(UN)BOUNDED SPATIAL CATEGORIES IN MANDARIN[1]

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Abstract. The goal of this paper is to account for the distribution of Mandarin spatial adpositions with measure phrases, categories that measure quantities under discussion (in this case, length, e.g. *shi mi* 'ten metres'). We account how this distribution determines their classification into bounded/unbounded prepositions. We show that such an account must consider localisers (e.g. *qian* 'front') and so-called spatial nouns (e.g. *qian-mian* 'front-face') as part of the adpositional phrase, even if previous studies leave spatial nouns aside. We show that in this language this distinction has two important and hitherto undocumented properties. First, it has a cross-categorial import, as it cuts across localisers and spatial nouns (e.g. *zai zhuozi qian shi mi* 'ten metres in front of the desk'). Second, "goal" path prepositions (e.g. *dao* 'to') favour rather than block the presence of MPs (e.g. *dao zhuozi qian-mian shi mi* 'to ten metres in front of the desk'). We propose an account based on a variant of Lexical Syntax in which pre- and post-positional items jointly contribute features licensing MPs, and discuss its import for a general theory of adpositions.

Keywords: adposition, measure phrase, Mandarin.

1. INTRODUCTION

Spatial case morphemes and adpositions have received renewed attention in recent decades (Cinque and Rizzi 2010; Hagége 2010). Works on the morpho-syntactic properties of prepositions in English abound (e.g. Jackendoff 1983, 1990; Svenonius 2010). Semantic taxonomies stemming from this wealth of research have also been proposed (e.g. Zwarts and Winter 2000; Aurnague 2004). Although details vary across proposals, certain semantic types are taken to be central, as we show via (1)–(6):

(1) *Mario is at the desk.*
(2) *Mario goes to the desk.*

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(3) *The car is behind the truck.*
(4) *The car is at the back of the truck.*
(5) *The pigeon flies ten metres above the cloud.*
(6) *#The pigeon flies ten metres on top of the cloud.*

Let us establish some key notions before fully tackling this topic. Prepositions denote a spatial relation between a landmark object or "ground" (e.g. the desk in (1)–(2)) and a located entity or "figure*"* (e.g. Mario in (1)–(2)). The NP referring to the ground is often called ground NP; the one referring to the figure, figure NP (Talmy 2000: Ch. 1). Prepositions form a "Preposition Phrase" (PP) with the ground NP. A PP usually becomes the complement of a verb expressing motion or location. The resulting sentence is a "Basic Locative Construction", a minimal sentence that describes a figure's location (BLC: Ameka and Levinson 2007).

Early works distinguished between "locative" and "directional" senses, respectively denoting a stable and a changing location for the figure (respectively *at* and *to* in (1)–(2); Jackendoff 1983, 1990). Locative senses can be sub-classified into "non-projective" and "projective" types. The first type includes prepositions only denoting a geometric relation (e.g. *at* in (1); Aurnague 2004). The second type includes prepositions denoting relations along an axis or "projection" (e.g. *behind*, *above* in (3), (5): Cresswell 1978; Zwarts and Winter 2000).

In Svenonius (2010), a different taxonomy is proposed. Prepositions resisting distribution with *Measure Phrases* (MPs, e.g. *ten metres* in (5)–(6)) are labelled *bounded* prepositions. They include two distinct sub-types. One is the established geometric sub-type, which also includes particle-like elements (e.g. *out*). The other is a cluster of morphologically complex prepositions denoting undirected, convex or "bounded" regions (e.g. *at the back of*, *on top of* in (4), (6)). The other two types are labelled "place" and "extended path", and mostly correspond to the projective type of previous works. For simplicity, we use the label "projective" for prepositions having these senses. Thus, while projective *above* can be distributed with MPs (cf. (5)), bounded *on top of* cannot do so, lest a sentence be uninterpretable (cf. (6), marked via the symbol "#"). Hence, the distribution of MPs with prepositions can identify at least two semantic (macro-)types: bounded and projective types. However, this distribution is poorly documented beyond English and other Germanic languages (cf. Real Puigdollers 2013: Ch. 3).

The goal of this paper is to explore whether and how this semantic distinction can be applied to Mandarin adpositions. In doing so, we also explore how this taxonomy can be connected to the morpho-syntactic structure of this category. We choose Mandarin because the language includes localisers and prepositions apparently forming discontinuous constituents, and MPs occur as sentence-final adjuncts. Therefore, the question is raised of which categories determine this distribution, at what "position" in the clausal spine they do so, and what mechanisms regulate their (un)interpretability. We illustrate these problems via (7)–(8):

(7) *Beijing zai Guangzhou bei-mian liang qian gong-li.*
Beijing be-at Guangzhou North-face two thousand kilometre
'Beijing is at two thousand kilometres North of Guangzhou'
(8) *#Beijing zai Guangzhou jin-tou liang qian gong-li.*
Beijing be-at Guangzhou end-head two thousand kilometre
'Beijing is at two thousand kilometres to the end of Guangzhou'

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In (7), the preposition *zai* can act as a co-verb, i.e. a preposition also covering the role of a copula, and can thus introduce the ground, the city of Guangzhou. The MP *liang qian gong-li* 'two thousand kilometres' denotes a distance, and the localiser *bei-mian* (literally, 'north-face') specifies that the 'North' direction/projection is being measured. If a sentence includes this MP and the spatial noun *jin-tou* lit. 'end-head', it becomes uninterpretable. Thus, (7) and (8) show that Mandarin BLCs and adpositional phrases display different structural properties from their English counterparts. They involve prepositions (e.g. *zai*) and morphologically complex items occurring after the ground NP (e.g. *bei-mian*, *jin-tou*). It also shows that the distribution of Mandarin adpositions with MPs involves language-specific, novel, and therefore still unanalysed data. To reach our goal, we organize our paper as follows. Section 2 and 3 present previous accounts and the novel data. Section 4 offers an account couched in Lexical Syntax (Hale and Keyser 2002) and a discussion; Section 5 concludes.

2. PREVIOUS ACCOUNTS

In the literature on Mandarin, prepositions are generally analysed as (functional) heads introducing an argument. They cannot act as full lexical verbs, hence resisting direct combination with aspect markers (Chao 1968; Li and Thompson 1974, 1981: 381–387; Peyraube 1980; Lü 2006; Djamouri et al. 2013: 41; Huang et al. 2017: 216–219; Zhang 2017). This category includes a rich inventory of items (66, in Huang et al. 2017). A non-exhaustive list of commonly attested prepositions is in (9) (cf. Djamouri et al. 2013; Zhang 2017):

(9) **Prepositions**={*zai* 'at', *dao* 'to', *cong* 'from', *dui* 'in the opposite direction of', *li* 'away', *wang* 'in the direction of', *xiang* 'in the direction of'}

Some works argue that prepositions also distinguish themselves as not occurring in so-called "V-not-V" constructions (i.e. yes-no questions), unlike other co-verbs (Yin 2003; Huang 2009; Basciano 2010; Zhang 2017). However, exceptions to this rule are (at least) *dao, zai, xiang* and *wang*, a fact suggesting that this property is not crucial for identifying this category.

Localisers (*fangweici* in the Mandarin literature) form a slightly broader set. Most works define them as parts of speech that allow reference to specific locations, usually attaching to an NP denoting a ground (Chao 1968: 626; Chappell and Peyraube 2008: 5; Djamouri et al. 2013: 72). As in the case of prepositions, their inventory is quite rich (more than 80 items in Huang et al. 2017, Appendix VII), but most works consider the monosyllabic items in (10) the most common or representative (Djamouri et al. 2013: 72; Zhang 2017: 700). Most localisers seem to be polysemous, although in (10) we only list what are the mostly commonly acknowledged senses (cf. Huang et al. 2017: 217):

(10) ***Localisers***:={*li* 'in', *wai* 'out', *shang* 'on, above', *xia* 'down, below', *qian* 'front', *hou* 'back, behind', *zuo* 'left', *you* 'right', *pang* 'aside', *bei* 'North', *xi* 'West', *dong* 'East', *nan* 'South', *zhong* 'middle',…}

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Localisers are often treated as categorially ambiguous items. They can occur as nominal elements referring to parts of objects and their corresponding locations (e.g. *shan shang* 'the top of the mountain': Hagège 2010: 108–110; Djamouri et al. 2013: 69–72). Bi-syllabic localisers combining monosyllabic items abound, and often capture distinct senses from their constituting items (e.g. *shang-xia* 'around', lit. 'up-down'). Localisers' senses seem to mostly refer to axes/projections of a ground (e.g. *qian* 'front'), or to parts thereof (e.g. *zhong* 'middle'). *Li* 'in', *wai* 'out', *shang* 'on, above' and *xia* 'down, below' seem closer to having geometrical senses. At first glance, prepositions seem to capture the directional/locative alternation. Instead, localisers specify the relation at stake, i.e. whether it involves projective or bounded senses (cf. Sun 2006, 2008; Lin 2013).

The morpho-syntactic status of localisers has been debated at length. In the non-generative Tai (1973), localisers are analysed as postpositions: heads following the ground NP and forming with it the complement of a preposition (cf. (11)). Further proposals offer minimal variations of this account (Hagège 1975; Ernst 1988; Li 1990; McCawley 1989, 1992; Liu 2003, 2008). Instead, generative accounts vary considerably in their proposals. Some works have suggested that localisers can be specifiers to PPs (cf. (12): Troike and Pan 1994; Lin 2013). Others, that localisers are elements of the "place noun" sub-class, thereby acting as clitics. They therefore attach to PPs (i.e. they are phrasal affixes), since they have neutral tone and can only be omitted in the presence of a toponym (cf. (13): Liu 1994, 1998; Huang et al. 2017).

Djamouri et al. (2013) suggest that prepositions and localisers form a single phrase with respect to extraposition operations (e.g. fronting, clefting, relativisation: cf. also Huang 1982: Ch. 4). They thus treat localisers as postpositions projecting a "Place" head, with prepositions projecting a "Path" head (cf. (14)). The cartographic account in Wu (2015) suggests that localisers realize the "AxPart" category and prepositions the "Place" category, with the ground DP moving to the specifier position of AxPart. Both are taken to be adpositional categories, so this work considers localisers as an adpositional, rather than nominal category (cf. (15)):

(11) $[_{PP}\ [_{P}$ zai $[_{PostP}[_{NP}$ zhuozi] $\text{qian}_{Post}\ ]]]]$
(12) $[_{PP}\ [_{P'}$ zai $[_{NP}$ zhuozi]] $[_{PostP}$ qian]]
(13) $[_{PP}$ zai $[_{LocP}[_{NP}$ zhuozi] $\text{qian}_{Loc}\ ]]$
(14) $[_{PathP}$ zai $[_{PlaceP}\ [_{NP}$ chezi] qian]]
(15) $[_{PlaceP}$ zai $[_{AxPartP}[_{DP}$ chezi] [qian $[_{DP}\ t_i]]]]$

A proposal introducing language-specific labels is found in Zhang (2002). This work follows the classic bi-partite analysis of English adpositions (e.g. Jackendoff 1983, 1990; Wunderlich 1991). Differently from Djamouri et al. (2013), it proposes distinct labels for the items making up a Mandarin PPs. Prepositions project a "Location Relation" (LR) head; localisers, a "Place Value" (PV) head. The ground NP (a "Region Entity" RE phrase) starts as a complement of the PV head, and then moves to the specifier position of the LR item, thereby leaving a trace (cf. (16)). These works also observe that localisers become optional when a toponym (e.g. *Bejing*) is present. Thus, they propose that toponyms move to a PV head, hence leaving an empty specifier (cf. (17)):

(16) $[_{LR}$ zai $[_{PVP}\ [_{RE}$ chezi $]_i$ shang [t_i]]]
(17) $[_{LR}$ zai $[_{PVP}\ [_{RE}$ e] Beijing_i [t_i]]

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Huang (2009) and Huang et al. (2009: Ch. 1–2) also defend a similar analysis. However, they propose that localisers project a distinct "L" head (for "Localiser"). L is thus treated as a nominal category and localisers as defective or "deviate" nouns (Huang et al. 2009: 16). Zhang (2017) also suggests to treat localisers as nominal-like categories, given their inability to receive stress and their (restricted) optionality (cf. also Liu 1998; Lin 2013; Huang et al. 2017). It thus proposes that ground NPs and localisers form a nominal compound (e.g. *jia-li* lit. 'house-in'). Overall, these works outline that localisers follow ground NPs and form a unit with prepositions. They also display morpho-syntactic properties that reveal their inherently nominal nature, e.g. their ability to act as affixes to ground NPs.

This picture is further complicated once we take in consideration "spatial nouns", nouns that can refer to locations and/or parts of grounds (Peyraube 1980; Levinson 1994). *Qua* nouns, they are usually left aside in formally oriented works on (Mandarin) adpositions (Djamouri et al. 2013: 72–73). Typologically oriented works, however, consider localisers and spatial nouns distinct members of a "place words" super-category (Li 1985, 1990; Peyraube 2003; Sun 2006, 2008; Chappell and Peyraube 2008; Xu 2008a; Huang et al. 2017). Five well-established elements guiding the derivation of spatial nouns are: *tou* 'head', *mian* 'face', *bian* 'edge', *fang* 'direction' and *bu* 'part'.[5] These are nouns re-interpreted as suffixes in (compound) spatial nouns (e.g. we have *qian-mian* 'front-face'). When occurring as suffixes, they receive falling and low tone (Liu 1998; Peyraube 1994, 2003). The resulting compounds *qua* spatial nouns have a relational status (e.g. *li-mian* 'inside, interior'; Huang et al. 2017: 219). They can also occur in nominal contexts, for instance in subject position (e.g. *li-mian you yi-zhi mao* 'there is a cat inside': Zhang 2017: (10a)). Crucial to our discussion is the fact that spatial nouns can occur within prepositional phrases, licensing their distribution with MPs. Therefore, they offer pivotal evidence regarding semantic types of adpositions in Mandarin, as we show in the next section.

3. THE DATA

We begin by discussing syntactic evidence showing that spatial nouns are a part of Mandarin PPs, since this evidence is seldom, if ever discussed in the literature. We propose three tests: occurrence in BLCs, *where*-questions and answers pairs, locative inversion. Our examples mostly feature *zai*, but their validity extends to all the other prepositions listed in (9). Other tests have been discussed in the literature to verify the status of adpositions (e.g. the occurrence of PPs in *ba*- and *bei*-constructions/structures: Zhang 2017). Here we concentrate on three of the more immediate but also reliable tests (Sun 2006: 420–431; Ursini & Long 2018), as the bulk of our discussion is on MPs and their distribution.

In Mandarin, BLCs include a verb possibly describing the posture (e.g. *zuo* 'sit'), or manner/type of movement that a figure performs). Most examples in the literature can be

[5] A sixth item that carries similar functions is *-chu*, which as a distinct noun denotes a generic 'place' (Huang et al. 2017: 196). However, a peculiarity of this suffix is that it seems to be attached to the whole PP. We have e.g. *Zhangsan zai shandong li yi mi chu*, 'Zhangsan is at a place one metre in the cave', with *chu* seemingly modifying the whole PP *zai shandong li yi mi*. We must leave aside this set of data, both for reasons of space and because these data involve a rather different structure.

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considered (types of) BLCs. However, they seldom offer evidence on whether their PPs can also include spatial nouns. We show that this is the case via (18)–(21):

(18)	*Beijing*	*zai*	*Xianggang*	*(de)*	*bei-mian.*
	Beijing	be.at	Hong Kong	(DE)	North-face
	'Beijing is North of Hong Kong'				
(19)	**Beijing*	*zai*	*Xianggang*	*de*	*bei* ∅.
	Beijing	be.at	Hong Kong	DE	North-∅
	'Beijing is North of Hong Kong'				
(20)	*Zhangsan*	*zai*	*zhuozi*	*(de)*	*qian-mian.*
	Zhangsan	be.at	desk	(DE)	front-face
	'Zhangsan is in front of the desk'				
(21)	*Zhangsan*	*zai*	*fangzi*	*(de)*	*qian-fang.*
	Zhangsan	be.at	house	(DE)	front-direction
	'Zhangsan is in (the) front of the house'				

Two important conclusions can be offered, based on these examples. First, spatial nouns can be introduced via *de* as a mediating element, although speakers generally consider this head optional (cf. (18)). Second, *de* cannot be distributed with "bare" localisers, lest a sentence be ungrammatical (cf. *bei* in (19)). When these conditions are met, most suffixes can combine with most localisers, although certain sense differences arise. For instance, *qian-mian* can be best understood as referring to the front 'face' of a desk (cf. (20)); *qian-fang*, to the front 'direction' of the house (cf. (21)). Overall, BLCs offer preliminary evidence of the role of spatial nouns and localisers in the emergence of region and projective sense types.

The second piece of evidence comes from fragment answers to *where*-questions (*nali*-questions in Mandarin). A well-known fact is that only spatial PPs can be answers to this type of questions, thus forming a congruent (i.e. semantically matching) question-answer pair (Jackendoff 1972; Merchant 2001: Ch. 2; Sun 2006: 428–430; Ward and Birner 2012). Crucially, either spatial nouns or localisers can be part of fragment answers, which usually feature a preposition as their head, viz. (22)–(23):

(22)	Q: *Zhangsan*	*zai*	*nali?*	A: *Zai*	*chezi*		*hou-mian.*
	Zhangsan	be.at	where?	At	car		back-face
	'Where is Zhangsan? Behind the car'						
(23)	Q: *Zhangsan*	*zai*	*nali?*	A: *Zai*	*chezi*	*de*	*hou-bian/*hou.*
	Zhangsan	be.at	where?	At	car	DE	back-side/back
	'Where is Zhangsan? Behind the car'						

The presence of *zai* in the answer is optional across registers and dialects (Sun 2006; Xu 2008b). When present, it establishes a congruence relation between question and answer: the pair involves "spatial" categories (cf. (22)). The presence of *de* with spatial nouns is generally preferred also in these structures (cf. (23)). The type of spatial noun that can occur in answers can involve any suffix, so that an answer can refer to a projection/axis along which the figure is located (e.g. *hou-mian* 'back-face' in (22)), or a specific location (e.g. *hou-bian* 'back-side/behind' in (23)). Thus, spatial nouns can occur in *nali*-questions, i.e. *where*-questions in Chinese, like localisers.

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The third piece of evidence comes from locative inversion. This structure involves the fronting of phrases usually but not necessarily describing the location of a figure (den Dikken 2006: Ch. 4) and appears an understudied pattern in Mandarin (cf. Djamouri et al. 2013; Ursini & Long 2018). Unsurprisingly, inverted/fronted PPs can include spatial nouns and localisers, viz. (24)–(25):

(24) *Zai chezi wai, Zhangsan chou le yi zhi yan.*
at car out Zhangsan smoke PF one CL cigarette
'Out of the car, Zhangsan has smoked a cigarette'

(25) *Zai chezi hou-bian/hou-fang, Zhangsan chou le yi zhi yan.*
at car back-side/back-direction Zhangsan smoke PF one CL cigarette
'Behind the car, Zhangsan has smoked a cigarette'

As (24)–(25) show, locative inversion offers further evidence that spatial nouns and localisers, although morphologically distinct but related categories, are nevertheless core constituents of Mandarin PPs. At least two predictions thus arise, when one takes in consideration their possible interaction with MPs. First, if spatial nouns and localisers alike can be part of PPs, then they can directly determine the distribution of MPs within BLCs. A second, more specific prediction is as follows. If Svenonius (2010)'s account of goal path prepositions extends to Mandarin, then *dao* and other 'goal' prepositions would prevent the presence of MPs. More in general, prepositions and localisers can jointly determine whether MPs are licensed in a BLC or not.

We tested this prediction as follows. We designed an elicitation task in which participants (N = 31) had to evaluate BLCs including MPs. We tested examples including each localiser, and spatial nouns including each of the attested suffixes. We then tested minimal pairs either featuring *zai* or *dao* as the key prepositions (or, more accurately, co-verbs). The results of this task paint a nuanced picture: three results play a key role.

First, participants generally accepted sentences including spatial nouns as perfectly interpretable (i.e. 4;0 or higher scores). The presence of MPs, however, triggered nuanced interpretive effects. The localisers *li*, *xia*, *shang*, *pang*, *zhong* were problematic with MPs (i.e. scores were close to 2;0). The other localisers were considered acceptable, although they involved a certain processing load (i.e. results were between 3;0 and 4;0). Participants generally commented that non-acceptable localisers describe specific, delimited locations, which are either part of a ground, or at a fixed, non-measurable, distance from it. We include uninterpretable examples in (26)–(27), and an interpretable example in (28):

(26) *#Zhangsan zai shandong li yi mi.*
Zhangsan be-at cave in one metre
'Zhangsan is one metre in the cave'

(27) *#Baozang mai zai zhuozi xia-fang yi mi.*
treasure bury at desk down-direction one metre
'The treasure is buried one metre underneath the desk'

(28) *Zhangsan zai fangzi wai yi mi.*
Zhangsan be-at house out one metre
'Zhangsan is one metre outside the room'

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Second, participants observed that examples involving certain spatial nouns and corresponding suffixes were generally preferred when MPs were involved. Furthermore, the presence of optional *de* did not affect judgments in a significant manner. For instance, spatial nouns referring to a ground's intrinsic sides and axes and including *-mian* and *-bian*, as suffixes (e.g. *qian-mian*, *hou-bian*) licensed acceptable responses (3;91, 3;78, 3;64, and 3;64 respectively: cf. (29)–(32)). Spatial nouns referring to polar coordinates elicited similarly acceptable responses (e.g. 3;75 for *bei-mian*, 3;79 for *nan-mian*: cf. (33)–(34)). Conversely, *-tou* mostly rendered the combination of spatial nouns with MPs highly problematic (i.e. scores were all around 2;0). Speakers observed that this suffix would force senses involving a location taken as an "edge" or "region" (e.g. front edge) of an object, and thus at a "null" distance from the ground (cf. (35)). The presence of suffix *-fang* instead elicited acceptable responses (e.g. 3;64 for *qian-fang*, cf. (36)):

(29) *Zhangsan zai che (de) qian-mian shi mi.*
Zhangsan be-at car (DE) front-face ten metre
'Zhangsan is ten metres in front of the car'

(30) *Xingli zai che (de) hou-mian shi mi.*
luggage be-at car (DE) back-face ten metre
'The luggage is ten metres behind the car'

(31) *Zhangsan zai zhuozi (de) zuo-bian shi mi.*
Zhangsan be-at desk (DE) left-side ten metre
'Zhangsan is ten metres to the left the desk'

(32) *Zhangsan zai zhuozi (de) you-bian shi mi.*
Zhangsan be-at desk (DE) right-side ten metre
'Zhangsan is ten metres to the right of the desk'

(33) *Beijing zai Guangzhou (de) bei-mian 2000 gong-li.*
Beijing be-at Guangzhou (DE) North-face 2000 kilometre
'Beijing is 2000 kilometres North of Guangzhou'

(34) *Shanghai zai Beijing (de) nan-mian 1000 gong-li.*
Shanghai be-at Beijing (DE) South-face 1000 kilometre
'Shanghai is 1000 kilometres South of Bejing'

(35) *#Haibao zai zhuozi (de) shang-tou yi mi.*
poster be-at desk (DE) up-head one metre
'The poster is one metre above the desk'

(36) *Zhangsan zai che (de) qian-fang shi mi.*
Zhangsan be-at car (DE) front-direction ten metre
'Zhangsan is ten metres in front of the car'

Third, the presence of *dao* favoured the licensing of MPs with localisers and spatial nouns across the board (i.e. values ranged 3;49 to 4;19). Participants considered *dao* as highlighting that a figure moved for a certain distance, reaching a location that a localiser/spatial noun would specify. This pattern was attested even when the localiser or spatial noun would not be compatible with an MP (e.g. *xia-tou* in (39)). An MP, when present, would specify the distance that the figure covered, as (37)–(40) show:

(37) *Zhangsan dao le shandong li-mian shi mi.*
Zhangsan go-to PF cave in-face ten metre
'Zhangsan has gone ten metres inside the cave'

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(38)	*Zhangsan dao*	*le*	*che*	*(de)*	*qian-mian*	*shi*	*mi.*
	Zhangsan go-to	PF	car	(DE)	front-face	ten	metre
	'Zhangsan has gone ten metres in front of the car'						
(39)	*#Zhangsan*	*dao*	*le*	*zhuozi*	*(de) xia-tou*	*yi*	*mi.*
	Zhangsan	go-to	PF	desk	(DE) down-head	one	metre
	'Zhangsan has gone one metre below the desk'						
(40)	*Zhangsan*	*dao*	*le*	*che*	*hou-mian*	*shi*	*mi.*
	Zhangsan	go-to	PF	car	back-face	ten	metre
	'Zhangsan has gone ten metres behind the car'						

We draw three conclusions from these data. First, spatial nouns are more strongly related to MPs than localisers are, and certain spatial nouns select sub-types of projective senses (i.e. *-mian*/*-bian* for intrinsic sides; *-bu* for polar coordinates). Both categories can occur in BLCs including MPs, although this is possible when MP and spatial noun/localiser "match" in sense type. Therefore, for both categories the distinction between projective and bounded types seems to be reflected in their distribution with MPs. Interestingly, speakers generally observed that "computing" a distance with respect to a direction, face or side required an evaluation of which exact direction was at stake. Thus, speakers displayed a reticence to offer "flawless" scores (i.e. 5;0). When *dao* was present, this task was considered easier, if not unproblematic, hence the generally near-optimal (i.e. >4;0) scores.

Second, the emergence of these senses seems not tightly connected to a given category or "position", as the data involving *dao* show. However, a mechanism that projects the properties of these parts of PPs at a sentential level seems clearly at work. Once MPs are added to a sentence, prepositions and localisers alike can match an MP's contribution. This is not possible only when certain localisers are attested in the presence of locative, non-directional, *zai*.[6] We thus have reached our first goal: a thorough overview of the data pertaining to the combination of MPs with Mandarin adpositions and spatial nouns. The next section, then, offers a formal account of these "incremental" principles.

4. THE ACCOUNT

Our account of the morpho-syntactic properties of Mandarin offers a variant the "P within P" hypothesis proposed within Lexical Syntax (Hale and Keyser 2002: Ch. 4; Mateu 2002; Ursini and Long 2018). We choose this approach for two reasons. First, it permits us to remain non-committal regarding claims about the nature of categories, i.e. whether localisers project postpositional, AxPart or nominal heads. Second, it nevertheless permits us to show how these categories form PPs and contribute features that license (or block) the presence of MPs. The key assumptions that play a role in our account are as follows.

[6] We tested 15 localisers × 5 suffixes × 2 prepositions, although several paradigms were incomplete. In some cases, the subtle lexical content of localisers and suffixes created very restricted conditions for MP licensing. For instance, *bei-fang* can be only used to describe a figure being located or moving along a "northern direction" of a ground. Conversely, *qian-bu* refers to the "external" part of the car. This is consistent with the fact that both language-internal (i.e. semantic) and language-external (i.e. pragmatic) factors play a key role in spatial categories' interpretation in context (cf. Zwarts and Winter 2000).

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First, language-specific categories (i.e. prepositions as co-verbs; localisers; spatial nouns) can project one of four language-general head types. An item can instantiate a 0-place, 1-place, or 2-place head type, depending on how many arguments they combine or "merge" with. A 0-place head represents a "bare" argument (i.e. a phrase). A 1-place head represents an affix or a marker (e.g. a clitic). A 2-place head type represents a "relational" head merging with a specifier and a complement. The framework proposes another type of 2-place head. However, we can ignore this distinction without loss of precision in our analysis (cf. Mateu and Amadas 2001; Hale and Keyser 2002: 13–14).

Second, prepositions project 2-place heads, which take ground NPs as their complement and possibly another prepositional phrase as their internal PP argument (a *specifier*, in generative terms). Third, each projected category can be further enriched with its assigned morphological features. We capture this latter aspect by using a formal treatment of features (Adger 2010, 2013; Sag et al. 2012). Thus, each head H is represented as projecting a category (e.g. P, V, D, N). The features associated to this category (e.g. *tense* for verbs) can also have values (e.g. *tense:past*). Categories and valued features are represented as ordered sequences of sub-scripts, e.g. $H_{<P,feature>}$. We will be partially imprecise by omitting features for constituents other than prepositions, localisers, and spatial nouns, to render our account more compact.

Let us now turn to an analysis of the relevant features. Models and hierarchies of features have become a standard tool of analysis in minimalist and non-minimalist, formal accounts (respectively Adger 2010, 2013; Sag et al. 2012). Both frameworks assume that phrasal feature structures can be computed via "feature unification", i.e. (set-)unification of the feature structures underpinning head and arguments, an idea originating in Shrieber (1986). This mechanism also doubles as a "feature percolation mechanism", and can determine whether the arguments of phrase can partake in (feature-)matching principles. We show why this is the case as we proceed in the discussion.

We start by proposing that MPs represent a category in which the classifier nouns (e.g. *mi* 'metre') carry (at least) two features, which can come into positive and negative values. One is a *m(easure)* feature, the other is a *d(irection)* feature. The first feature is usually used in accounts of mensural classifiers (cf. Li 2011; Li and Rothstein 2012). We believe that *mi* and related items can be treated as mensural classifiers, since they denote the "measures" by which distances are measured. The second feature, *d*, has been proposed to account the content of directional prepositions since Jackendoff (1983), and may be associated to the "Dir" head in Cartography accounts (cf. Svenonius 2010). The pre-theoretical intuition is that MPs denote distances associated to paths/directions, and can merge in sentences when prepositions carrying these features are also present (cf. Zhang 2013 for a similar proposal).

Let us move to localisers and spatial nouns. We assume that localisers include a *+m* feature: they always introduce a location whose distance from the ground can be measured, whence the positive value. Suffixes forming spatial nouns establish that a (specific) direction is under discussion. Thus, they carry a *+d* feature when a specific "face", "side", "direction" or "part" is to be measured (e.g. *-mian*, *-bian, -fang,* and *-bu*). In the case of *-tou*, a *–d* feature is instead added: that is, spatial nouns suffixed via *-tou* denote "heads" or "edges" of a ground rather than directions. We make all these assumptions formally precise via (41)–(42):

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(41) [$_{<MP,+m,+d>}$[$_{<NumP>}$ yi] mi$_{<M,+m,+d>}$]
(42) a. [$_{<LocP,+m>}$[$_{<NP>}$ shandong] li$_{<Loc,+m>}$]
b. [$_{<LocP,+m,+d>}$[$_{<NP>}$ shandong] qian$_{<Loc,+m,+d>}$]
c. [$_{<LocP,+m+d>}$[$_{<NP>}$ zhuozi] [de$_{<Loc>}$ [$_{<LocP,+m,+d>}$[$_{<LocP,+m>}$ you]-mian$_{<Loc,+d>}$]]]
d. [$_{<LocP,+m–d>}$[$_{<NP>}$ zhuozi] [de$_{<Loc>}$ [$_{<LocP,+m,–d >}$[$_{<LocP,+m>}$ shang]-tou$_{<Loc,–d >}$]]]

In (41), the Num(ber)P(hrase) *yi* 'one' acts as an argument to the measure noun *mi* 'metre' (Li and Rothstein 2012; Zhang 2013). Thus, the resulting phrase is an MP that carries *+d*, *+m* features, i.e. a phrase denoting a *d*egree (scale) of a measurable length. In (42a), ground NP *shandong* and localiser *li* form a LocP in which *li* acts as a suffix-like element (cf. again Zhang 2017). We assume that *li* only carries a *+m* feature, and omit an empty feature for *d* (i.e.∅) for mere reasons of space. This localiser only specifies that a figure occupies an "internal" location, and only its spatial noun counterparts (e.g. *li-mian*) can merge with MPs, for they add a *+d* feature. Similarly, *qian* in (42b) can contribute a *+d* feature, since unlike *li* it can merge with an MP (cf. (26) vs. (29)). Via this simple assumption, we can capture how some localisers can block the latter merge of MPs, whereas other localisers license their merge.

In (42b–c), instead, we have *de* acting as a distinct (2-place) head, which we also label "Loc". Although *de* has a broad distribution across Mandarin (cf. Zhang 2012, 2013: Ch. 3), in the structures it acts as an element "connecting" phrases denoting localisers. Our label choice thus reflects this specific pattern. This head can take another LocP and the ground NP as its arguments. In this case, the "internal" LocP is a spatial noun: *you-mian* in (42c), *shang-tou* in (42d). This spatial noun can introduce a *±d* feature via a suffix (*+d* for *-mian*, *-bian*; *-bu*; *-d* for *-tou*). We can thus account the fact that spatial nouns can generally merge with MPs except for the *-tou* series, irrespective of the localiser acting as a base. We also show that spatial nouns can be treated as a form of "recursive" localisers, which can then be merge with *de*, the 2-place version of this specific category.

Once we have an account of LocPs and MPs, we can move to PPs. For this purpose, we assume that the presence of *dao* invariably coincides with the merge of a *+d* feature: *dao* specifies that a figure moves in a certain direction, and a localiser/spatial nouns selects the relevant direction. To maintain our structures compact, we only represent features and phrases for PPs and MPs in (43)–(47):

(43) [$_{<RP,[+m, –m]=#>}$[$_{<PP,+m>}$[$_{NP}$Zhangsan] [zai$_{<P>}$[$_{<LocP,+m>}$ shandong li] R[$_{<MP,+m,+d>}$ yi mi]]]
(44) [$_{<RP,+m,+d>}$[$_{<PP,+m,+d>}$[$_{NP}$Zhangsan] [zai$_{<P>}$[$_{<LocP,+m,+d>}$ zhuozi you-bian] R[$_{<MP,+m,+d>}$ shi mi]]]
(45) [$_{<RP,+m,+d>}$[$_{<PP,+m,+d>}$[$_{NP}$G.] [zai$_{<P>}$[$_{<LocP,+m,+d>}$ Beij. de dong-bu] R[$_{<MP,+m,+d>}$ 1000 gong-li]]]
(46) [$_{<RP,+m,+d>=#}$[$_{<PP,+m,+d>}$[$_{NP}$ H.] [zai$_{<P>}$[$_{<LocP,+m,+d>}$ zhuozi de shang-tou] R[$_{<MP,+m,+d>}$ yi li mi]]]
(47) [$_{<RP,+m,+d>=#}$[$_{<PP,+m,+d>}$[$_{NP}$ Z.] [dao le$_{<P>}$[$_{<LocP,+m,+d>}$ shandong-li] R[$_{<MP,+m,+d>}$ yi mi]]]

In the structures in (43)–(47) we assume that a preposition as a co-verb licenses the formation of a PP that acts as the maximal projection for a sentence. Furthermore, we assume that *zai* does not carry *d* features, for it simply captures a spatial relation. We trade precision for simplicity, as we leave open whether other functional categories (e.g. I, C) can be present in Mandarin clauses. We then assume that an "R" (for "relator") head mediates between PP and MP (cf. den Dikken 2006). We leave open the possibility that this corresponds to the Deg head of Cartography approaches (e.g. Svenonius 2010; den Dikken

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2010). In each structure, the head R does not contribute features, but forces feature matching between its arguments, hence acting as an "identity" marker (cf. Kracht 2002 for a similar proposal). At a morphological level, this entails that the features of its arguments are unified directly, and must thus match in value. The consequences can be defined as follows.

When an MP carrying *+m*, *+d* features merge with a PP carrying *–m*, *–d* features, a sentence becomes uninterpretable. Feature-matching fails, because no specific value for a given feature is percolated at a sentential (i.e. RP) level (e.g. we have $(+d \cup -d) = \{-d, +d\} \neq +d$: Shrieber 1986: 27; Adger 2010: 430). This occurs when a sentence includes a LocP including a localiser such as *li*, which carries a *–d* feature (cf. (42a), (43)). Spatial nouns *you-bian* and *dong-bu* in (44)–(45) instead contribute a *+d* feature, which must however percolate at an RP level to be accessible. Spatial noun *shang-tou* also involves a mismatch, since *-tou* licenses reference to edges, and thus carries a *–d* feature too (cf. (46)).

When *dao* is present, the *+d* feature is merged at a higher level in the clause, and the contribution of localisers/spatial appears "transparent" (cf. *li* in (47)). We conjecture that the difference in evaluation is related to these structural differences. With *zai*, the *d* features of localisers and spatial nouns (i.e. LocPs) must percolate at a sentential level for the merge of MPs to be successful. With *dao*, this feature is already present at a PP level, thereby rendering percolation not necessary. In other words, *dao* "locally" establishes that an MP denotes the distance and direction of a figure with respect to the ground. This analysis is consistent with speakers' intuitions that this preposition always establishes a (measurable) direction, even if defined via a restricted type of location (e.g. a "side") as a reference[7].

Once we have an account of prepositional phrases, we indirectly have an account of their role as answers to *nali*-questions. These questions require a phrase carrying spatial features (i.e. being a spatial PP), and the *d* feature may double for such a role. Thus, spatial nouns and localisers can equally appear in answers, since they both carry this feature. Locative inversion data follow a similar tack, as inverted PPs nevertheless carry this feature. A formal account of these patterns is certainly possible (cf. Ursini & Long 2018). Here we must leave it aside, however, for mere reasons of space. Overall, we believe that our account allows us to propose three key results.

First, Svenonius (2010)'s distinction between bounded and projective prepositions seems mostly attested in Mandarin, although it centres on "post-" elements: localisers and spatial nouns. Some localisers and the *-tou* spatial nouns series cannot merge with MPs. By denoting bounded locations (e.g. edges for *-tou* nouns, internal locations for *li*) these items render problematic to measure distances. Second, while *zai* seems "neutral" to the bounded/projective alternation, *dao* clearly introduces features that point at its projective status. This fact suggests that Mandarin may lack goal prepositions *qua* a bounded sub-type, thus introducing an interesting asymmetry between English and Mandarin.

Third, localisers and spatial nouns contribute a *m(easure)* feature to PPs, thereby determining their ability to merge with MPs. This fact holds insofar as the presence of *zai* and possibly other prepositions triggers feature percolation. This is not surprising if we conceive these categories as inherently nominal, although carrying spatial senses and features. Case in point, the nominal domain is generally considered the locus of categories

[7] Note here that via feature percolation, the merge of *dao* with spatial nouns/localisers carrying *+d* or empty features "confirms" the possibility to merge with MPs (i.e. $+d \cup +d = +d$, via idempotence, and $\varnothing \cup +d = +d$ via absorption: Shrieber 1986: 28).

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of measurement and classification in Mandarin (cf. Li 2011; Huang et al. 2017: 228–234). In these cases, spatial adpositions seem to require the intervention of nominal elements, for spatial measurements to occur. Our account is thus consistent with those accounts that model localisers and localiser phrases as inherently nominal elements (e.g. clitics: Huang et al. 2017; Zhang 2017). Conversely, it shows that a postpositional analysis may be problematic (e.g. Djamouri et al. 2013), unless one assumes the existence of "intermediate" categories (e.g. AxPart in Wu 2015).

We do not further explore the theoretical consequences of these results for mere reasons of space. Nevertheless, our account has overall shown that the contribution of localisers and spatial nouns converges at a sentential level, once a full PP has been merged and can thus be matched with an MP. Since we now have reached our second goal, we turn to the conclusions.

5. CONCLUSIONS

The goal of this paper has been to investigate whether Mandarin adpositions display the distinction between bounded and projective adpositions. We have shown that this distinction exists, since some but not all localisers and spatial nouns (cf. *li* vs. *hou* and *hou-mian*) when merging with spatial prepositions (e.g. *zai* vs. *dao*), can merge with MPs. At the same time, we have shown that this semantic distinction has a flexible relation with morphological structures. Type of preposition, localiser, and spatial noun interact via their features to determine the presence of MPs. For further data and a broader overview of these patterns, however, we defer to future research.

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