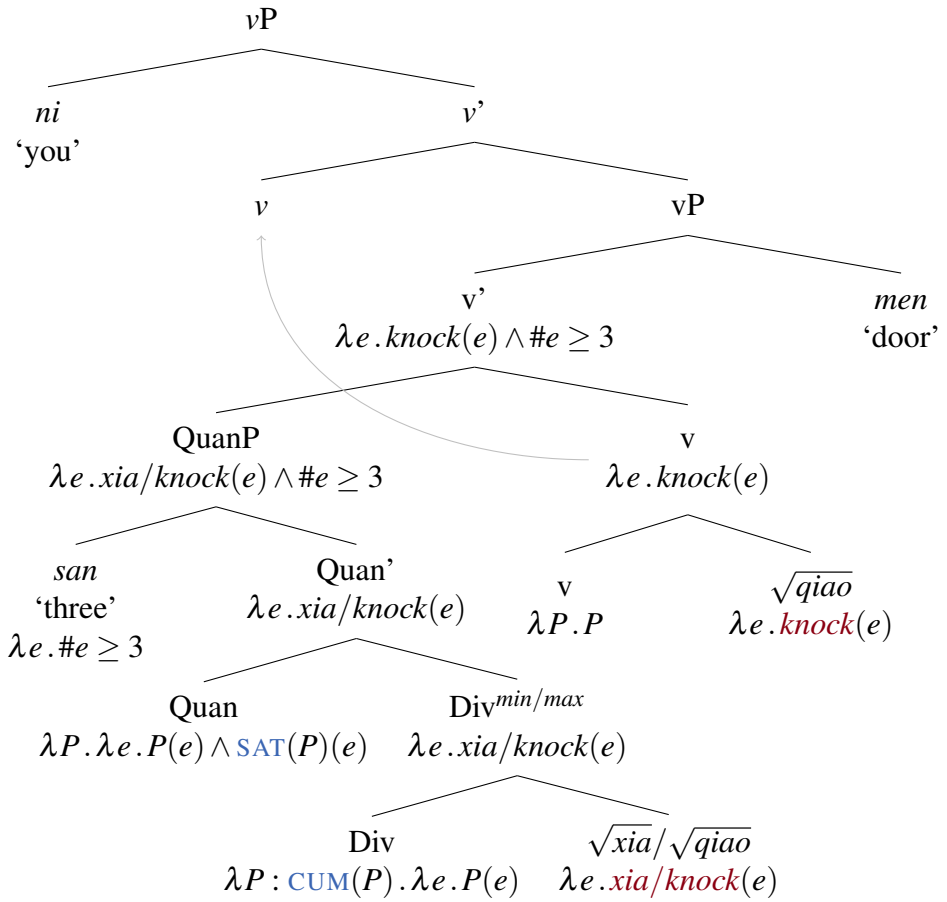
(28) a. ni **qiao san xia** men.
you knock three CL_{evt} door
'You give three knocks on the door.'

b. jiang mashaoer qu na menxian-shang **qiao san qiao**.
take spoon go that threshold-LOC knock three knock
'Use the spoon to give three knocks on that threshold.'
(*Taohuanv po fa jia Zhougong*, Drama, 1200s A.D.)

Adopting Neo-Davidsonian event semantics (Parsons, 1990; Carlson, 1984; a.o.), we treat verbs as one-place predicates of events, combined with the thematic arguments via predicate modification. (29) illustrates our proposal of the semantic composition of V-NUM-CL.

[8]See also Wągiel (2018) for a mereotopological analysis of groups, according to which a group is taken as a cluster, i.e., a plurality of transitively connected entities.

(29)



4.2.1. Cumulativity and Puzzle II

Given that cognate verbal classifiers share the same lexical form as verbs, and verbal classifiers are grammaticalized out of verbs in Medieval Chinese (Liu, 1959), we put forward that verbal classifiers have the same semantic type as verbs. Since a verb can be decomposed into a root and a categorizer (Marantz, 1997; a.o.), we assume, for simplicity, that the root denotes a set of events, and the verbal categorizer carries an identity function. As for verbal classifiers, the root also denotes a set of events, and the categorizer Div selects a certain type of roots, given the compatibility pattern of VV and V-NUM-CL (**Puzzle II**; see the table below).

Class	Example	VV	V-one-CL$_{evt}$	V-NUM-CL$_{occ}$
Statives	*shi* (‘be’)	−	−	−
Achievements	*dao* (‘reach’)	−	−	+
Activities	*qiao* (‘knock’), *deng* (‘wait’)	+	+	+

To account for the compatibility pattern, we propose that the categorizer Div selects roots via the cumulativity presupposition (cf. Scha, 1981; Schein, 1986), as in (30). The cumulativity presupposition requires the input of Div to contain complex events (i.e., divisible events).

(30) **Cumulativity of events**
$\text{CUM}(P) \stackrel{\text{def}}{=} \forall e[P(e) \rightarrow \forall e'[P(e') \rightarrow P(e \oplus e')]]$

Essentially, the categorizer Div determines what types of roots can form a verbal classifier, which further results in the compatibility of VV and V-NUM-CL with verbs of different lexical

aspects. Given the cumulativity presupposition, Div exclusively selects activity roots, since only activity roots have complex events in their denotations. That is, only activity roots (e.g., $\sqrt{qiao}$ 'knock', $\sqrt{deng}$ 'wait') can form verbal classifiers; stative roots like $\sqrt{shi}$ 'be', denoting a set of states rather than events, do not match the type of the input of Div; achievement roots like $\sqrt{dao}$ 'reach' denote a set of events consisting of atomic events only, do not meet the cumulativity presupposition. Consequently, only activity roots can form VV.

One special case of activity roots selected by Div is $\sqrt{xia}$. Etymologically, the verb *xia* ('move down') denotes a set of events with a downward trajectory, as in (31a); then, it undergoes semantic bleaching and is used as a dedicated verbal classifier. Since the verbal classifier *xia* provides a natural counting unit for all activity events, it is reasonable to assume that the denotation of bleached $\sqrt{xia}$ is the union of all the activity roots, as in (31b).[9,10]

(31) a. $[\![\sqrt{xia}]\!] = \{e_{down1}, e_{down2}, e_{down1} \oplus e_{down2}, \ldots\}$

b. $[\![\sqrt{xia}_{bleached}]\!] = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots, e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

Given the denotation of $\sqrt{xia}_{bleached}$ in (31b), again, only activities can serve as the main verb in V-one-CL_{evt} (i.e., V-one-*xia*). As introduced previously, one-*xia* and V are combined via predicate modification, i.e., intersecting two sets of events. Since the set of events denoted by *xia* includes only activity events, and its intersection with the set of events denoted by V cannot be an empty set, the denotation of V must include activity events. As a result, V must be activities.

Note that there is no achievement events in the denotation of $\sqrt{xia}_{bleached}$. Given the cumulativity presupposition in (30), the input of Div must contain members that are summable. Since achievement events are not summable (Section 4.1), they are excluded from the denotation of $\sqrt{xia}_{bleached}$. Consequently, for V-one-*xia*, V cannot be achievements.

As for V-NUM-CL_{occ} (i.e., V-NUM-*ci*), the denotation of the verbal classifier *ci* is assumed as follows.

(32) $[\![\sqrt{ci}]\!] = \{\uparrow(e_{knock1}), \uparrow(e_{knock2}), \uparrow(e_{knock1} \oplus e_{knock2}), \uparrow(e_{knock1}) \oplus \uparrow(e_{knock2}), \ldots$
$\uparrow(e_{wait1}), \uparrow(e_{wait2}), \uparrow(e_{wait1} \oplus e_{wait2}), \uparrow(e_{wait1}) \oplus \uparrow(e_{wait2}), \ldots$
$\uparrow(e_{reach1}), \uparrow(e_{reach2}), \uparrow(e_{reach1}) \oplus \uparrow(e_{reach2}), \ldots\}$

The denotation of *ci* differs from that of *xia* in two aspects. First, *ci* tragets groups of events (see Section 2.1), and hence $\sqrt{ci}$ denotes a set of groups of events. Before merging with NUM-*ci*, V is first combined with the groupification operator (↑), rendering a set of groups of events. Since the intersection of NUM-*ci* and ↑V is a non-empty set, V cannot be statives that fail to match the type of NUM-*ci*. Second, the denotation of $\sqrt{ci}$ contains sums of groups of achievement events. As discussed in Section 4.1, there are no sums of achievement events within one occasion. However, among multiple occasions, there exist sums of groupified achievement events like $\uparrow(e_{reach1}) \oplus \uparrow(e_{reach2})$. That is the reason why, in addition to activities, achievements can serve as the verb in V-NUM-*ci*.

[9] The bleached $\sqrt{xia}$ cannot form a verb, which could be attributed to the lexical blocking by *zuo* ('do').

[10] The denotation of $\sqrt{xia}_{bleached}$ in (31b) satisfies the cumulativity presupposition in (30), as the sum operator only applies to entities of the same kind – in principle, there are no complex events like $e_{knock} \oplus e_{wait}$.

4.2.2. Stable atomicity and Puzzle III

Let us proceed to the other functional head, Quan, which takes the output of Div, i.e., verbal classifiers formed with activity roots. Quan is related to the differences between two the types of activities in Mandarin with respect to the interpretation of VV and the restriction on numerals. First, VV formed with Activities I (*qiao* 'knock') exhibits pluractionality, while VV formed with Activities II (*deng* 'wait') does not (**Puzzle III**). Second, Activities I are compatible with any numerals in V-NUM-CL$_{evt}$, whereas for Activities II, the numeral is limited to *yi* ('one').[11]

Class	Example	VV	V-one-CL$_{evt}$	V-three-CL$_{evt}$	V-NUM-CL$_{occ}$
Activities I	*qiao* ('knock')	$+_{pluractional}$	+	+	+
Activities II	*deng* ('wait')	$+_{singular}$	+	−	+

To account for the pattern above, we propose two flavours of Quan that diverge in terms of stable atomicity, specifically, whether an atomic event maintains atomic across contexts, as (33) illustrates (cf. Chierchia, 2010). As defined in (34), Quan$_1$ takes a set of events and yields a set of events with its members composed of stable atoms, whereas Quan$_2$ takes a set of events and yields a set of events with its members composed of unstable atoms.

(33) **Stable atomicity of events**
$\text{SAT}(P)(e) \stackrel{\text{def}}{=} \exists e'[e' \sqsubseteq e \wedge P(e') \wedge \forall c[\neg\exists e'' \text{ in } c[e'' \sqsubset e']]]$

(34) a. $[\![\text{Quan}_1]\!] = \lambda P.\lambda e.P(e) \wedge \text{SAT}(P)(e)$
b. $[\![\text{Quan}_2]\!] = \lambda P.\lambda e.P(e) \wedge \neg\text{SAT}(P)(e)$

For an intuitive illustration, consider the difference between knocking events, which have stable atoms, and waiting events, which have unstable atoms. An atomic knocking event is stable in the sense that in different contexts it remains minimal and has no subevent that could be considered as a knocking event. However, atomic waiting events vary across different contexts. For instance, consider a scenario where John waited for Mary for an hour, went to the restroom, and then returned to wait for her for an additional hour. In this scenario, John's waiting could potentially be construed as either a single waiting event or as two distinct waiting events.

Events with stable atoms can be precisely counted, whereas events with unstable atoms are too vaguely specified to be counted. In our analysis, the difference on the counting result can be represented as the requirement of Quan on the numerals in its specifier position. We analyse numerals in NUM-CL as intersective modifiers rather than quantifiers, as evidenced by (23), and assume that their basic semantics is the *at least* reading, following Horn (1972), Levinson (2000), Schulz and van Rooij (2006) among others; see the illustrations in (35).[12] Consequently, Quan$_1$ allows for precise counting results and thus can take any numerals as its specifier, while Quan$_2$ only allows for vague counting results limited to the unfocused *yi* ('one') with an *at least* reading, indicating the existence of events.

(35) $[\![yi \text{ ('one')}]\!] = \lambda e.|\{e' \mid e' \leq_{atom} e\}| \geq 1 = \lambda e.\#e \geq 1$ $\quad$ $[\![san \text{ ('three')}]\!] = \lambda e.|\{e' \mid e' \leq_{atom} e\}| \geq 3 = \lambda e.\#e \geq 3$

[11] The same pattern is also observed in V-NUM-V in early Modern Chinese. V-NUM-V with Activities I allows for any numerals, while V-NUM-V with Activities II is only compatible with *yi* ('one').

[12] See Bylinina and Nouwen, 2020 for an overview of numeral semantics. As a modifier, the numeral can be decomposed into a number and a covert cardinality operator MANY (Buccola and Spector, 2016; a.o.).

Now we are equipped to explain the differences between two types of activities. For V-NUM-CL_{evt} (i.e., V-NUM-*xia*), recall that the denotation of bleached $\sqrt{xia}$ contains all activity events and that Div does not alter its input. If *xia* merges with Quan_1, the output is restricted to a set containing only the events composed of stable atoms, namely, the union set of the events denoted by Activities I. In this case, the verb in V-NUM-CL_{evt} can only be Activities I. Since the output of Quan_1 can take any numerals as its specifier, V-NUM-CL_{evt} with Activities I does not pose any constraints on numerals.

(36) Illustration of *qiao san*$_{\text{F}}$ *xia* ('knock three CL_{evt}')

a. $[\![\text{Div}]\!]([\![\sqrt{xia}]\!]) = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots, e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

b. $[\![\text{Quan}_1]\!]([\![\text{Div}]\!]([\![\sqrt{xia}]\!])) = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots\}$

c. $([\![san_{\text{F}}]\!])([\![\text{Quan}_1]\!]([\![\text{Div}]\!]([\![\sqrt{xia}]\!]))) = \{e_{knock1} \oplus e_{knock2} \oplus e_{knock3}, \ldots\}$

d. $([\![qiao]\!])(([\![san_{\text{F}}]\!])([\![\text{Quan}_1]\!]([\![\text{Div}]\!]([\![\sqrt{xia}]\!])))) = \{e_{knock1} \oplus e_{knock2} \oplus e_{knock3}, \ldots\}$

If *xia* merges with Quan_2, the output is restricted to a set of events composed of unstable atoms, i.e., the union set of the events denoted by Activities II. In this case, the verb in V-NUM-CL_{evt} can only be Activities II. Since Quan_2 only allows for the unfocused *yi* ('one') to be its specifier, the numeral in V-NUM-CL_{evt} with Activities II is limited to the unfocused *yi* ('one').

(37) Illustration of *deng yi*$_{\text{UF}}$ *xia* ('wait one CL_{evt}')

a. $[\![\text{Div}]\!]([\![\sqrt{xia}]\!]) = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots, e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

b. $[\![\text{Quan}_2]\!]([\![\text{Div}]\!]([\![\sqrt{xia}]\!])) = \{e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

c. $([\![yi_{\text{UF}}]\!])([\![\text{Quan}_2]\!]([\![\text{Div}]\!]([\![\sqrt{xia}]\!]))) = \{e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

d. $([\![deng]\!])(([\![yi_{\text{UF}}]\!])([\![\text{Quan}_2]\!]([\![\text{Div}]\!]([\![\sqrt{xia}]\!])))) = \{e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

Note that for V-NUM-CL_{occ} with Activities II, the numeral is not limited to the unfocused *yi* ('one'). For example, *deng san ci* ('wait three CL_{occ}') is grammatical, indicating three groups of waiting events. This seems to suggest that groups have the property of stable atomicity. We leave this issue for future work.

As for VV, namely, V-(one_{UF})-V, whether it exhibits pluractionality (**Puzzle III**) is also related to the stable atomicity of events. Roughly speaking, with Activities I, V-(one_{UF})-V denotes a set of events composed of stable atoms, and competes with the singular expression V-one_{F}-V, yielding pluractionality. With Activities II, V-(one_{UF})-V denotes a set of events composed of unstable atoms that cannot be precisely counted, and thus simply indicates the existence of events[13]. As a result, VV formed with Activities II has no singular alternatives like V-one_{F}-V for competition and lacks pluractionality. We will discuss the details of the pragmatic competition in Section 5.

(38) Illustration of *qiao yi*$_{\text{UF}}$ *qiao* ('knock one CL_{KNOCK}')

a. $[\![\text{Div}]\!]([\![\sqrt{qiao}]\!]) = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots\}$

b. $[\![\text{Quan}_1]\!]([\![\text{Div}]\!]([\![\sqrt{qiao}]\!])) = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots\}$

c. $([\![yi_{\text{UF}}]\!])([\![\text{Quan}_1]\!]([\![\text{Div}]\!]([\![\sqrt{qiao}]\!]))) = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots\}$

d. $([\![qiao]\!])(([\![yi_{\text{UF}}]\!])([\![\text{Quan}_1]\!]([\![\text{Div}]\!]([\![\sqrt{qiao}]\!])))) = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots\}$

[13] Such a vague counting interpretation may give rise to a durative reading of VV (cf. Donazzan, 2013).

(39) Illustration of *deng yi*$_{\text{UF}}$ *deng* ('wait one CL$_{\text{WAIT}}$')

a. $[\![\text{Div}]\!]([\![\sqrt{deng}]\!]) = \{e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

b. $[\![\text{Quan}_2]\!]([\![\text{Div}]\!]([\![\sqrt{deng}]\!])) = \{e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

c. $([\![yi_{\text{UF}}]\!])([\![\text{Quan}_2([\![\text{Div}]\!]([\![\sqrt{deng}]\!]))) = \{e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

d. $([\![deng]\!])(([\![yi_{\text{UF}}]\!])([\![\text{Quan}_2([\![\text{Div}]\!]([\![\sqrt{deng}]\!])))) = \{e_{wait1}, e_{wait2}, e_{wait1} \oplus e_{wait2}, \ldots\}$

4.2.3. Denotation of V-NUM-CL

Eventually, according to our analysis, V-NUM-CL denotes some quantity of events, where the counting unit is CL and the counting result is NUM. The verbal classifier can be a general classifier that encodes the natural unit, or, a cognate classifier that takes the event itself as the unit, as exemplified by (40).

(40) a. $[\![knock\ one\ xia]\!] = \lambda e\,.\,knock(e) \wedge \#e \geq 1$
There are at least one knock, the counting unit of which is the **natural unit**.

b. $[\![knock\ one\ knock]\!] = \lambda e\,.\,knock(e) \wedge \#e \geq 1$
There are at least one knock, the counting unit of which is the **knock** itself.

The numerals in general get the *at least* reading, from which the *exactly* reading can be derived as a Gricean scalar implicature (Horn, 1972; Schulz and van Rooij, 2006; a.o.). For instance, when *yi* ('one') is not focused, it has the *at least* reading '≥ 1'. When focused, it triggers stronger alternatives such as '≥ 2' and '≥ 3' and negates them, yielding the *exactly* reading '$= 1$'. For V-NUM-CL$_{evt}$, as discussed in Section 4.2.2, only the ones formed with Activities I (*qiao* 'knock') can have different numerals as alternatives to derive the scalar implicature. That is, only V-NUM-CL$_{evt}$ formed with Activities I can have the *exactly* reading. As for Activities II (*deng* 'wait'), the numeral in V-NUM-CL$_{evt}$ is limited to the unfocused *yi* ('one') with no alternatives, and hence can only receive the *at least* reading. Compare (41a) with (41b).

(41) a. $[\![knock\ one_{\text{UF}}\ xia]\!] = \lambda e\,.\,knock(e) \wedge \#e \geq 1$
$[\![knock\ one_{\text{F}}\ xia]\!] = \lambda e\,.\,knock(e) \wedge \#e = 1$

b. $[\![wait\ one_{\text{UF}}\ xia]\!] = \lambda e\,.\,wait(e) \wedge \#e \geq 1$
$^{*}[\![wait\ one_{\text{F}}\ xia]\!] = \lambda e\,.\,wait(e) \wedge \#e = 1$

One special case of V-one$_{\text{UF}}$-CL$_{evt}$ is VV. As demonstrated in Section 3.1, VV is in fact V-one-CL$_{evt}$ with an unfocused, elided *yi* ('one'). Thereby, VV denotes an indefinite quantity of events, as in (42).

(42) a. $[\![knock\ (one_{\text{UF}})\ knock]\!] = \lambda e\,.\,knock(e) \wedge \#e \geq 1$

b. $[\![wait\ (one_{\text{UF}})\ wait]\!] = \lambda e\,.\,wait(e) \wedge \#e \geq 1$

5. Pluractionality via competition

On the basis of the semantics of V-NUM-CL, we propose a pragmatic mechanism to derive the pluractionality of VV formed with Activities I (**Puzzle IV**), as in (43).

(43) **Competition between VV and V-one$_{\text{F}}$-V**

a. VV formed with Activities I denotes an indefinite quantity of events.
For example, $[\![knock\ knock]\!] = \lambda e\,.\,knock(e) \wedge \#e \geq 1$

b. V-one$_{\mathrm{F}}$-V formed with Activities I denotes exactly one event.
For example, $[\![\textit{knock one}_{\mathrm{F}}\ \textit{knock}]\!] = \lambda e\,.\,\textit{knock}(e) \wedge \#e = 1$

c. V-one$_{\mathrm{F}}$-V is a stronger alternative of VV.[14]

d. Using VV implicates that V-one$_{\mathrm{F}}$-V does not hold, i.e., VV denotes non-singular events.
For example, $[\![\textit{knock knock}]\!] = \lambda e\,.\,\textit{knock}(e) \wedge \#e > 1$

As mentioned in Section 3.1, V-NUM-V formed with Activities I is commonly used in late Medieval and early Modern Chinese (1200s – 1500s A.D.). As exemplified by (44) and (45), the numerals in V-NUM-V are focused, and have the *exactly* reading.

(44) qu menxian-shang **qiao** **yi**$_{\mathrm{F}}$ **qiao**, zhuo zhougongjia si yi kou.
go threshold-LOC knock one CL$_{\mathrm{KNOCK}}$ make Mr. Zhou's die one CL
'If you give one knock on the threshold, one person in Mr. Zhou's family will die.'

Q: **qiao** **liang**$_{\mathrm{F}}$ **qiao** ne? A: zhuo zhougongjia si liang kou.
knock two CL$_{\mathrm{KNOCK}}$ Q make Mr. Zhou's die two CL
'How about giving two knocks?' 'Two people in Mr. Zhou's family will die.'

Q: **qiao** **san**$_{\mathrm{F}}$ **qiao** ne? A: si san kou.
knock three CL$_{\mathrm{KNOCK}}$ Q die three CL
'How about giving three knocks?' 'Three will die.'

(*Taohuanv po fa jia Zhougong*, Drama, 1200s A.D.)

(45) Context: The precious weapon requires three knocks to be activated.

wangming na-chu baobei lai, **qiao**-le **san**$_{\mathrm{F}}$ **qiao**.
Wangming take-out precious.weapon come knock-PERF three CL$_{\mathrm{KNOCK}}$
'Wangming took the secret weapon out and gave it three knocks.'

(*Sanbao taijian xiyang ji*, Novel, 1500s A.D.)

The pragmatic competition between VV and V-one$_{\mathrm{F}}$-V is observed in early Modern Chinese (1500s A.D.), as shown by (46) and (47). V-one$_{\mathrm{F}}$-V in (46) has the *exactly* reading, since the master administered every servant one knock. VV in (47) is pluractional, indicating Wangming's intention of making several knocks, which is supported by the fact that Wangming eventually gave two or three knocks. In Mandarin, the pluractionality of VV formed with Activities I is inherited from cases like (47), although V-NUM-V diminishes and V-one$_{\mathrm{F}}$-V disappears.

(46) Context: The master is rousing the servants by administering knocks to them. Every servant is administered one knock.

que you **qiao**-le **yi**$_{\mathrm{F}}$ **qiao**, qiahao shi dier-ge changban jiao-qilai.
but again knock-PERF one CL$_{\mathrm{KNOCK}}$ just is second-CL servant scream-up
'But (he) again gave one knock, and the second servant just screamed.'

jizhi zai **qiao**-le **yi**$_{\mathrm{F}}$ **qiao**, disan-ge changban you jiaojiang-qilai.
until again knock-PERF one CL$_{\mathrm{KNOCK}}$ third-CL servant also scream-up
'Until (he) gave another knock, the third servant also screamed.'

(*Sanbao taijian xiyang ji*, Novel, 1500s A.D.)

[14] See Katzir (2007) for a definition of alternatives based on structural complexity.

(47) Context: The door is closed, but Wangming wants to know what is going on inside.

'bumian **qiao** ta **qiao**, kan shi zenme.' ta qiao-le liang san qiao.
have.to knock it CL_{KNOCK} see is how he knock-PERF two three CL_{KNOCK}
'Wangming thought, "it is necessary to give several knocks on the door to see what is happening inside." Then he gave two or three knocks.'

(*Sanbao taijian xiyang ji*, Novel, 1500s A.D.)

As for Activities II (e.g., *deng* 'wait'), VV has no alternatives like V-one$_F$-V, since the numeral inside V-NUM-V is limited to the unfocused *yi* ('one'), as discussed in Section 4.2.2. Consequently, VV formed with Activities II does not compete with any related forms, and hence does not exhibit pluractionality.

6. Motivation for cognate classifiers

We have advanced in Section 3 that the underlying structure of VV consists of a verb and its cognate verbal classifier, where the cognate classifier is base generated within the adjunct of the verb. This analysis does not attribute the connection between the verb and the cognate classifier to syntactic movement or copying. Instead, we would like to propose that cognate classifiers in Mandarin are motivated by a semantic requirement.

Intuitively, the way of counting depends on the object being counted, which can be explicitly formulated as the subset requirement in (48). For V-NUM-CL, the selection of verbal classifiers is determined by the verbs, that is, the denotation of the verb is required to be a subset of the denotation of the verbal classifier. In principle, there are two possibilities: (i) The denotation of the verb is a proper subset of that of the classifier, as is the case for the general classifier *xia*. (ii) The denotation of the verb equals to that of the classifier, as is the case for a cognate classifier.

(48) **Subset requirement of dependency**

Let A and B be two sets. If A depends on B, then $B \subseteq A$.

In our case, $[\![\text{v}]\!] \subseteq [\![\text{Div}^{min/max}]\!]$.

(i) If $[\![\text{v}]\!] \subset [\![\text{Div}^{min/max}]\!]$, then $\text{Div}^{min/max}$ is realised as the general classifier *xia*.

(ii) If $[\![\text{v}]\!] = [\![\text{Div}^{min/max}]\!]$, then $\text{Div}^{min/max}$ is realised as a cognate classifier.

Overall, given the subset requirement, there are two strategies for specifying the counting unit – a general classifier representing the union set of all the objects that can be counted, or a cognate classifier that is identical to the object being counted. This is the semantic motivation for cognate classifiers.

The subset requirement is supported by the selectional restriction of classifiers. The general classifier *xia* is compatible with different verbs, as shown by (49a). However, a cognate classifier, due to the lack of subset relations among different verbal roots, is only compatible with the verb that shares the same lexical form, as shown by (49b).

(49) a. {**da / qiao**} yi xia
hit knock one CL_{evt}
'to give a hit' / 'to give a knock'

b. {**da / *qiao**} yi da
hit knock one CL_{HIT}
'to give a hit' / Int.: 'to give a knock'

Note that cases like (50) are ungrammatical in Mandarin, although there are certain entailment

relations between the verbs and the classifiers[15]. This could be attributed to the distinction between the entailment relations and the subset relations defined in (48). The entailment relations between events are captured by conjunction, as originated in Davidson (1967). For instance, to account for the fact that *qiao* ('knock') entails *dong* ('act'), we could analyse a knocking event as a modified acting event, as illustrated by (51). However, the subset relations pertain to sets of events, and therefore are not guaranteed by the entailment relations between events. For instance, there is no subset relation between (51a) and (51b), that is, the denotation of *qiao* ('knock') is not a subset of the denotation of *dong* ('act'). This may explain why *dong* ('act') cannot serve as a classifier for the verb *qiao* ('knock').

(50) a. *qiao yi dong
knock one CL_{ACT}
Intended: 'to give a knock'

b. *da yi dong
hit one CL_{ACT}
Intended: 'to give a hit'

(51) a. $[\![\sqrt{qiao}]\!] = \{e_{knock1}, e_{knock2}, e_{knock1} \oplus e_{knock2}, \ldots\}$
$= \{(e_{act} \wedge e_{w/hand})_1, (e_{act} \wedge e_{w/hand})_2, (e_{act} \wedge e_{w/hand})_1 \oplus (e_{act} \wedge e_{w/hand})_2, \ldots\}$

b. $[\![\sqrt{dong}]\!] = \{e_{act1}, e_{act2}, e_{act1} \oplus e_{act2}, \ldots\}$

Our analysis sheds light on nominal classifiers as well. For example, Archaic Chinese features two types of nominal classifiers – a general classifier *tou* (CL_{HEAD}) that is compatible with different nouns, as in (52), and a cognate classifier that has the identical lexical form as the noun, as in (53). These two strategies in the nominal domain can also be viewed as an outcome of the subset requirement in (48).

(52) huo **niu ma yang** shi-wan yu **tou**.
obtain ox horse sheep ten-ten.thousand more CL_{HEAD}
'(Chongguo) obtained more than a hundred thousand oxen, horses, and sheep.'
(*Qian han ji*, 100s A.D.)

(53) fu **niu** san-bai-wu-shi-wu **niu**, **yang** nian-ba **yang**.
capture ox three-hundred-five-ten-five CL_{OX} sheep twenty-eight CL_{SHEEP}
'(The king) captured three hundred and fifty-five oxen and twenty eight sheep.'
(Bronze inscriptions on *Xiao Yu Ding*, 900s B.C.)

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[15] Thanks to a reviewer for bringing this to our attention.

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